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## Suture anchor


### Abstract

A knotless suture anchor system is disclosed for improved anchoring in tissue. The knotless suture anchor system includes an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a distal opening communicating with the longitudinal passageway nearer the distal end. The knotless suture anchor system also includes an interference member insertable distally into the longitudinal passageway to secure a portion of a suture within the longitudinal passageway by compressing the portion of the suture between the interference member and the anchor body, and a frangible connection that joins a proximal member to the anchor body.



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us-provisional-application US 62458975 20170214
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## References Cited

**U.S. PATENT DOCUMENTS**

| Patent No. | Issued Date | Patentee Name | U.S. Cl. | CPC |
|---|---|---|---|---|
| 1583271 | 12/1925 | Biro | N/A | N/A |
| 1586721 | 12/1925 | Tryon | N/A | N/A |
| 1856721 | 12/1931 | Nagelmann | N/A | N/A |
| 2291413 | 12/1941 | Siebrandt | N/A | N/A |
| 4312337 | 12/1981 | Donohue | N/A | N/A |
| 4441497 | 12/1983 | Paudler | N/A | N/A |
| 4622960 | 12/1985 | Tam | N/A | N/A |
| 4672957 | 12/1986 | Hourahane | N/A | N/A |
| 4738255 | 12/1987 | Goble et al. | N/A | N/A |
| 4741330 | 12/1987 | Hayhurst | N/A | N/A |
| 4784126 | 12/1987 | Hourahane | N/A | N/A |
| 4809408 | 12/1988 | Abrahamson | N/A | N/A |
| 4890615 | 12/1989 | Caspari et al. | N/A | N/A |
| 4898156 | 12/1989 | Gatturna et al. | N/A | N/A |
| 4959069 | 12/1989 | Brennan et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 5037422 | 12/1990 | Hayhurst et al. | N/A | N/A |
| 5041129 | 12/1990 | Hayhurst et al. | N/A | N/A |
| 5100417 | 12/1991 | Cerier et al. | N/A | N/A |
| 5176682 | 12/1992 | Chow | N/A | N/A |
| 5224946 | 12/1992 | Hayhurst et al. | N/A | N/A |
| 5236445 | 12/1992 | Hayhurst et al. | N/A | N/A |
| 5250055 | 12/1992 | Moore et al. | N/A | N/A |
| 5254126 | 12/1992 | Filipi et al. | N/A | N/A |
| 5257996 | 12/1992 | McGuire | N/A | N/A |
| 5258016 | 12/1992 | Dipoto et al. | N/A | N/A |
| 5268001 | 12/1992 | Nicholson et al. | N/A | N/A |
| 5269809 | 12/1992 | Hayhurst et al. | N/A | N/A |
| 5312438 | 12/1993 | Johnson | N/A | N/A |
| 5330468 | 12/1993 | Burkhart | N/A | N/A |
| 5336240 | 12/1993 | Metzler et al. | N/A | N/A |
| 5342369 | 12/1993 | Harryman, II | N/A | N/A |
| 5350380 | 12/1993 | Goble et al. | N/A | N/A |
| 5354300 | 12/1993 | Goble et al. | N/A | N/A |
| 5411523 | 12/1994 | Goble | N/A | N/A |
| 5417691 | 12/1994 | Hayhurst | N/A | N/A |
| 5417701 | 12/1994 | Holmes | N/A | N/A |
| 5439467 | 12/1994 | Benderev et al. | N/A | N/A |
| 5454823 | 12/1994 | Richardson et al. | N/A | N/A |
| 5464427 | 12/1994 | Curtis et al. | N/A | N/A |
| 5466243 | 12/1994 | Schmieding et al. | N/A | N/A |
| 5480403 | 12/1995 | Lee et al. | N/A | N/A |
| 5486197 | 12/1995 | Le et al. | N/A | N/A |
| 5544664 | 12/1995 | Benderev et al. | N/A | N/A |
| 5545180 | 12/1995 | Le et al. | N/A | N/A |
| 5562683 | 12/1995 | Chan | N/A | N/A |
| 5562684 | 12/1995 | Kammerer | N/A | N/A |
| 5562687 | 12/1995 | Chan | N/A | N/A |
| 5569306 | 12/1995 | Thal | N/A | N/A |
| 5572770 | 12/1995 | Boden | N/A | N/A |
| 5575801 | 12/1995 | Habermeyer et al. | N/A | N/A |
| 5584836 | 12/1995 | Ballintyn et al. | N/A | N/A |
| 5584839 | 12/1995 | Gieringer | N/A | N/A |
| 5601557 | 12/1996 | Hayhurst | N/A | N/A |
| 5601562 | 12/1996 | Wolf et al. | N/A | N/A |
| 5620012 | 12/1996 | Benderev et al. | N/A | N/A |
| 5624446 | 12/1996 | Harryman, II | N/A | N/A |
| 5630824 | 12/1996 | Hart | N/A | N/A |
| 5637112 | 12/1996 | Moore et al. | N/A | N/A |
| 5643321 | 12/1996 | McDevitt | N/A | N/A |
| 5645568 | 12/1996 | Chervitz et al. | N/A | N/A |
| 5647874 | 12/1996 | Hayhurst | N/A | N/A |
| 5649963 | 12/1996 | McDevitt | N/A | N/A |
| 5658313 | 12/1996 | Thal | N/A | N/A |
| 5665112 | 12/1996 | Thal | N/A | N/A |
| 5681333 | 12/1996 | Burkhart et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 5683401 | 12/1996 | Schmieding et al. | N/A | N/A |
| 5683418 | 12/1996 | Luscombe et al. | N/A | N/A |
| 5683419 | 12/1996 | Thal | N/A | N/A |
| 5688284 | 12/1996 | Chervitz et al. | N/A | N/A |
| 5690676 | 12/1996 | Dipoto et al. | N/A | N/A |
| 5690677 | 12/1996 | Schmieding et al. | N/A | N/A |
| 5700266 | 12/1996 | Harryman, II | N/A | N/A |
| 5702397 | 12/1996 | Goble et al. | N/A | N/A |
| 5702398 | 12/1996 | Tarabishy | N/A | N/A |
| 5709708 | 12/1997 | Thal | N/A | N/A |
| 5720765 | 12/1997 | Thal | N/A | N/A |
| 5725529 | 12/1997 | Nicholson et al. | N/A | N/A |
| 5728136 | 12/1997 | Thal | N/A | N/A |
| 5730747 | 12/1997 | Ek et al. | N/A | N/A |
| 5733307 | 12/1997 | Dinsdale | N/A | N/A |
| 5746754 | 12/1997 | Chan | N/A | N/A |
| 5746763 | 12/1997 | Benderev et al. | N/A | N/A |
| 5749884 | 12/1997 | Benderev et al. | N/A | N/A |
| 5755728 | 12/1997 | Maki | N/A | N/A |
| 5766221 | 12/1997 | Benderev et al. | N/A | N/A |
| 5776151 | 12/1997 | Chan | N/A | N/A |
| 5782864 | 12/1997 | Lizardi | N/A | N/A |
| 5797963 | 12/1997 | McDevitt | N/A | N/A |
| 5800447 | 12/1997 | Wenstrom, Jr. | N/A | N/A |
| 5814071 | 12/1997 | McDevitt et al. | N/A | N/A |
| 5824009 | 12/1997 | Fukuda et al. | N/A | N/A |
| RE36020 | 12/1997 | Moore et al. | N/A | N/A |
| 5842478 | 12/1997 | Benderev et al. | N/A | N/A |
| 5860978 | 12/1998 | McDevitt et al. | N/A | N/A |
| 5868762 | 12/1998 | Cragg et al. | N/A | N/A |
| 5891150 | 12/1998 | Chan | N/A | N/A |
| 5891168 | 12/1998 | Thal | N/A | N/A |
| 5895425 | 12/1998 | Grafton et al. | N/A | N/A |
| 5906624 | 12/1998 | Wenstrom, Jr. | N/A | N/A |
| 5911721 | 12/1998 | Nicholson et al. | N/A | N/A |
| 5918604 | 12/1998 | Whelan | N/A | N/A |
| 5935129 | 12/1998 | McDevitt et al. | N/A | N/A |
| 5938686 | 12/1998 | Benderev et al. | N/A | N/A |
| 5947982 | 12/1998 | Duran | N/A | N/A |
| 5948000 | 12/1998 | Larsen et al. | N/A | N/A |
| 5957924 | 12/1998 | Toermaelae et al. | N/A | N/A |
| 5961530 | 12/1998 | Moore et al. | N/A | N/A |
| 5964783 | 12/1998 | Grafton et al. | N/A | N/A |
| 5968044 | 12/1998 | Nicholson et al. | N/A | N/A |
| 5980558 | 12/1998 | Wiley | N/A | N/A |
| 6001104 | 12/1998 | Benderev et al. | N/A | N/A |
| 6024758 | 12/1999 | Thal | N/A | N/A |
| 6029805 | 12/1999 | Alpern et al. | N/A | N/A |
| 6045574 | 12/1999 | Thal | N/A | N/A |
| 6086608 | 12/1999 | Ek et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 6099538 | 12/1999 | Moses et al. | N/A | N/A |
| 6120511 | 12/1999 | Chan | N/A | N/A |
| 6132433 | 12/1999 | Whelan | N/A | N/A |
| 6143017 | 12/1999 | Thal | N/A | N/A |
| 6156039 | 12/1999 | Thal | N/A | N/A |
| 6183479 | 12/2000 | Toermaelae et al. | N/A | N/A |
| 6267766 | 12/2000 | Burkhart | N/A | N/A |
| 6290711 | 12/2000 | Caspari et al. | N/A | N/A |
| 6302886 | 12/2000 | McDevitt et al. | N/A | N/A |
| 6319252 | 12/2000 | McDevitt et al. | N/A | N/A |
| 6319269 | 12/2000 | Li | N/A | N/A |
| 6368335 | 12/2001 | Chan | N/A | N/A |
| 6371124 | 12/2001 | Whelan | N/A | N/A |
| 6387129 | 12/2001 | Rieser et al. | N/A | N/A |
| RE37963 | 12/2002 | Thal | N/A | N/A |
| 6508830 | 12/2002 | Steiner | N/A | N/A |
| 6511487 | 12/2002 | Oren et al. | N/A | N/A |
| 6514274 | 12/2002 | Boucher et al. | N/A | N/A |
| 6517546 | 12/2002 | Whittaker et al. | N/A | N/A |
| 6520980 | 12/2002 | Foerster | N/A | N/A |
| 6524316 | 12/2002 | Nicholson et al. | N/A | N/A |
| 6524317 | 12/2002 | Ritchart et al. | N/A | N/A |
| 6527794 | 12/2002 | McDevitt et al. | N/A | N/A |
| 6527795 | 12/2002 | Lizardi | N/A | N/A |
| 6537319 | 12/2002 | Whelan | N/A | N/A |
| 6540750 | 12/2002 | Burkhart | N/A | N/A |
| 6544281 | 12/2002 | Elattrache et al. | N/A | N/A |
| 6547807 | 12/2002 | Chan et al. | N/A | N/A |
| 6585730 | 12/2002 | Foerster | N/A | N/A |
| 6599295 | 12/2002 | Tornier et al. | N/A | N/A |
| 6605096 | 12/2002 | Ritchart | N/A | N/A |
| 6610064 | 12/2002 | Goble et al. | N/A | N/A |
| 6616674 | 12/2002 | Schmieding | N/A | N/A |
| 6623524 | 12/2002 | Schmieding | N/A | N/A |
| 6629984 | 12/2002 | Chan | N/A | N/A |
| 6638283 | 12/2002 | Thal | N/A | N/A |
| 6641596 | 12/2002 | Lizardi | N/A | N/A |
| 6641597 | 12/2002 | Burkhart et al. | N/A | N/A |
| 6645227 | 12/2002 | Fallin et al. | N/A | N/A |
| 6652561 | 12/2002 | Tran | N/A | N/A |
| 6656182 | 12/2002 | Hayhurst | N/A | N/A |
| 6656183 | 12/2002 | Colleran et al. | N/A | N/A |
| 6660023 | 12/2002 | McDevitt et al. | N/A | N/A |
| 6673094 | 12/2003 | McDevitt et al. | N/A | N/A |
| 6692516 | 12/2003 | West et al. | N/A | N/A |
| 6712849 | 12/2003 | Re et al. | N/A | N/A |
| 6716234 | 12/2003 | Grafton et al. | N/A | N/A |
| 6723107 | 12/2003 | Skiba et al. | N/A | N/A |
| 6733506 | 12/2003 | McDevitt et al. | N/A | N/A |
| 6733529 | 12/2003 | Whelan | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 6743233 | 12/2003 | Baldwin et al. | N/A | N/A |
| 6770073 | 12/2003 | McDevitt et al. | N/A | N/A |
| 6770076 | 12/2003 | Foerster | N/A | N/A |
| 6770084 | 12/2003 | Bain et al. | N/A | N/A |
| 6780198 | 12/2003 | Gregoire et al. | N/A | N/A |
| 6830572 | 12/2003 | McDevitt et al. | N/A | N/A |
| 6855157 | 12/2004 | Foerster et al. | N/A | N/A |
| 6860887 | 12/2004 | Frankle | N/A | N/A |
| 6878166 | 12/2004 | Clark et al. | N/A | N/A |
| 6887259 | 12/2004 | Lizardi | N/A | N/A |
| 6932826 | 12/2004 | Chan | N/A | N/A |
| 6942683 | 12/2004 | Dunshee | N/A | N/A |
| 6942684 | 12/2004 | Bonutti | N/A | N/A |
| 6955678 | 12/2004 | Gabriel et al. | N/A | N/A |
| 6958067 | 12/2004 | Whittaker et al. | N/A | N/A |
| 6974477 | 12/2004 | Whelan | N/A | N/A |
| 6984237 | 12/2005 | Hatch et al. | N/A | N/A |
| 6986781 | 12/2005 | Smith | N/A | N/A |
| 6991636 | 12/2005 | Rose | N/A | N/A |
| 6994719 | 12/2005 | Grafton | N/A | N/A |
| 6994725 | 12/2005 | Goble | N/A | N/A |
| 7029490 | 12/2005 | Grafton et al. | N/A | N/A |
| 7033364 | 12/2005 | Walters et al. | N/A | N/A |
| 7037324 | 12/2005 | Martinek | N/A | N/A |
| 7063724 | 12/2005 | Re et al. | N/A | N/A |
| 7066956 | 12/2005 | Schmieding et al. | N/A | N/A |
| 7074203 | 12/2005 | Johanson et al. | N/A | N/A |
| 7077863 | 12/2005 | Schmieding et al. | N/A | N/A |
| 7081126 | 12/2005 | McDevitt et al. | N/A | N/A |
| 7083638 | 12/2005 | Foerster | N/A | N/A |
| 7108700 | 12/2005 | Chan | N/A | N/A |
| 7112208 | 12/2005 | Morris et al. | N/A | N/A |
| 7147651 | 12/2005 | Morrison et al. | N/A | N/A |
| 7172595 | 12/2006 | Goble | N/A | N/A |
| 7175632 | 12/2006 | Singhatat et al. | N/A | N/A |
| 7195642 | 12/2006 | McKernan et al. | N/A | N/A |
| 7201756 | 12/2006 | Ross et al. | N/A | N/A |
| 7226469 | 12/2006 | Benavitz et al. | N/A | N/A |
| 7229448 | 12/2006 | Goble et al. | N/A | N/A |
| 7235100 | 12/2006 | Martinek | N/A | N/A |
| 7247164 | 12/2006 | Ritchart et al. | N/A | N/A |
| 7285124 | 12/2006 | Foerster | N/A | N/A |
| 7306626 | 12/2006 | Whelan | N/A | N/A |
| 7309337 | 12/2006 | Colleran et al. | N/A | N/A |
| 7309346 | 12/2006 | Martinek | N/A | N/A |
| 7329272 | 12/2007 | Burkhart et al. | N/A | N/A |
| 7341592 | 12/2007 | Walters et al. | N/A | N/A |
| D569973 | 12/2007 | Oren et al. | N/A | N/A |
| 7377926 | 12/2007 | Topper et al. | N/A | N/A |
| 7381212 | 12/2007 | Topper et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 7381213 | 12/2007 | Lizardi | N/A | N/A |
| 7399302 | 12/2007 | Goble et al. | N/A | N/A |
| D576277 | 12/2007 | Oren et al. | N/A | N/A |
| 7458975 | 12/2007 | May et al. | N/A | N/A |
| 7465308 | 12/2007 | Sikora et al. | N/A | N/A |
| 7500990 | 12/2008 | Whelan | N/A | N/A |
| 7517357 | 12/2008 | Abrams et al. | N/A | N/A |
| 7527648 | 12/2008 | May et al. | N/A | N/A |
| 7530999 | 12/2008 | Clark et al. | N/A | N/A |
| 7556640 | 12/2008 | Foerster | N/A | N/A |
| 7569059 | 12/2008 | Cerundolo | N/A | N/A |
| 7585305 | 12/2008 | Dreyfuss | N/A | N/A |
| 7585311 | 12/2008 | Green et al. | N/A | N/A |
| 7588587 | 12/2008 | Barbieri et al. | N/A | N/A |
| 7588595 | 12/2008 | Miller et al. | N/A | N/A |
| 7594917 | 12/2008 | Whittaker et al. | N/A | N/A |
| 7608084 | 12/2008 | Oren et al. | N/A | N/A |
| 7625386 | 12/2008 | Abe et al. | N/A | N/A |
| 7637926 | 12/2008 | Foerster et al. | N/A | N/A |
| 7651495 | 12/2009 | McDevitt et al. | N/A | N/A |
| 7655011 | 12/2009 | Whittaker et al. | N/A | N/A |
| 7662171 | 12/2009 | West et al. | N/A | N/A |
| 7674275 | 12/2009 | Martin et al. | N/A | N/A |
| 7674290 | 12/2009 | McKernan et al. | N/A | N/A |
| 7678134 | 12/2009 | Schmieding et al. | N/A | N/A |
| 7682374 | 12/2009 | Foerster et al. | N/A | N/A |
| 7695494 | 12/2009 | Foerster | N/A | N/A |
| 7713286 | 12/2009 | Singhatat | N/A | N/A |
| 7713300 | 12/2009 | Meridew et al. | N/A | N/A |
| 7749237 | 12/2009 | Chan | N/A | N/A |
| 7771441 | 12/2009 | Cerundolo | N/A | N/A |
| 7803173 | 12/2009 | Burkhart et al. | N/A | N/A |
| 7819898 | 12/2009 | Stone et al. | N/A | N/A |
| 7833230 | 12/2009 | Cerundolo | N/A | N/A |
| 7833244 | 12/2009 | Cerundolo | N/A | N/A |
| 7837710 | 12/2009 | Lombardo et al. | N/A | N/A |
| 7837718 | 12/2009 | Clark et al. | N/A | N/A |
| 7842050 | 12/2009 | Diduch et al. | N/A | N/A |
| 7867251 | 12/2010 | Colleran et al. | N/A | N/A |
| 7867264 | 12/2010 | McDevitt et al. | N/A | N/A |
| 7868251 | 12/2010 | Gladd et al. | N/A | N/A |
| 7879046 | 12/2010 | Weinert et al. | N/A | N/A |
| 7879048 | 12/2010 | Bain et al. | N/A | N/A |
| 7883519 | 12/2010 | Oren et al. | N/A | N/A |
| 7892256 | 12/2010 | Grafton et al. | N/A | N/A |
| 7896907 | 12/2010 | McDevitt et al. | N/A | N/A |
| 7896917 | 12/2010 | Walters et al. | N/A | N/A |
| 7905903 | 12/2010 | Stone et al. | N/A | N/A |
| 7931657 | 12/2010 | Walters et al. | N/A | N/A |
| 7938847 | 12/2010 | Fanton et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 7942878 | 12/2010 | Fernandez | N/A | N/A |
| 7942914 | 12/2010 | Cerundolo | N/A | N/A |
| 7955341 | 12/2010 | Cerundolo | N/A | N/A |
| 7959649 | 12/2010 | Burkhart | N/A | N/A |
| 7959650 | 12/2010 | Kaiser et al. | N/A | N/A |
| 7963972 | 12/2010 | Foerster et al. | N/A | N/A |
| 7963983 | 12/2010 | Cerundolo | N/A | N/A |
| RE42526 | 12/2010 | Reiser et al. | N/A | N/A |
| 7976565 | 12/2010 | Meridew | N/A | N/A |
| 7981140 | 12/2010 | Burkhart | N/A | N/A |
| 7988697 | 12/2010 | Miller et al. | N/A | N/A |
| 7993369 | 12/2010 | Dreyfuss et al. | N/A | N/A |
| 8012171 | 12/2010 | Schmieding | N/A | N/A |
| 8012172 | 12/2010 | Grafton et al. | N/A | N/A |
| 8012174 | 12/2010 | Elattrache et al. | N/A | N/A |
| 8029537 | 12/2010 | West et al. | N/A | N/A |
| 8038652 | 12/2010 | Morrison et al. | N/A | N/A |
| 8043308 | 12/2010 | Bittenson | N/A | N/A |
| 8062295 | 12/2010 | McDevitt et al. | N/A | N/A |
| 8080013 | 12/2010 | Whittaker et al. | N/A | N/A |
| 8083769 | 12/2010 | Cauldwell et al. | N/A | N/A |
| 8088146 | 12/2011 | Wert et al. | N/A | N/A |
| 8100942 | 12/2011 | Green et al. | N/A | N/A |
| 8105343 | 12/2011 | White et al. | N/A | N/A |
| 8109966 | 12/2011 | Ritchart et al. | N/A | N/A |
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| 8114128 | 12/2011 | Cauldwell et al. | N/A | N/A |
| 8118835 | 12/2011 | Weisel et al. | N/A | N/A |
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| 8133258 | 12/2011 | Foerster et al. | N/A | N/A |
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| 8137381 | 12/2011 | Foerster et al. | N/A | N/A |
| 8137383 | 12/2011 | West et al. | N/A | N/A |
| 8147505 | 12/2011 | Delli-Santi | N/A | N/A |
| 8162978 | 12/2011 | Lombardo et al. | N/A | N/A |
| 8167906 | 12/2011 | Cauldwell et al. | N/A | N/A |
| 8177796 | 12/2011 | Akyuz et al. | N/A | N/A |
| 8202295 | 12/2011 | Kaplan | N/A | N/A |
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| 8226716 | 12/2011 | McKernan et al. | N/A | N/A |
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| 8262675 | 12/2011 | Cropper et al. | N/A | N/A |
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| 8277484 | 12/2011 | Barbieri et al. | N/A | N/A |
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| | | | | |
|---|---|---|---|---|
| 8298262 | 12/2011 | Stone et al. | N/A | N/A |
| 8317829 | 12/2011 | Foerster et al. | N/A | N/A |
| 8317862 | 12/2011 | Troger et al. | N/A | N/A |
| 8328843 | 12/2011 | Oren et al. | N/A | N/A |
| 8348975 | 12/2012 | Dreyfuss | N/A | N/A |
| 8361079 | 12/2012 | Pandya | N/A | N/A |
| 8372124 | 12/2012 | Paulk et al. | N/A | N/A |
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| 8383188 | 12/2012 | Mazzocca et al. | N/A | N/A |
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| 8394112 | 12/2012 | Nason | N/A | N/A |
| 8394123 | 12/2012 | Cauldwell et al. | N/A | N/A |
| 8409204 | 12/2012 | Martin et al. | N/A | N/A |
| 8409225 | 12/2012 | Bull et al. | N/A | N/A |
| 8419794 | 12/2012 | Elattrache et al. | N/A | N/A |
| 8425536 | 12/2012 | Foerster et al. | N/A | N/A |
| 8430909 | 12/2012 | Dreyfuss et al. | N/A | N/A |
| 8435264 | 12/2012 | Sojka et al. | N/A | N/A |
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| 8460340 | 12/2012 | Sojka et al. | N/A | N/A |
| 8465521 | 12/2012 | Cook et al. | N/A | N/A |
| 8465522 | 12/2012 | Burkhart | N/A | N/A |
| 8469998 | 12/2012 | Sojka et al. | N/A | N/A |
| 8475436 | 12/2012 | Jordan | N/A | N/A |
| 8491595 | 12/2012 | Volpi et al. | N/A | N/A |
| 8491600 | 12/2012 | McDevitt et al. | N/A | N/A |
| 8506596 | 12/2012 | Stone et al. | N/A | N/A |
| 8512378 | 12/2012 | Green et al. | N/A | N/A |
| 8518091 | 12/2012 | McDevitt et al. | N/A | N/A |
| 8523902 | 12/2012 | Heaven et al. | N/A | N/A |
| 8529577 | 12/2012 | Hirt et al. | N/A | N/A |
| 8529601 | 12/2012 | Green et al. | N/A | N/A |
| 8535350 | 12/2012 | Lizardi et al. | N/A | N/A |
| 8540732 | 12/2012 | Weinert et al. | N/A | N/A |
| 8540737 | 12/2012 | Chudik | N/A | N/A |
| 8551123 | 12/2012 | Pandya | N/A | N/A |
| 8556911 | 12/2012 | Mehta et al. | N/A | N/A |
| 8579974 | 12/2012 | Pandya | N/A | N/A |
| 8591580 | 12/2012 | McKernan et al. | N/A | N/A |
| 8597328 | 12/2012 | Cauldwell et al. | N/A | N/A |
| 8613756 | 12/2012 | Lizardi et al. | N/A | N/A |
| 8617186 | 12/2012 | White et al. | N/A | N/A |
| 8617219 | 12/2012 | Oren et al. | N/A | N/A |
| 8623032 | 12/2013 | Diduch et al. | N/A | N/A |
| 8652171 | 12/2013 | Stone et al. | N/A | N/A |
| 8657854 | 12/2013 | Foerster et al. | N/A | N/A |
| 8663279 | 12/2013 | Burkhart et al. | N/A | N/A |

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|---|---|---|---|---|
| 8663280 | 12/2013 | Kaplan | N/A | N/A |
| 8672954 | 12/2013 | Oren et al. | N/A | N/A |
| 8672966 | 12/2013 | Wert et al. | N/A | N/A |
| 8672967 | 12/2013 | Dimatteo et al. | N/A | N/A |
| 8672970 | 12/2013 | Ferragamo et al. | N/A | N/A |
| 8685060 | 12/2013 | Foerster | N/A | N/A |
| 8690915 | 12/2013 | Hootstein | N/A | N/A |
| 8696688 | 12/2013 | Stone | N/A | N/A |
| 8702752 | 12/2013 | Schmieding et al. | N/A | N/A |
| 8702754 | 12/2013 | Dimatteo et al. | N/A | N/A |
| 8709040 | 12/2013 | Anderhub et al. | N/A | N/A |
| 8709395 | 12/2013 | Boutros | N/A | N/A |
| 8721650 | 12/2013 | Fanton et al. | N/A | N/A |
| 8740913 | 12/2013 | Schneider | N/A | N/A |
| 8747469 | 12/2013 | Wang et al. | N/A | N/A |
| 8764798 | 12/2013 | Housman | N/A | N/A |
| 8771315 | 12/2013 | Lunn et al. | N/A | N/A |
| 8771351 | 12/2013 | Elattrache et al. | N/A | N/A |
| 8777990 | 12/2013 | Van et al. | N/A | N/A |
| 8784449 | 12/2013 | Snyder et al. | N/A | N/A |
| 8784489 | 12/2013 | Walters et al. | N/A | N/A |
| 8790370 | 12/2013 | Spenciner et al. | N/A | N/A |
| 8808326 | 12/2013 | Gagliano | N/A | N/A |
| 8814905 | 12/2013 | Sengun et al. | N/A | N/A |
| 8828029 | 12/2013 | White et al. | N/A | N/A |
| 8834495 | 12/2013 | White et al. | N/A | N/A |
| 8834521 | 12/2013 | Pinto et al. | N/A | N/A |
| 8834543 | 12/2013 | McDevitt et al. | N/A | N/A |
| 8858560 | 12/2013 | Bradley et al. | N/A | N/A |
| 8870877 | 12/2013 | Koogle, Jr. | N/A | N/A |
| 8881635 | 12/2013 | Martin | N/A | N/A |
| 8882801 | 12/2013 | Dimatteo et al. | N/A | N/A |
| 8906060 | 12/2013 | Hart | N/A | N/A |
| 8926663 | 12/2014 | Green et al. | N/A | N/A |
| 8936620 | 12/2014 | Kaiser et al. | N/A | N/A |
| 8943941 | 12/2014 | Dow et al. | N/A | N/A |
| 8951292 | 12/2014 | Paulk et al. | N/A | N/A |
| 8961576 | 12/2014 | Hodge et al. | N/A | N/A |
| 8986345 | 12/2014 | Denham et al. | N/A | N/A |
| 8986346 | 12/2014 | Dreyfuss | N/A | N/A |
| 8986347 | 12/2014 | Housman | N/A | N/A |
| 8992573 | 12/2014 | Van et al. | N/A | N/A |
| 9005246 | 12/2014 | Burkhart et al. | N/A | N/A |
| 9017381 | 12/2014 | Kaiser et al. | N/A | N/A |
| 9023083 | 12/2014 | Foerster et al. | N/A | N/A |
| 9034014 | 12/2014 | Catania et al. | N/A | N/A |
| 9044222 | 12/2014 | Dross | N/A | N/A |
| 9044226 | 12/2014 | Green et al. | N/A | N/A |
| 9107653 | 12/2014 | Sullivan | N/A | N/A |
| 9113859 | 12/2014 | Dooney et al. | N/A | N/A |

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|---|---|---|---|---|
| 9144425 | 12/2014 | Kaplan | N/A | N/A |
| 9149268 | 12/2014 | Graul et al. | N/A | N/A |
| 9155542 | 12/2014 | Markarian | N/A | N/A |
| 9161750 | 12/2014 | Zirps et al. | N/A | N/A |
| 9179907 | 12/2014 | Elattrache et al. | N/A | N/A |
| 9198649 | 12/2014 | Karapetian et al. | N/A | N/A |
| 9226742 | 12/2015 | Wolf et al. | N/A | N/A |
| 9265496 | 12/2015 | Sojka et al. | N/A | N/A |
| 9307979 | 12/2015 | Bennett et al. | N/A | N/A |
| 9445805 | 12/2015 | Snell et al. | N/A | N/A |
| 9498232 | 12/2015 | Perez, III | N/A | N/A |
| 9782165 | 12/2016 | Murphy et al. | N/A | N/A |
| 10154868 | 12/2017 | Fallin et al. | N/A | N/A |
| 10219813 | 12/2018 | Okuno et al. | N/A | N/A |
| 10258401 | 12/2018 | Fallin et al. | N/A | N/A |
| 10426460 | 12/2018 | Taber et al. | N/A | N/A |
| 2001/0016747 | 12/2000 | Romano et al. | N/A | N/A |
| 2002/0029066 | 12/2001 | Foerster | N/A | N/A |
| 2002/0065526 | 12/2001 | Oren et al. | N/A | N/A |
| 2003/0105524 | 12/2002 | Paulos et al. | N/A | N/A |
| 2003/0171778 | 12/2002 | Lizardi | N/A | N/A |
| 2003/0195528 | 12/2002 | Ritchart | N/A | N/A |
| 2003/0195563 | 12/2002 | Foerster | N/A | N/A |
| 2003/0229362 | 12/2002 | Chan et al. | N/A | N/A |
| 2004/0010286 | 12/2003 | Gieringer | N/A | N/A |
| 2004/0082956 | 12/2003 | Baldwin et al. | N/A | N/A |
| 2004/0088004 | 12/2003 | Rosch | N/A | N/A |
| 2004/0098051 | 12/2003 | Fallin et al. | N/A | N/A |
| 2004/0098053 | 12/2003 | Tran | N/A | N/A |
| 2004/0116843 | 12/2003 | Chan | N/A | N/A |
| 2004/0172062 | 12/2003 | Burkhart | N/A | N/A |
| 2004/0267317 | 12/2003 | Higgins et al. | N/A | N/A |
| 2005/0033362 | 12/2004 | Grafton | N/A | N/A |
| 2005/0033364 | 12/2004 | Gregoire et al. | N/A | N/A |
| 2005/0149122 | 12/2004 | McDevitt et al. | N/A | N/A |
| 2005/0245932 | 12/2004 | Fanton et al. | N/A | N/A |
| 2005/0277986 | 12/2004 | Foerster et al. | N/A | N/A |
| 2006/0074438 | 12/2005 | Chan | N/A | N/A |
| 2006/0079904 | 12/2005 | Thal | N/A | N/A |
| 2006/0142784 | 12/2005 | Kontos | N/A | N/A |
| 2006/0149258 | 12/2005 | Sousa | N/A | N/A |
| 2006/0155328 | 12/2005 | Foerster | N/A | N/A |
| 2006/0235413 | 12/2005 | Denham | 606/907 | A61B 17/0401 |
| 2006/0241658 | 12/2005 | Cerundolo | N/A | N/A |
| 2006/0247641 | 12/2005 | Re et al. | N/A | N/A |
| 2006/0271060 | 12/2005 | Gordon | N/A | N/A |
| 2006/0282081 | 12/2005 | Fanton et al. | N/A | N/A |
| 2006/0282082 | 12/2005 | Fanton et al. | N/A | N/A |
| 2006/0282083 | 12/2005 | Fanton et al. | N/A | N/A |
| 2006/0293691 | 12/2005 | Mitra et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 2007/0005067 | 12/2006 | Dross | N/A | N/A |
| 2007/0005068 | 12/2006 | Sklar | N/A | N/A |
| 2007/0016251 | 12/2006 | Roby | N/A | N/A |
| 2007/0021751 | 12/2006 | Reay-Young et al. | N/A | N/A |
| 2007/0027475 | 12/2006 | Pagedas | N/A | N/A |
| 2007/0088362 | 12/2006 | Bonutti et al. | N/A | N/A |
| 2007/0156149 | 12/2006 | Fanton et al. | N/A | N/A |
| 2007/0156150 | 12/2006 | Fanton et al. | N/A | N/A |
| 2007/0156176 | 12/2006 | Fanton et al. | N/A | N/A |
| 2007/0167950 | 12/2006 | Tauro et al. | N/A | N/A |
| 2007/0173845 | 12/2006 | Kim | N/A | N/A |
| 2007/0203498 | 12/2006 | Gerber et al. | N/A | N/A |
| 2007/0213730 | 12/2006 | Martinek et al. | N/A | N/A |
| 2007/0213770 | 12/2006 | Dreyfuss | N/A | N/A |
| 2007/0219557 | 12/2006 | Bourque et al. | N/A | N/A |
| 2007/0219558 | 12/2006 | Deutsch | N/A | N/A |
| 2007/0288023 | 12/2006 | Pellegrino et al. | N/A | N/A |
| 2008/0009904 | 12/2007 | Bourque et al. | N/A | N/A |
| 2008/0033460 | 12/2007 | Ziniti | 606/148 | A61B 17/0401 |
| 2008/0033486 | 12/2007 | Whittaker et al. | N/A | N/A |
| 2008/0057838 | 12/2007 | Huang et al. | N/A | N/A |
| 2008/0077161 | 12/2007 | Kaplan | N/A | N/A |
| 2008/0103528 | 12/2007 | Zirps et al. | N/A | N/A |
| 2008/0125815 | 12/2007 | Heaven et al. | N/A | N/A |
| 2008/0188936 | 12/2007 | Ball et al. | N/A | N/A |
| 2008/0208253 | 12/2007 | Dreyfuss et al. | N/A | N/A |
| 2008/0234730 | 12/2007 | Cotton et al. | N/A | N/A |
| 2008/0243174 | 12/2007 | Oren et al. | N/A | N/A |
| 2008/0243177 | 12/2007 | Oren et al. | N/A | N/A |
| 2008/0243178 | 12/2007 | Oren et al. | N/A | N/A |
| 2008/0275453 | 12/2007 | Lafosse et al. | N/A | N/A |
| 2008/0287992 | 12/2007 | Tornier et al. | N/A | N/A |
| 2008/0300629 | 12/2007 | Surti | N/A | N/A |
| 2009/0018561 | 12/2008 | Schwartz et al. | N/A | N/A |
| 2009/0018581 | 12/2008 | Anderson et al. | N/A | N/A |
| 2009/0036905 | 12/2008 | Schmieding | N/A | N/A |
| 2009/0048623 | 12/2008 | Lafosse et al. | N/A | N/A |
| 2009/0062819 | 12/2008 | Burkhart et al. | N/A | N/A |
| 2009/0099598 | 12/2008 | McDevitt et al. | N/A | N/A |
| 2009/0138002 | 12/2008 | Fenton | N/A | N/A |
| 2009/0149884 | 12/2008 | Snyder et al. | N/A | N/A |
| 2009/0171360 | 12/2008 | Whelan | N/A | N/A |
| 2009/0187216 | 12/2008 | Schmieding et al. | N/A | N/A |
| 2009/0192546 | 12/2008 | Schmieding et al. | N/A | N/A |
| 2009/0222039 | 12/2008 | Dreyfuss et al. | N/A | N/A |
| 2009/0287246 | 12/2008 | Cauldwell et al. | N/A | N/A |
| 2009/0292313 | 12/2008 | Anspach et al. | N/A | N/A |
| 2009/0312782 | 12/2008 | Park | N/A | N/A |
| 2009/0312794 | 12/2008 | Nason et al. | N/A | N/A |
| 2009/0318960 | 12/2008 | Burkhart | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 2010/0004683 | 12/2009 | Hoof et al. | N/A | N/A |
| 2010/0087872 | 12/2009 | Morihara et al. | N/A | N/A |
| 2010/0100129 | 12/2009 | West et al. | N/A | N/A |
| 2010/0106194 | 12/2009 | Bonutti et al. | N/A | N/A |
| 2010/0121337 | 12/2009 | Pandya | N/A | N/A |
| 2010/0121348 | 12/2009 | Van et al. | N/A | N/A |
| 2010/0121375 | 12/2009 | Pandya | N/A | N/A |
| 2010/0137889 | 12/2009 | Oren et al. | N/A | N/A |
| 2010/0179573 | 12/2009 | Levinsohn et al. | N/A | N/A |
| 2010/0198235 | 12/2009 | Pierce et al. | N/A | N/A |
| 2010/0249835 | 12/2009 | Schwartz et al. | N/A | N/A |
| 2010/0262184 | 12/2009 | Dreyfuss | N/A | N/A |
| 2010/0292732 | 12/2009 | Hirotsuka et al. | N/A | N/A |
| 2010/0318125 | 12/2009 | Gerber et al. | N/A | N/A |
| 2010/0318139 | 12/2009 | Beauchamp | N/A | N/A |
| 2010/0324575 | 12/2009 | Chan | N/A | N/A |
| 2011/0009867 | 12/2010 | Oren et al. | N/A | N/A |
| 2011/0009884 | 12/2010 | Kaplan | N/A | N/A |
| 2011/0022087 | 12/2010 | Cerundolo | N/A | N/A |
| 2011/0028997 | 12/2010 | Gregoire et al. | N/A | N/A |
| 2011/0071550 | 12/2010 | Diduch et al. | N/A | N/A |
| 2011/0106013 | 12/2010 | Whittaker et al. | N/A | N/A |
| 2011/0106124 | 12/2010 | Beauchamp | N/A | N/A |
| 2011/0112550 | 12/2010 | Heaven et al. | N/A | N/A |
| 2011/0112576 | 12/2010 | Nguyen et al. | N/A | N/A |
| 2011/0118757 | 12/2010 | Pierce | N/A | N/A |
| 2011/0152928 | 12/2010 | Colleran et al. | N/A | N/A |
| 2011/0190815 | 12/2010 | Saliman | N/A | N/A |
| 2011/0208198 | 12/2010 | Anderson et al. | N/A | N/A |
| 2011/0224726 | 12/2010 | Lombardo et al. | N/A | N/A |
| 2011/0238111 | 12/2010 | Frank | N/A | N/A |
| 2011/0238112 | 12/2010 | Kim et al. | N/A | N/A |
| 2011/0238113 | 12/2010 | Fanton et al. | N/A | N/A |
| 2011/0245869 | 12/2010 | Burkhart | N/A | N/A |
| 2011/0295279 | 12/2010 | Stone et al. | N/A | N/A |
| 2011/0301622 | 12/2010 | Oren et al. | N/A | N/A |
| 2012/0041484 | 12/2011 | Briganti et al. | N/A | N/A |
| 2012/0059415 | 12/2011 | Sklar | N/A | N/A |
| 2012/0116451 | 12/2011 | Tepic | N/A | N/A |
| 2012/0143224 | 12/2011 | Chan | N/A | N/A |
| 2012/0150225 | 12/2011 | Burkhart et al. | N/A | N/A |
| 2012/0150235 | 12/2011 | Snyder et al. | N/A | N/A |
| 2012/0158051 | 12/2011 | Foerster | N/A | N/A |
| 2012/0165868 | 12/2011 | Burkhart et al. | N/A | N/A |
| 2012/0179200 | 12/2011 | Cauldwell et al. | N/A | N/A |
| 2012/0197296 | 12/2011 | Mayer et al. | N/A | N/A |
| 2012/0209279 | 12/2011 | Snyder et al. | N/A | N/A |
| 2012/0209325 | 12/2011 | Gagliano et al. | N/A | N/A |
| 2012/0245634 | 12/2011 | Kaplan | N/A | N/A |
| 2012/0265219 | 12/2011 | Rushdy et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 2012/0272816 | 12/2011 | Ueda et al. | N/A | N/A |
| 2013/0023928 | 12/2012 | Dreyfuss | N/A | N/A |
| 2013/0023929 | 12/2012 | Sullivan et al. | N/A | N/A |
| 2013/0023930 | 12/2012 | Stone et al. | N/A | N/A |
| 2013/0035720 | 12/2012 | Perriello et al. | N/A | N/A |
| 2013/0053959 | 12/2012 | Lizardi et al. | N/A | N/A |
| 2013/0060280 | 12/2012 | Wolf et al. | N/A | N/A |
| 2013/0103083 | 12/2012 | Baird | N/A | N/A |
| 2013/0123809 | 12/2012 | Murphy et al. | N/A | N/A |
| 2013/0123842 | 12/2012 | Chan et al. | N/A | N/A |
| 2013/0123843 | 12/2012 | Chan et al. | N/A | N/A |
| 2013/0144335 | 12/2012 | Sandow | N/A | N/A |
| 2013/0150885 | 12/2012 | Dreyfuss | N/A | N/A |
| 2013/0165972 | 12/2012 | Sullivan | N/A | N/A |
| 2013/0178854 | 12/2012 | Sholev et al. | N/A | N/A |
| 2013/0190782 | 12/2012 | Nason | N/A | N/A |
| 2013/0197578 | 12/2012 | Gregoire et al. | N/A | N/A |
| 2013/0204253 | 12/2012 | Oren et al. | N/A | N/A |
| 2013/0204299 | 12/2012 | Mantovani et al. | N/A | N/A |
| 2013/0211429 | 12/2012 | Snyder et al. | N/A | N/A |
| 2013/0218273 | 12/2012 | Bull et al. | N/A | N/A |
| 2013/0226231 | 12/2012 | Weinert et al. | N/A | N/A |
| 2013/0267998 | 12/2012 | Vijay et al. | N/A | N/A |
| 2013/0296936 | 12/2012 | Burkhart | N/A | N/A |
| 2013/0325011 | 12/2012 | Cleveland et al. | N/A | N/A |
| 2013/0338710 | 12/2012 | Heaven et al. | N/A | N/A |
| 2013/0345711 | 12/2012 | Mehta et al. | N/A | N/A |
| 2013/0345749 | 12/2012 | Sullivan et al. | N/A | N/A |
| 2013/0345750 | 12/2012 | Sullivan | N/A | N/A |
| 2014/0046369 | 12/2013 | Heaven et al. | N/A | N/A |
| 2014/0046443 | 12/2013 | McKernan et al. | N/A | N/A |
| 2014/0081320 | 12/2013 | Sengun et al. | N/A | N/A |
| 2014/0107672 | 12/2013 | Dross | N/A | N/A |
| 2014/0107700 | 12/2013 | Baird et al. | N/A | N/A |
| 2014/0114317 | 12/2013 | Oren et al. | N/A | N/A |
| 2014/0114411 | 12/2013 | Baird et al. | N/A | N/A |
| 2014/0121467 | 12/2013 | Vayser et al. | N/A | N/A |
| 2014/0134802 | 12/2013 | Lin et al. | N/A | N/A |
| 2014/0135802 | 12/2013 | Mantovani | N/A | N/A |
| 2014/0163612 | 12/2013 | Hootstein | N/A | N/A |
| 2014/0171948 | 12/2013 | Griffiths et al. | N/A | N/A |
| 2014/0172016 | 12/2013 | Housman | N/A | N/A |
| 2014/0186416 | 12/2013 | Boutros | N/A | N/A |
| 2014/0186418 | 12/2013 | Boutros | N/A | N/A |
| 2014/0194906 | 12/2013 | Topper et al. | N/A | N/A |
| 2014/0207189 | 12/2013 | Foerster et al. | N/A | N/A |
| 2014/0214038 | 12/2013 | Sholev et al. | N/A | N/A |
| 2014/0222072 | 12/2013 | Gerber et al. | N/A | N/A |
| 2014/0243892 | 12/2013 | Choinski | N/A | N/A |
| 2014/0257384 | 12/2013 | Dreyfuss et al. | N/A | N/A |

| | | | | |
|---|---|---|---|---|
| 2014/0276984 | 12/2013 | Burbank et al. | N/A | N/A |
| 2014/0277129 | 12/2013 | Arai | 606/232 | A61B 17/0401 |
| 2014/0288594 | 12/2013 | Shaefers et al. | N/A | N/A |
| 2014/0303625 | 12/2013 | Sholev et al. | N/A | N/A |
| 2014/0324100 | 12/2013 | Burkhart | N/A | N/A |
| 2014/0343605 | 12/2013 | Lunn et al. | N/A | N/A |
| 2014/0364876 | 12/2013 | White et al. | N/A | N/A |
| 2014/0364905 | 12/2013 | Lunn et al. | N/A | N/A |
| 2014/0364907 | 12/2013 | White et al. | N/A | N/A |
| 2014/0379027 | 12/2013 | Dreyfuss et al. | N/A | N/A |
| 2014/0379028 | 12/2013 | Lo | N/A | N/A |
| 2015/0005773 | 12/2014 | Oren et al. | N/A | N/A |
| 2015/0005817 | 12/2014 | Snyder et al. | N/A | N/A |
| 2015/0005818 | 12/2014 | McDevitt et al. | N/A | N/A |
| 2015/0025552 | 12/2014 | Stoll | N/A | N/A |
| 2015/0032155 | 12/2014 | Dreyfuss et al. | N/A | N/A |
| 2015/0032157 | 12/2014 | Dooney et al. | N/A | N/A |
| 2015/0045795 | 12/2014 | Sholev et al. | N/A | N/A |
| 2015/0051645 | 12/2014 | Green et al. | N/A | N/A |
| 2015/0066079 | 12/2014 | Schmieding | N/A | N/A |
| 2015/0066080 | 12/2014 | Olson et al. | N/A | N/A |
| 2015/0066081 | 12/2014 | Martin | N/A | N/A |
| 2015/0088196 | 12/2014 | Kaplan | N/A | N/A |
| 2015/0119937 | 12/2014 | Lunn et al. | N/A | N/A |
| 2015/0141998 | 12/2014 | Kiapour et al. | N/A | N/A |
| 2015/0150551 | 12/2014 | Paulk et al. | N/A | N/A |
| 2015/0157312 | 12/2014 | Burkhart et al. | N/A | N/A |
| 2015/0196388 | 12/2014 | Housman et al. | N/A | N/A |
| 2015/0216522 | 12/2014 | Ticker | N/A | N/A |
| 2015/0216542 | 12/2014 | Libby et al. | N/A | N/A |
| 2015/0223926 | 12/2014 | Foerster et al. | N/A | N/A |
| 2015/0245831 | 12/2014 | Sullivan | N/A | N/A |
| 2015/0297211 | 12/2014 | Sullivan et al. | N/A | N/A |
| 2015/0297274 | 12/2014 | Dreyfuss et al. | N/A | N/A |
| 2015/0313586 | 12/2014 | Burkhart et al. | N/A | N/A |
| 2015/0327849 | 12/2014 | Dooney et al. | N/A | N/A |
| 2015/0335327 | 12/2014 | Ferguson et al. | N/A | N/A |
| 2015/0351752 | 12/2014 | Rousseau et al. | N/A | N/A |
| 2015/0359533 | 12/2014 | Kaplan | N/A | N/A |
| 2016/0015380 | 12/2015 | Sholev et al. | N/A | N/A |
| 2016/0296224 | 12/2015 | Snell et al. | N/A | N/A |
| 2016/0338689 | 12/2015 | Baird | N/A | N/A |
| 2016/0338693 | 12/2015 | Graul et al. | N/A | N/A |
| 2017/0042533 | 12/2016 | Lunn et al. | N/A | N/A |
| 2017/0065273 | 12/2016 | Hart et al. | N/A | N/A |
| 2017/0100182 | 12/2016 | Shah et al. | N/A | N/A |
| 2018/0078251 | 12/2017 | Copple et al. | N/A | N/A |
| 2019/0167251 | 12/2018 | Fallin et al. | N/A | N/A |
| 2021/0177394 | 12/2020 | Rippe et al. | N/A | N/A |

**FOREIGN PATENT DOCUMENTS**

| Patent No. | Application Date | Country | CPC |
|---|---|---|---|
| 95/15726 | 12/1994 | WO | N/A |
| 98/06344 | 12/1997 | WO | N/A |
| 03/65904 | 12/2002 | WO | N/A |
| 2004/049958 | 12/2003 | WO | N/A |
| 2009/018565 | 12/2008 | WO | N/A |
| 2009/042951 | 12/2008 | WO | N/A |
| 2009/055800 | 12/2008 | WO | N/A |
| 2009/076526 | 12/2008 | WO | N/A |
| 2010/005749 | 12/2009 | WO | N/A |
| 2010/009217 | 12/2009 | WO | N/A |
| 2010/056786 | 12/2009 | WO | N/A |
| 2010/056787 | 12/2009 | WO | N/A |
| 2011/056701 | 12/2010 | WO | N/A |
| 2011/059995 | 12/2010 | WO | N/A |
| 2011/060022 | 12/2010 | WO | N/A |
| 2011/060437 | 12/2010 | WO | N/A |
| 2011/133233 | 12/2010 | WO | N/A |
| 2012/024446 | 12/2011 | WO | N/A |
| 2012/052891 | 12/2011 | WO | N/A |
| 2012/129388 | 12/2011 | WO | N/A |
| 2013/014553 | 12/2012 | WO | N/A |
| 2013/027210 | 12/2012 | WO | N/A |
| 2013/052128 | 12/2012 | WO | N/A |
| 2013/112449 | 12/2012 | WO | N/A |
| 2013/151817 | 12/2012 | WO | N/A |
| 2013/181212 | 12/2012 | WO | N/A |
| 2014/018946 | 12/2013 | WO | N/A |
| 2014/051930 | 12/2013 | WO | N/A |
| 2014/055678 | 12/2013 | WO | N/A |
| 2014/059378 | 12/2013 | WO | N/A |
| 2014/066116 | 12/2013 | WO | N/A |
| 2014/071052 | 12/2013 | WO | N/A |
| 2014/071066 | 12/2013 | WO | N/A |
| 2015/005951 | 12/2014 | WO | N/A |
| 2015/008176 | 12/2014 | WO | N/A |
| 2015/017426 | 12/2014 | WO | N/A |
| 2015/031559 | 12/2014 | WO | N/A |
| 2016/148941 | 12/2015 | WO | N/A |

**OTHER PUBLICATIONS**

2.5 mm PushLock Knotless Suture Anchor, Arthrex, Inc., www.arthrex.com, 2013, 2 pp. cited by applicant

Achilles SpeedBridge Surgical Technique, Arthrex, Inc., www.arthrex.com, 2013, 6 pp. cited by applicant

Achilles SutureBridge Surgical Technique, Arthrex, Inc., www.arthrex.com, 2014, 6 pp. cited by applicant

ALLThread Knotless Suture Anchor, Double Row Rotator Cuff Repair, Biomet Orthopedics,

www.biomet.com, 2012, 12 pp. cited by applicant
Arthrex is Reaching New Heights in Rotator Cuff Repair, Arthrex, Inc., www.arthrex.com, 2007, 8 pp. cited by applicant
Arthrex SpeedBridge and Tomier Arthro Tunneler Biomechanical Cadavar Testing, Arthrex, Inc., 2010, 2 pp. cited by applicant
Arthroscopic and Mini-Open Rotator Cuff Repair Using JuggerKnot Soft Anchor—2.9 mm with ALLthread Knotless Anchor Surgical Technique, Biomet Sports Medicine, www.biomet.com, 2013, 16 pp. cited by applicant
Arthroscopic Shoulder Repair Using the Smith & Nephew Footpring PK Suture Anchor, Smith & Nephew, Inc., www.smith-nephew.com, 2008, 12 pp. cited by applicant
ArthroTunneler TunnelPro System, Transosseous Rotator Cuff Repair, Tornier, Inc., www.tornier.com, 2012, 6 pp. cited by applicant
Biceps Tenodesis SwiveLock System Surgical Technique, Arthrex, Inc., www.arthrex.com, 2012, 6 pp. cited by applicant
BioRaptor Knotless Suture Anchor, Smith & Nephew, Inc., www.smith-nephew.com, 2010, 6 pp. cited by applicant
Carter, Sally L., et al, “Suture Performance in Standard Arthroscopic Knots-Effects of Material and Design” Smith & Nephew, Inc., www.smith-nephew.com, 2004, 4 pp. cited by applicant
Chu, T., et al., “Biomechanical Evaluation of Knotless Fixation Systems for Rotator Cuff Repairs”, 56th Annual Meeting of the Orthopaedic Research Society, Post No. 1791, 1 pp. cited by applicant
Cinch Lock SS (Sports Sheath) Knotless Labrum Restoration, Stryker Corporation, www.stryker.com, 6 pp, accessed online on Jun. 22, 2022. cited by applicant
Comprehensive Product Offerings for your Rotator Cuff Repair, Smith & Nephew, Inc., www smith-nephew.com, 2015, 12 pp. cited by applicant
DeFranco, Michael J., et al., “Arthroscopic Rotator Cuff Repair Failure Resulting from Decorticiation of the Rotator Cuff Footprint: A Case Report”, The American Journal of Orthopedics, Dec. 2009, pp. 32-33. cited by applicant
Double Row Rotator Cuff Repair using the Bio-Corkscrew Ft Surgical Technique, Arthrex, Inc., www.arthrex.com, 2007, 6 pp. cited by applicant
Dr. S. D. Gerber Double Row Method Surgical Technique, Stryker Corporation, www.stryker.com, 2010, 12 pp. cited by applicant
Efird, Chad, et al., “Knotless Single-Row Rotator Cuff Repair: A Comparative Biomechanical Study of 2 Knotless Suture Anchors”, Healio.com/Orthopedics, Aug. 2013, 5 pp. cited by applicant
Flores, Steve, “Comparison of the Pull-Back Effect of Rotator Cuff Anchors”, Arthrex, Inc., 2007, 2 pp. cited by applicant
Halbrecht, Jeffrey, “Versalok A New Technique for Arthroscopic Knotless Rotator Cuff Repair”, 44 pp, accessed online on Jun. 22, 2022. cited by applicant
Introducing tie Healix Advance Family of Suture Anchors, DePuy Mitek, Inc, 2012, 4 pp. cited by applicant
Knotless SutureTak Instability Repair Surgical Technique, Arthrex, Inc., www.arthex.com, 2017, 6 pp. cited by applicant
Knotless SutureTak Instability Repair Surgical Technique, Arthrex, Inc., www.arthrex.com, 2015, 6 pp. cited by applicant
Mall, Nathan A., et al., “Transosseous-Equivalent Rotator Cuff Repair: A Systematic Review on the Biomechanical Importance of Tying the Medial Row”, Arthroscopy: The Journal of Arthroscopic and Related Surgery, vol. 29, No. 2, Feb. 2013, pp. 377-386. cited by applicant
Massive Rotator Cuff Repair and Augmentation using the SpeedBridge and ArthroFlex Dermal Matrix Surgical Technique, Arthrex, Inc., www.arthrex.com, 2012, 4 pp. cited by applicant
Multifix's PEEK 5.5mm and 6.5mm Knotless Implants Technique Guide, ArthroCare Corporation, www.smith-nephew.com, 2015, 8 pp. cited by applicant

Nho, Shane J., et al.,. “Bioabsorbable Anchors in Glenohumeral Shoulder Surgery”, Arthrscopy: The Journal of Arthroscopic and Related Surgery, vol. 25, No. 7, Jul. 2009, pp. 788-793. cited by applicant
Opus AutoCuff Magnum X Knotless Fixation Implant with Independent Tensioning, ArthroCare Sports Medicine, www.arthrocaresportsmedicine.com, 2009, 2 pp. cited by applicant
Pull-Out Strength Comparison of Arthrex to Mitek Suture Anchors, Arthrex Research and Development, Arthrex, Inc., 2010, 1 pp. cited by applicant
Quattro Shoulder System—Innovative Rotator Cuff Solutions, https://www.zimmerbiomet.com/en/products-and-solutions/specialties/sports-medicine/quattro-x-suture-anchors.html#04-Info, 12 pp, accessed online Jun. 22, 2022. cited by applicant
Quattro Shoulder System—Innovative Rotator Cuff Solutions, Cayenne Medical, Inc., www.cayennemedical.com, 6 pp. cited by applicant
Quickdraw Knotless Suture Anchor System Surgical Technique, Writght Medical Technology, Inc. www.wmt.com, 2011, 28 pp. cited by applicant
ReelX STT Knotless Anchor System, Stryker Corporation, www.stryker.com, 2010, 4 pp. cited by applicant
Revolutionizing Orthopedic Surgery, FiberWire Braided Composite Suture, Arthrex, Inc., www.arthrex.com, 2012, 8 pp. cited by applicant
Shoulder Restoration System, ConMed Linvatec, wwww.linvatec.com, 2014, 20 pp. cited by applicant
Shoulder Restoration System, PopLok Knotless Suture Anchor, ConMed Linvatec, www.linvatec.com, 8 pp, 2013. cited by applicant
SpeedBridge and SpeedFix Knotless Rotator Cuff Repair using the SwiveLock C and FiberTape Surgical Technique, Arthrex, Inc., www.arthrex.com, 2013, 8 pp. cited by applicant
Supplementary European Search Report dated Jun. 26, 2019 for corresponding European Application No. EP16833705. cited by applicant
Surgical Technique Sharc-FT and Taylor Stitcher Transosseus Devices for Fast Rotator Cuff Repair, NCS Lab Medical Devices Factory, 14 pp., accessed online Jun. 22, 2022, https://ncs-company.com/en/medical-devices/sport-medicine/. cited by applicant
SutureBridge Double Row Rotator Cuff Repair Surgical Technique, Arthrex, Inc., www.arthrex.com, 2013, 6 pp. cited by applicant
SwiveLock and FiberChain Knotless Rotator Cuff Repair Surgical Technique, Arthrex, Inc, www.arthrex.com, 2011, 8 pp. cited by applicant
The DoublePlay Biocomposite Suture Anchor, ArthroCare Sports Medicine, www.arthrocaresportsmedicine.com, 2009, 12 pp. cited by applicant
The Fully Threaded Family of Soft Tissue Repair Anchors, Arthrex, Inc., www.arthrex.com, 2012, 6 pp. cited by applicant
The Next Generation in Rotator Cuff Repair, DePuy Mitek, Inc., 2007, 18 pp. cited by applicant
The Next Generation in Shoulder & Elbow Repair and Reconstruction Technology, Arthrex, Inc., www.arthrex.com, 2014, 56 pp. cited by applicant
The Next Generation in Shoulder & Elbow Repair and Reconstruction Technology, Arthrex, Inc., www.arthrex.com, 2015, 56 pp. cited by applicant
The Opus AutoCuff System for Rotator Cuff Repair, ArthroCare Sports Medicine, www.arthrocaresportsmedicine.com, 2006, 8 pp. cited by applicant
The Opus TwinLock Knotless Fixation System, ArthroCare Sports Medicine, www.arthrocaresportsmedicine.com, 2010, 2 pp. cited by applicant
Versalok PEEK, the New, 100% Radiolucent, Self-Punching, Knotless Anchor, DePuy Mitek, Inc., 2010, 4 pp. cited by applicant
Versalok, The Next Generation in Rotator Cuff Repair, DePuy Mitek, 18 pp., 2007. cited by applicant

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## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation-in-part of U.S. patent application Ser. No. 16/268,973 filed on Feb. 6, 2019, entitled “Transosseous Suture Anchor”, which is a continuation of U.S. patent application Ser. No. 15/224,273 filed on Jul. 29, 2016, entitled “Transosseous Suture Anchor”, now issued as U.S. Pat. No. 10,226,243 on Mar. 12, 2019, which claims the benefit of U.S. Provisional Application No. 62/200,696, filed Aug. 4, 2015, which are hereby incorporated by reference in their entirety. This application is also a continuation-in-part of U.S. patent application Ser. No. 16/545,371 filed on Aug. 20, 2019, entitled “Extra Joint Stabilization Construct”, which is a continuation of U.S. patent application Ser. No. 15/641,592 filed on Jul. 5, 2017 entitled “Extra Joint Stabilization Construct”, now issued as U.S. Pat. No. 10,426,459 on Oct. 1, 2019, which claims the benefit of U.S. Provisional Application No. 62/458,975, filed Feb. 14, 2017, U.S. Provisional Application No. 62/456,217, filed Feb. 8, 2017, U.S. Provisional Application No. 62/425,560, filed Nov. 22, 2016, and U.S. Provisional Application No. 62/358,231, filed Jul. 5, 2016, which are hereby incorporated by reference in their entirety. This application is also a continuation-in-part of U.S. patent application Ser. No. 16/871,485 filed on May 11, 2020, entitled “Intra Joint Stabilization Construct”, which is a continuation of U.S. patent application Ser. No. 15/641,573 filed on Jul. 5, 2017 entitled “Intra Joint Stabilization Construct”, now U.S. Pat. No. 10,682,131 issued on Jun. 16, 2020, which also claims the benefit of U.S. Provisional Application No. 62/458,975, filed Feb. 14, 2017, U.S. Provisional Application No. 62/456,217, filed Feb. 8, 2017, U.S. Provisional Application No. 62/425,560, filed Nov. 22, 2016, and U.S. Provisional Application No. 62/358,231, filed Jul. 5, 2016, which are hereby incorporated by reference in their entirety.

TECHNICAL FIELD

(1) Examples of the present disclosure relate to implants, instruments and methods for surgical transosseous attachment to a bone and/or surgical attachment to soft or hard tissue. More particularly, examples of the present disclosure relate to knotless suture anchors.

BACKGROUND

(2) A variety of surgical procedures require the attachment of something relative to a surgical site. For example, in surgery relating to the skeletal system, it is often advantageous to attach soft tissue, suture, implants, and/or other items in or adjacent to a bone. For example, soft tissues such as ligaments, tendons, fascia, other capsular material, and/or muscle may be attached to a bone. Such soft tissues may be adjacent bones at skeletal joints including but not limited to the joints of the hands and feet, ankle, wrist, knee, elbow, hip, shoulder, and spine. For example, it is often advantageous to pass a suture through a portion of a bone to form a transosseous attachment to the bone.

SUMMARY

(3) The various apparatus, devices, systems, and/or methods of the present disclosure have been developed in response to the present state of the art, and in particular, in response to the problems and needs in the art that have not yet been fully solved by currently available suture anchors and related instrumentation. One general aspect of the present disclosure can include, a knotless suture anchor system that includes an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal

passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a distal opening communicating with the longitudinal passageway nearer the distal end; an interference member insertable distally into the longitudinal passageway to secure a portion of a suture within the longitudinal passageway by compressing the portion of the suture between the interference member and the anchor body, and a frangible connection that joins a proximal member to the anchor body.

(4) Implementations may include one or more of the following features. The knotless suture anchor system may include a driver operable to urge the interference member into the anchor body, and operable to move the interference member out of the anchor body. The driver may include: a drive shaft having a proximal end and a distal end; a drive coupler connected to the drive shaft at the proximal end; a drive feature connected to the drive shaft at the distal end; and external drive threads between the proximal end and the distal end, the external drive threads configured to engage internal drive threads of an inserter. The driver is configured to apply a torque to the interference member that engages at least one external helical thread of the interference member with an internal thread of the anchor body. The proximal end of the anchor body includes internal helical threads, and the interference member may include a set screw having external helical threads configured to interface with the internal helical threads in a clearance fit having a length of thread engagement shorter than a length of the external helical threads.

(5) The external helical threads of the set screw may include knuckle threads having an external helical thread pitch different from an internal helical thread pitch of the internal helical threads. The knotless suture anchor system may include a tensioner operable to engage the proximal member and secure a suture extending from the anchor body. The shaft, carriage, and second handle are coaxial with the longitudinal axis and include an inserter longitudinal passageway in communication with the longitudinal passageway of the anchor body. The suture grip member may include: a superior grip plate having ridges; an inferior grip plate having ridges; and a fastener that compresses the superior grip plate against the inferior grip plate and secure a portion of the suture between the superior grip plate and inferior grip plate.

(6) The fastener may include a thumb screw and the superior grip plate may include a recess that accepts a boss of the inferior grip plate, the boss having ridges. The knotless suture anchor system may include an inserter operable to engage the proximal member in an axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod operable to engage one of the interference member and the anchor body in an axial force transmitting relationship in a second direction opposite the first direction and break the frangible connection between the proximal member and the anchor body in response to axial translation of the pushrod relative to the inserter.

(7) One general aspect of the present disclosure can include the knotless suture anchor system having an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a first distal opening communicating with the longitudinal passageway nearer the distal end; and a tensioner connected to the anchor body and operable to engage the proximal end, secure a suture extending from the anchor body, and apply tension to the suture.

(8) Implementations may include one or more of the following features. The knotless suture anchor system may include an interference member insertable distally into the longitudinal passageway to secure a portion of a suture within the longitudinal passageway by compressing the portion of the suture between the interference member and the anchor body. The knotless suture anchor system may include a proximal member connected to the proximal end of the anchor body by a frangible connection. The knotless suture anchor system may include an inserter operable to engage the

proximal member in an axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod operable to engage the interference member in an axial force transmitting relationship in a second direction opposite the first direction and break the frangible connection between the proximal member and the anchor body in response to axial translation of the pushrod relative to the inserter.

(9) The inserter may include a shaft having a proximal end and a distal end, the shaft operable to engage the proximal member at the distal end of the shaft, the shaft coupled to a tensioner may include: a carriage having a suture grip member that removably secures a portion of the suture to the carriage, the carriage having first threads; a puller connected to the shaft near the proximal end of the shaft, the puller having second threads that engage the first threads; where the shaft, carriage, and puller are coaxial with the longitudinal axis and include an inserter longitudinal passageway in communication with the longitudinal passageway of the anchor body. The proximal member may include external helical threads configured to engage internal helical threads of the shaft.

(10) One general aspect of the present disclosure can include the knotless suture anchor system having an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a first distal opening communicating with the longitudinal passageway nearer the distal end; a proximal member joined to the anchor body, the proximal member having external threads at a proximal end of the proximal member; a set screw insertable distally into the longitudinal passageway to releasably secure a first portion of a suture within the longitudinal passageway by compressing the first portion of the suture between external knuckle threads of the set screw and internal helical threads at the proximal end of the anchor body; a frangible connection that joins the proximal member to the anchor body; and a tensioner connected to an inserter operable to engage the proximal member, the tensioner operable to secure a second portion of the suture contiguous to the first portion and extending from the anchor body, the tensioner also operable to apply tension to the second portion of the suture.

(11) Implementations may include one or more of the following features. The knotless suture anchor system where the inserter is operable to engage the proximal member in an axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod operable to engage the set screw in an axial force transmitting relationship in a second direction opposite the first direction and break the frangible connection to separate the anchor body from the proximal member in response to axial translation of the pushrod relative to the inserter.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) Exemplary embodiments of the technology will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only exemplary embodiments and are, therefore, not to be considered limiting of the scope of the technology, the exemplary embodiments will be described with additional specificity and detail through use of the accompanying drawings in which:

(2) FIG. **1** is a perspective view of an implant according to one embodiment;

(3) FIG. **2** is a top view of the implant of FIG. **1**;

(4) FIG. **3** is a left side view of the implant of FIG. **1**;

(5) FIG. **4** is a front view of the implant of FIG. **1**;

(6) FIG. **5** is a right side view of the implant of FIG. **1**;

(7) FIG. **6** is a bottom view of the implant of FIG. **1**;
(8) FIG. **7** is an exploded perspective view of the implant of FIG. **1**;
(9) FIG. **8** is an exploded perspective view of the implant of FIG. **1**;
(10) FIG. **9** is an exploded top view of the implant of FIG. **1**;
(11) FIG. **10** is an exploded section view taken along line **10**-**10** of FIG. **9**;
(12) FIG. **11** is an exploded front view of the implant of FIG. **1**;
(13) FIG. **12** is an exploded section view taken along line **12**-**12** of FIG. **11**;
(14) FIG. **13** is a side section view of an instrument useable with the implant of FIG. **1** according to one embodiment;
(15) FIGS. **14**-**16** are a sequence of detail top section views illustrating the interaction of the implant of FIG. **1** with the system of FIG. **13** according to one embodiment;
(16) FIGS. **17**-**19** are a sequence of detail top views illustrating the sequence of FIGS. **14**-**16**;
(17) FIGS. **20**-**22** are a sequence of perspective views illustrating the threading of suture through the implant of FIG. **1** according to one embodiment;
(18) FIG. **23** is a perspective section view illustrating the suture and implant after threading the suture according to the example of FIGS. **20**-**22**;
(19) FIG. **24** is a side view of the implant of FIG. **1** preloaded with suture and a suture passer according to one embodiment;
(20) FIG. **25** is a top view of a suture keeper according to one embodiment;
(21) FIGS. **26**-**31** are a sequence of top and bottom views of the implant of FIG. **1** preloaded as in FIG. **24** being loaded onto the suture keeper of FIG. **25**;
(22) FIGS. **32**-**41** are a sequence of perspective views illustrating a transosseous surgical repair technique according to one embodiment;
(23) FIG. **42** is a perspective view of an implant according to one embodiment;
(24) FIG. **43** is a top view of the implant of FIG. **42**;
(25) FIG. **44** is a left side view of the implant of FIG. **42**;
(26) FIG. **45** is a front view of the implant of FIG. **42**;
(27) FIG. **46** is a right side view of the implant of FIG. **42**;
(28) FIG. **47** is a bottom view of the implant of FIG. **42**;
(29) FIG. **48** is a side section view of the implant of FIG. **42** taken along line **48**-**48** of FIG. **43**;
(30) FIG. **49** is a perspective view of the implant of FIG. **42** preloaded with suture passers according to one embodiment;
(31) FIG. **50** is a perspective view of the implant of FIG. **42** preloaded with suture passers and a suture management tube according to one embodiment;
(32) FIG. **51** is a side section view of the implant of FIG. **42** with a suture routed according to one embodiment;
(33) FIG. **52** is an exploded perspective view of an implant according to one embodiment;
(34) FIG. **53** is an exploded perspective view of an implant according to one embodiment;
(35) FIG. **54** is a perspective exploded view of an interference member and an implant of FIG. **52**;
(36) FIG. **55** is a top exploded view of the interference member and implant of FIG. **52** according to one embodiment;
(37) FIG. **56** is a left side exploded view of the interference member and implant of FIG. **52** according to one embodiment;
(38) FIG. **57** is a front exploded view of the interference member and implant of FIG. **52** according to one embodiment;
(39) FIG. **58** is a right exploded side view of the interference member and implant of FIG. **52** according to one embodiment;
(40) FIG. **59** is a bottom exploded view of the interference member and implant of FIG. **52** according to one embodiment;
(41) FIG. **60** is a back exploded view of the interference member and implant of FIG. **52** according

to one embodiment;
(42) FIG. **61** is a side exploded section view of the interference member and implant of FIG. **52** taken along line **61**-**61** of FIG. **57**;
(43) FIG. **62** is a perspective view of the interference member of FIG. **52** according to one embodiment;
(44) FIG. **63** is a side view of the interference member of FIG. **52** according to one embodiment;
(45) FIG. **64** is a right side view of the interference member of FIG. **52** according to one embodiment;
(46) FIG. **65** is a left side view of the interference member of FIG. **52** according to one embodiment;
(47) FIG. **66** is a perspective view of an instrument useable with the implant of FIG. **52** according to one embodiment;
(48) FIG. **67** is a distal perspective view of a shaft of the system of FIG. **66** according to one embodiment;
(49) FIG. **68** is a proximal perspective view of a shaft of the system of FIG. **66** according to one embodiment;
(50) FIG. **69** is a proximal perspective view of a shaft and a collar of the system of FIG. **66** according to one embodiment;
(51) FIG. **70** is a section view of a collar and a puller on a shaft of the system of FIG. **66** according to one embodiment;
(52) FIG. **71** is a perspective view of a carriage of the system of FIG. **66** according to one embodiment;
(53) FIG. **72** is a right side view of a carriage of the system of FIG. **66** according to one embodiment;
(54) FIG. **73** is a left side perspective view of a carriage of the system of FIG. **66** according to one embodiment;
(55) FIG. **74** is a left side perspective view of a puller of the system of FIG. **66** according to one embodiment;
(56) FIG. **75** is a top view of the system of FIG. **66** according to one embodiment;
(57) FIG. **76** is a bottom view of the system of FIG. **66** according to one embodiment;
(58) FIG. **77** is a right side view of the system of FIG. **66** according to one embodiment;
(59) FIG. **78** is a left side view of the system of FIG. **66** according to one embodiment;
(60) FIG. **79** is a top view of parts of the system of FIG. **66** according to one embodiment;
(61) FIG. **80** is a bottom view of parts of the system of FIG. **66** according to one embodiment;
(62) FIG. **81** is a front view of parts of the system of FIG. **66** according to one embodiment;
(63) FIG. **82** is a bottom view of a grip plate of the system of FIG. **66** according to one embodiment;
(64) FIG. **83** is a top view of a grip plate of the system of FIG. **66** according to one embodiment;
(65) FIG. **84** is a side view of a grip plate of the system of FIG. **66** according to one embodiment;
(66) FIG. **85** is a front view of a grip plate of the system of FIG. **66** according to one embodiment;
(67) FIG. **86** is a bottom perspective view of a grip plate of the system of FIG. **66** according to one embodiment;
(68) FIG. **87** is a perspective view of a fastener of the system of FIG. **66** according to one embodiment;
(69) FIG. **88** is a perspective view of part of a fastener of the system of FIG. **66** according to one embodiment;
(70) FIG. **89** is a bottom view of part of a fastener of the system of FIG. **66** according to one embodiment;
(71) FIG. **90** is a top view of part of a fastener of the system of FIG. **66** according to one embodiment;

(72) FIG. **91** is a perspective view of the system of FIG. **66** with portions exploded according to one embodiment;
(73) FIG. **92** is a perspective exploded view of the system of FIG. **66** according to one embodiment;
(74) FIGS. **93-96** are a sequence of perspective views illustrating use of the system of FIG. **66** and the implant of FIG. **52** according to one embodiment;
(75) FIG. **97** is a perspective view of a driver for use with the system of FIG. **66** and the implant of FIG. **52** according to one embodiment;
(76) FIG. **98** is a perspective view illustrating use of the system of FIG. **66** and the implant of FIG. **52** according to one embodiment in another stage of the sequence illustrated in FIGS. **93-96**;
(77) FIG. **99** is a perspective view of a driver for use within the system of FIG. **66** and the implant of FIG. **52** according to one embodiment;
(78) FIGS. **100-101** are a sequence of perspective views illustrating use of the system of FIG. **66** and the implant of FIG. **52** according to one embodiment;
(79) FIG. **102** is a section view illustrating use of the system of FIG. **66** and the implant of FIG. **52** according to one embodiment;
(80) FIG. **103** is a close-up section view illustrating part of FIG. **102** according to one embodiment; and
(81) FIG. **104** is a close-up section view illustrating part of FIGS. **102** and **103** according to separation stage of the implant of FIG. **52** according to one embodiment.

DETAILED DESCRIPTION

(82) The following illustrative examples depict implants, instruments and methods to anchor a suture to a bone. The illustrative examples depict anchoring a round suture in a bone tunnel to attach soft tissue to the bone. However, examples of instruments and methods of the present disclosure may be used to anchor other elements in a bone tunnel including suture tapes, cables, soft tissues, grafts, and other elements. While illustrative examples of methods depict the attachment of the soft tissue of the rotator cuff to a humeral bone, it will be understood that examples of instruments and methods of the present disclosure may be used to anchor any member in any bone, at surgical sites anywhere in a patient's body, and for any purpose.
(83) Standard medical planes of reference and descriptive terminology are employed in this specification. While these terms are commonly used to refer to the human body, certain terms are applicable to physical objects in general. A standard system of three mutually perpendicular reference planes is employed. A sagittal plane divides a body into right and left portions. A coronal plane divides a body into anterior and posterior portions. A transverse plane divides a body into superior and inferior portions. A mid-sagittal, mid-coronal, or mid-transverse plane divides a body into equal portions, which may be bilaterally symmetric. The intersection of the sagittal and coronal planes defines a superior-inferior or cephalad-caudal axis. The intersection of the sagittal and transverse planes defines an anterior-posterior axis. The intersection of the coronal and transverse planes defines a medial-lateral axis. The superior-inferior or cephalad-caudal axis, the anterior-posterior axis, and the medial-lateral axis are mutually perpendicular. Anterior means toward the front of a body. Posterior means toward the back of a body. Superior or cephalad means toward the head. Inferior or caudal means toward the feet or tail. Medial means toward the midline of a body, particularly toward a plane of bilateral symmetry of the body. Lateral means away from the midline of a body or away from a plane of bilateral symmetry of the body. Axial means toward a central axis of a body. Abaxial means away from a central axis of a body. Ipsilateral means on the same side of the body. Contralateral means on the opposite side of the body.
(84) Proximal means toward the trunk of the body. Proximal may also mean toward a user or operator. Distal means away from the trunk. Distal may also mean away from a user or operator. Dorsal means toward the top of the foot. Plantar means toward the sole of the foot. Antegrade means forward moving from a proximal location/position to a distal location/position or moving in

a forward direction. Retrograde means backward moving from a distal location/position to a proximal location/position or moving in a backwards direction.

(85) The terms “suture” and/or “suture strand” are used herein to mean any strand or flexible member, natural or synthetic, able to be anchored in a bone tunnel and useful in a surgical procedure. In certain embodiments, “suture” and/or “suture strand” refers to a flexible line or flexible member of natural material, natural biological material, biomaterial, biomimetic materials, manmade material, or a combination of these either in a single structure, a composite structure, or a plurality of tissue structures that extend in parallel and/or may be woven or bonded together. In certain embodiments, a suture may be long and thin. In certain embodiments, a suture may be planar or may be elastic or inelastic. Examples of a suture include, but are not limited to, a thread, a suture, suture tape, a woven structure, a fibrous material, a cord, and/or any of these in combination with each other, and the like. The term “transverse” is used herein to mean to cross at an angle; i.e. not parallel. The term includes but is not limited to right angles.

(86) FIGS. **1-12** depict an illustrative example of a suture anchor. The anchor **100** has an anchor body **102**, a proximal member **104** joined to the anchor body **102** by a frangible connection **106** and a suture locking member **160**. The frangible connection may include, for example, a thin wall (as shown), a perforated section, an intermediate material such as an adhesive, and/or other suitable frangible constructions. In the illustrative example of FIGS. **1-12**, the anchor body **102** is generally cylindrical and has a sidewall **103** (FIG. **10**) defining an exterior surface, a proximal end **108**, a distal end **110**, and a longitudinal axis **112** extending between the proximal and distal ends **108**, **110**. An interior longitudinal passageway **114** extends at least partway from the proximal end **108** toward the distal end **110**. A proximal opening communicates with the longitudinal passageway nearer the proximal end **108** and a distal opening communicates with the longitudinal passageway nearer the distal end **110**. In the illustrative embodiment of FIGS. **1-12**, the proximal opening **116** communicates through the proximal end **108** of the anchor body **102** along the axis **112** with the passageway **114**. The distal opening comprises a plurality of distal openings that communicate from the exterior surface of the anchor body **102** through the sidewall **103** to the passageway **114**.

(87) In the illustrative example of FIGS. **1-12**, the distal openings include a single superior opening **118** and two inferior openings **120**, **122**. The superior opening **118** is formed through the sidewall **103** and centered over the longitudinal axis of the anchor body. The two inferior openings **120**, **122** are formed through the sidewall **103** opposite the superior opening **118** and spaced on either side of the longitudinal axis and separated by a dividing wall **124**. All of the superior and inferior distal openings **118**, **120**, **122** are spaced proximally away from the distal end **110** of the anchor body.

(88) In the illustrative example of FIGS. **1-12**, the anchor body **102** has a first exterior dimension **128**, perpendicular to the longitudinal axis, over a first portion **130** of its exterior length **132**; a second exterior dimension **134**, perpendicular to the longitudinal axis, greater than the first dimension **128**, over a second portion **136** of its exterior length **132**; and a third exterior dimension **138**, perpendicular to the longitudinal axis, greater than the second dimension **134**, over a third portion **140** of its exterior length **132**. For example, the first dimension **128** may be less than or equal to a radial dimension of a bone hole to ease alignment and initial insertion of the anchor body **102** into the bone hole. The second dimension **134** may be larger than the radial dimension of the bone hole to create a press fit of the second portion **136** within the bone hole to resist removal of the anchor body **102** from the bone hole. The third dimension **138** may create an even tighter press fit in the bone hole. The third portion **140** will require the greatest insertion force. By making the length of the third portion **140** relatively short, the total effort to insert the anchor body **102** will be lessened and the maximum insertion force will only be required to insert the relatively short third portion. The second and third portions **136**, **140** may also have ribbed surfaces to further resist removal of the anchor body **102** from the bone hole. The spacing, or pitch, of the ribs may vary. For example, the second portion **136** may have ribs with relatively wider spacing for positioning in a relatively wide band of cancellous bone and the third portion **140** may have ribs with relatively

narrower spacing for positioning in a relatively narrow band of cortical bone.
(89) In the illustrative example of FIGS. **1-12**, the proximal member **104** is generally cylindrical and has a sidewall **150** (FIG. **10**) defining an exterior surface, a proximal end **152**, a distal end **154**, and a longitudinal axis coaxial with the anchor body longitudinal axis **112** extending between the proximal and distal ends **152**, **154**. An axial through bore **156** extends through the proximal member **104** from the proximal end **152** to the distal end **154** and communicates with the longitudinal passageway **114** of the anchor body **102**. At least one opening formed through the sidewall **150** of the proximal member **104** allows one or more sutures to be routed through the anchor body **102** without passing through the proximal end of the proximal member axial through bore **156**. In the illustrative example of FIGS. **1-12**, a first, superior "U"-shaped opening **158** is formed through the sidewall **150** near the distal end **154** and a second, inferior "U"-shaped opening **159** is formed through the sidewall **150** near the distal end **154** opposite the first opening **158**. The "U"-shaped openings intersect the frangible connection **106**. While the proximal member **104** and anchor body **102** are joined, the "U"-shaped openings **158**, **159** each have a closed perimeter. When the proximal member **104** and anchor body **102** are separated at the frangible connection **106**, the distal perimeter of each opening **158**, **159** is removed such that separation of the proximal member **104** and anchor body **102** at the frangible connection **106** transforms the opening **158**, **159** into open, "U"-shaped slots with the open side facing distally. The proximal member **104** includes an engagement portion for engaging a driver. In the illustrative example of FIGS. **1-12**, the engagement portion includes an internal helical thread **161** operable to engage a driver in axial force transmitting relationship.
(90) In the illustrative example of FIGS. **1-12**, the suture locking member **160** is in the form of an interference member operable to axially slide into the longitudinal passageway **114** of the anchor body **102** to secure a suture within the longitudinal passageway **114** by compressing the suture between the locking member **160** and the anchor body **102**. In the illustrative example of FIGS. **1-12**, the suture locking member **160** has an elongate cylindrical body **162** having a proximal end **164**, a distal end **166**, and a longitudinal axis **168** extending between the proximal and distal ends **164**, **166**. The body **162** has a dimension perpendicular to the longitudinal axis **168** less than or equal to the diameter of the anchor body passageway **114**. Preferably the body **162** tapers distally. More preferably the body **162** tapers to a point **170**.
(91) In the illustrative example of FIGS. **1-12**, the suture locking member **160** is mounted in the axial through bore **156** of the proximal member **104** in axial sliding relationship so that it may be pressed out of the proximal member **104** and into the anchor body **102** to lock a suture in the anchor body **102**.
(92) In the illustrative example of FIGS. **1-12**, the suture locking member **160** is retained in the proximal member **104** by a retainer **180** having an outer surface engaging the axial through bore **156** of the proximal member in axial sliding relationship and an axial aperture **182** receiving the locking member **160** in axial sliding relationship. The retainer **180** is also arranged to engage the anchor body **102** in axial force transmitting relationship. In the illustrative example of FIGS. **1-12**, the retainer **180** is generally cylindrical and the axial aperture **182** extends through the retainer **180** from a proximal end **183** to a distal end **184**. The outer diameter of the distal end **184** of the retainer **180** is larger than the diameter of the passageway **114** in the implant body **102**. The distal end of the retainer **180** is operable to engage the proximal end of the implant body **102**. The retainer **180** includes opposed superior and inferior "U"-shaped slots **186**, **188** opening distally and aligning with the superior and inferior "U"-shaped openings **158**, **159** in the proximal member **104** when the retainer **180** is seated in the proximal member **104**. The retainer **180** includes a distal facing shoulder **190** operable to engage a proximal facing shoulder **192** formed in the through bore **156** of the proximal member to prevent the retainer from being completely expelled distally from the proximal member **104**.
(93) FIG. **13** depicts an illustrative example of an inserter **200** for use with the suture anchor **100**.

FIGS. **14-19** depict the inserter **200** in use with the suture anchor **100**. The inserter **200** extends from a proximal end **202** to a distal end **204**. The inserter **200** has an elongated hollow shaft **206** and an elongated pushrod **208** mounted for axial translation within the hollow shaft. The shaft **206** includes an engagement feature at its distal end operable to engage the proximal member **104** of the suture anchor **100** in axial force transmitting relationship. In the illustrative example of FIG. **13**, the shaft **206** includes an external helical thread **216** engageable with the internal helical thread **161** of the proximal member **104** (FIG. **14**). The distal end of the pushrod **208** has a first portion **210** sized to engage the proximal end of the suture locking member **160** in axial force transmitting relationship while being operable to slide through the aperture **182** of the retainer **180**. The distal end of the pushrod **208** has a second portion **212** sized to engage the proximal end of the retainer **180** in axial force transmitting relationship. The first portion **210** extends distally from the second portion **212**. An advancement mechanism **214** at the proximal end of the inserter **200** is operable to advance the pushrod **208** distally relative to the shaft **206**. For example, the advancement mechanism **214** may include any pushrod advancement mechanism such as those well known in the art for advancing plungers in syringe injectors, bone cement injectors, and other liquid and paste dispensers. The example of FIG. **13** illustrates such a mechanism including a trigger mounted to a base member in pivoting relationship. The pushrod is slidingly engaged with the base member and a pair of advancement plates. When the trigger is actuated, it presses on the advancement plates causing them to tilt and bind on the pushrod. Further actuation of the trigger advances the advancement plates and the pushrod distally together. When the trigger is released, a spring straightens the advancement plates and moves the advancement plates and the trigger proximally back to their initial positions. A ratchet mechanism prevents the pushrod from moving proximally. The ratchet mechanism includes ratchet teeth cut into the proximal end of the pushrod and a spring loaded ratchet pawl mounted in the base member at the rear of the pushrod. An actuator (not shown) may be actuated to disengage the ratchet pawl so that the pushrod may be moved proximally and reset to its initial position.

(94) Referring to FIGS. **14-19** one or more sutures are threaded through the anchor body **102** between the proximal and distal openings. In the illustrative example of FIGS. **14-19**, separate suture limbs **220**, **222** are threaded through each of the inferior distal openings **120**, **122** of the anchor body **102**, through the longitudinal passageway **114** of the anchor body **102**, out the proximal opening **116** of the anchor body **102** and down through the inferior "U"-shaped slot **188** of the retainer **180** and the inferior "U"-shaped opening **159** of the proximal member **104**. The suture locking member **160** is retained within the retainer **180** which is received in the proximal member **104**. The shaft **206** of the inserter **200** is threadingly engaged with the proximal end of the proximal member **104**.

(95) In FIG. **15**, the advancement mechanism **214** has been operated to advance the pushrod **208** so that it has pushed the suture locking member **160** out of the proximal member **104** and into the anchor body **102** to secure the suture limbs **220**, **222** within the anchor body **102**. Preferably, the first portion **210** of the pushrod **208** extends sufficiently far distally from the second portion **212** of the pushrod **208** that the suture locking member **160** is fully inserted into the anchor body **102** before the second portion **212** of the pushrod begins to transmit axial force through the retainer **180** to the proximal end **108** of the anchor body **102**. Once the suture locking member **160** is fully inserted, further operation of the advancement mechanism **214** presses the second portion **212** of the pushrod against the retainer **180** which presses against the anchor body **102** causing anchor body **102** to separate from the proximal member **104** at the frangible connection **106** as shown in FIG. **16**. Separation of the members transforms the "U"-shaped openings **158**, **159** of the proximal member **104** into distally open "U"-shaped slots that will release the suture limbs **220**, **222** sideways out of the slots without the need for the ends of the suture limbs to be pulled through the openings **158**, **159**. In this way, the suture limbs **220**, **222** will be released from the proximal member **104** even if the ends of the suture limbs **220**, **222** are attached at another location or

otherwise inaccessible.
(96) FIGS. **20-23** depict an illustrative example of a suture routing through the suture anchor **100**. A suture threader **280** is pre-loaded into the anchor body **102**. The suture threader includes a filament **282** forming a distal loop portion **284** and a proximal grip portion **286** joined to the loop portion. The suture threader **280** is inserted through the longitudinal passageway of the anchor body from the superior distal opening **118** to the proximal opening **116** with at least part of the loop portion **284** extending up and out of the superior "U"-shaped opening **158** of the proximal member **104** and the grip portion **286** extending out of the distal opening **118**. In the illustrative example of FIGS. **20-23**, two sutures **250**, **251** are depicted. Any number of sutures may be utilized in accordance with the present disclosure and each of the depicted sutures may represent multiple sutures that are routed together. For simplicity, the suture locking member **160** and retainer **180** have been omitted from FIGS. **20-23** and the routing of only one suture **250** of the illustrated sutures will be described in detail. The suture **250** is threaded through an inferior distal opening **122** of the anchor body **102**, with a first portion **252** extending through the longitudinal passageway **114** of the anchor body **102** between the proximal opening **116** and the distal opening. A proximal end **254** of the suture **250** extends out the proximal opening **116** of the anchor body **102** and down through the inferior "U"-shaped slot **188** of the retainer **180** (not shown) and the inferior "U"-shaped opening **159** of the proximal member **104**. In FIG. **21**, a second portion **256** of the suture **250** contiguous to the first portion **252** extends away from the anchor body **102**. A distal end **258** of the suture **250** is inserted through the loop portion **284** of the threader **280**. The threader **280** is pulled distally through the anchor body **102** to route the distal end **258** of the suture **250** back through the anchor body **102** so that a third portion **260** of the suture contiguous to the second portion **256** extends within the longitudinal passageway **114** between the proximal opening **116** and the superior distal opening **118**. The distal end **258** of the suture is then pulled proximally so that a fourth portion **262** of the suture contiguous to the third portion **260** extends along the exterior surface of the anchor body **102** between the distal opening **118** and the proximal end **108**. The suture locking member **160** may then be inserted into the anchor body to secure the first portion **252** of the suture and the third portion **260** of the suture within the longitudinal passageway by compressing the suture portions between the suture locking member **160** and the anchor body **102**. For example, the suture may be compressed between the sides of the suture locking member and the interior sidewall of the anchor body as shown in FIGS. **15** and **16**. In an example according to the present disclosure, the suture **250**, **251** and threader may be provided preloaded to the anchor as shown in the configuration of FIG. **20**.
(97) FIGS. **24-31** illustrate a suture keeper **300** for managing the suture anchor **100** and sutures in storage and use. Referring to FIG. **24**, the suture anchor **100** is prepared as in FIG. **20** with the threader **280** inserted into the suture anchor **100** with the grip portion **286** extending out of the superior distal opening **118** and the loop portion **284** extending out of the superior "U"-shaped opening **158**. Four suture strands are loaded in the suture anchor. Preferably each suture strand is uniquely identifiable such as by color, pattern, or otherwise. A first pair of suture strands **310**, **311** extends through the longitudinal passageway **114** with proximal ends **312**, **313** extending from the inferior "U"-shaped opening **159** and distal ends **314**, **315** extending from the first inferior distal opening **120**. A second pair of suture strands **320**, **321** extends through the longitudinal passageway **114** with proximal ends **322**, **323** extending from the inferior "U"-shaped opening **159** and distal ends **324**, **325** extending from the second inferior distal opening **122**.
(98) Referring to FIG. **25**, the suture keeper **300** includes an elongate, generally planar body **330** extending from a proximal end **332** to a distal end **334** and having a length **336** between the proximal and distal ends **332**, **334** and a width **338** between first and second sides **326**, **328**. A first slot **340** formed in the body **330** defines a first, proximal, cantilevered tab **342** free at its distal end **344**. Preferably the first slot **340** is narrower than the suture anchor **100** so that the suture anchor can lie in the first slot **340** without passing through the first slot **340**. A second slot **346** defines a

second, distal, cantilevered tab **348** free at its proximal end **350**. Four holes are formed through the body **330** adjacent the first slot **340** with a first pair of holes **352**, **354** adjacent a side of the first slot **340** nearer the first side **326** of the body **330** and a second pair of holes **356**, **358** adjacent an opposite side of the first slot **340** nearer the second side **328** of the body **330**. First and second spaced apart proximal notches **360**, **362** are formed into the proximal end **332** of the body **330** with the notches **360**, **362** being nearer the first and second sides **326**, **328** of the body **330** respectively. First and second spaced apart distal notches **364**, **366** are formed into the distal end **334** of the body **330** with the notches **364**, **366** being nearer the first and second sides **326**, **328** of the body respectively. First and second spaced apart distal slits **368**, **369** are formed in the distal end **334** of the body **330** with the slits **368**, **369** being nearer the first and second sides **326**, **328** of the body respectively. Preferably the distal slits **368**, **369** are located between the distal notches **364**, **366**. In the illustrative example of FIG. **25**, the suture keeper is made from a thin, flexible sheet of material.

(99) Referring to FIG. **26**, a tube **370** is placed over the distal ends of the suture strands of the suture anchor **100** of FIG. **24**. Optionally, the tube may be a dual lumen tube so that each pair of suture strands passes through a separate lumen in the tube further isolating the first and second pairs from one another. Preferably, the tube **370** is frangible so that it may be torn from the sutures. For example, a thin walled tube **370** may be torn along its length to split the tube and remove it laterally away from the sutures. One or more starter notches may be formed in the sidewall at one or both ends to facilitate tearing the tube. The proximal ends **312**, **313**, **322**, **323** of the first and second suture pairs are passed through the first slot **340**. The proximal ends **312**, **313** of the first suture pair is passed through the distal most hole **354** of the first pair of holes and then through the proximal most hole **352** of the first pair of holes. The proximal ends **322**, **323** of the second suture pair is passed through the distal most hole **356** of the second pair of holes and then through the proximal most hole **358** of the second pair of holes. The proximal ends **312**, **313**, **322**, **323** are all tied together to join them to the suture keeper **300** (FIG. **27**). Thus joined, the suture keeper prevents the proximal ends from being pulled back into the suture anchor **100**. The suture anchor **100** is mounted on the suture keeper **300** by bending the proximal and distal tabs **342**, **348** upwardly and inserting the suture anchor **100** into the first slot **340** between the tabs with the proximal tab **342** pressing against the proximal end **152** of the proximal member **104** and the distal tab **348** pressing against the distal end **110** of the anchor body **102** to releasably hold the suture anchor **100**. The first pair of suture strands **310**, **311** is positioned in the first distal notch **364** and the second pair of suture strands **320**, **321** is positioned in the second distal notch **366**.

(100) FIG. **27** is a rear view of the configuration of FIG. **26**.

(101) Referring to FIG. **28**, the suture strands are folded back through the distal notches so that the suture strands and tube **370** lie along the back of the suture keeper **300**. The first pair of suture strands **310**, **311** is positioned in the first proximal notch **360** and the second pair of suture strands **320**, **321** is positioned in the second proximal notch **362**.

(102) Referring to FIG. **29**, the suture strands are wrapped around the suture keeper **300** between the proximal and distal notches as many times as necessary to contain the length of the suture strands while keeping the first pair of strands together on the first side and the second pair of strands together on the second side. The ends of the sutures are pulled into the slits **368**, **369** to secure the sutures to the suture keeper **300**.

(103) FIG. **30** is a rear view of the configuration of FIG. **29**.

(104) FIG. **31** is a side view of the configuration of FIG. **29**.

(105) FIGS. **32-41** illustrate a transosseous surgical repair method using the components illustrated in FIGS. **1-31**. The illustrative method of FIGS. **32-41** depicts a rotator cuff repair. However, the implants, instruments, and method illustrated may be used to form transosseous attachments at other locations and for other purposes.

(106) Referring to FIG. **32**, a lateral tunnel **400** has been formed into a humerus **402**. First and second medial tunnels **404**, **406** have been formed into the humerus **402**. The medial tunnels **404**,

**406** are spaced apart at the surface of the bone near the rotator cuff **408** and the medial tunnels **404**, **406** intersect the lateral tunnel **400** inside the humerus **402**. First and second suture shuttles **410**, **412** are inserted into the medial tunnels **404**, **406** and exit the bone through the lateral tunnel **400**. The sutures are unwound from the suture keeper and the first pair of suture strands **310**, **311** is engaged with the first suture shuttle **410** and the second pair of suture strands **320**, **321** is engaged with the second suture shuttle **412**. By utilizing the suture keeper **300** to manage the sutures, the various strands of sutures may be easily isolated to prevent tangling and to facilitate independent manipulation of a desired suture strand. The tube **370** may be positioned within a surgical portal (not shown) and acts to confine the suture strands to prevent them from entangling one another and/or instruments and other items passed through the portal.

(107) Referring to FIG. **33**, the suture shuttles **410**, **412** have been pulled to shuttle the suture strands through the bone tunnels.

(108) Referring to FIG. **34**, the first pair of suture strands **310**, **311** has been passed through the rotator cuff **408**.

(109) Referring to FIG. **35**, the second pair of suture strands **320**, **321** has been passed through the rotator cuff **408** and the rotator cuff **408** has been repositioned to a desired lateral margin of the humerus.

(110) Referring to FIG. **36**, a simple overhand knot **420**, **421** has been tied in each suture pair. This may be done easily outside the cannula, outside of the patient's body without the need for arthroscopic knot tying techniques.

(111) Referring to FIG. **37**, the proximal portions of the sutures may be pulled to move the knots **420**, **421** into the patient to a position adjacent to the rotator cuff **408**. Since the suture strands have been kept separate by the suture keeper **300** and the surgical technique, the knots **420**, **421** may be independently positioned and tensioned to provide precise control over the final position and tension of the rotator cuff **408**. The distal ends **314**, **315**, **324**, **325** of the suture pairs are passed through the loop **284** of the suture threader **280**.

(112) Referring to FIG. **38**, the suture threader **280** is pulled out the distal end of the suture anchor **100** to thread the suture strands back through the suture anchor **100** as shown in FIGS. **20-23**. The protective tube **370** is split and removed laterally away from the sutures.

(113) Referring to FIG. **39**, the inserter **200** is engaged with the proximal member **104** of the suture anchor **100**. Any slack in the suture strands may be pulled through the suture anchor **100** by pulling on the proximal ends of the suture strands retained by the suture keeper **300**. The suture anchor **100** is inserted into the lateral bone tunnel **400**. A mallet **424** may be used to impact the end of the inserter **200** to urge the suture anchor into the lateral bone tunnel **400**.

(114) Referring to FIG. **40**, the distal portions of the suture strands have passed through the anchor body twice and have been pulled back proximally along the outside of the anchor body so that they are compressed between the anchor body and the bone tunnel wall. The proximal portions of the sutures have passed through the anchor body once, exited outwardly through the inferior distal openings, and then been pulled superiorly through the medial tunnels. This suture routing provides sufficiently low friction that the friction may be overcome by a user to independently pull each suture strand through the anchor body **102** to adjust the position and tension of the soft tissue yet sufficiently high friction that when the suture strands are released the imparted position and tension are maintained so the user can evaluate the repair and determine if further adjustments are needed. The inserter **200** may be used to provide an axial counterforce to keep the anchor body **102** in the bone tunnel while adjustments are made. Once the sutures are adjusted as desired, the inserter **200** is actuated to press the suture locking member **160** into the suture anchor **100** and secure the sutures to the suture anchor **100**. The inserter **200** is further actuated to press the retainer **180** against the proximal end of the anchor body **102** and separate the proximal member **104** from the anchor body **102**. When the proximal end **104** separates from the anchor body **102**, the “U”-shaped openings **158**, **159** transform into distally opening slots and the sutures release distally from the

slots as the proximal end **104** is pulled away from the bone.
(115) If desired, the proximal ends **312**, **313**, **322**, **323** of the suture strands may be separated from the suture keeper **300**, such as by cutting the sutures, and the ends of the sutures may be passed through the soft tissue to form adjunctive stitches to further anchor the soft tissue. The proximal suture ends are preferably used since any loads carried by the proximal suture ends only act perpendicularly on the proximal end of the anchor and thus, they do not exert a significant axial force tending to dislodge the anchor body from the lateral tunnel **400**.
(116) Referring to FIG. **41**, any remaining suture ends are trimmed.
(117) FIGS. **42-48** depict a suture anchor **500** according to an example of the present disclosure. The suture anchor **500** is the same as the suture anchor **100** of the example of FIGS. **1-12** except for the configuration of the distal openings. The anchor **500** has an anchor body **502**, a proximal member **504** joined to the anchor body **502** by a frangible connection **506** and a suture locking member **560** all configured as in the example of FIGS. **1-12**. The anchor body **502** is generally cylindrical and has a sidewall **503** defining an exterior surface, a proximal end **508**, a distal end **510**, and a longitudinal axis **512** extending between the proximal and distal ends **508**, **510**. An interior longitudinal passageway **514** extends at least partway from the proximal end **508** toward the distal end **510**. A proximal opening **516** communicates through the proximal end **508** of the anchor body **502** along the axis **512** with the interior longitudinal passageway **514**. The distal opening comprises a plurality of distal openings that communicate from the exterior surface of the anchor body **502** through the sidewall **503** to the interior longitudinal passageway **514**. In the illustrative example of FIGS. **42-48**, the distal openings include a first, more proximal superior opening **518** and a second, more distal superior opening **520**. The first and second distal openings **518**, **520** are formed through the sidewall **503** to communicate with the interior longitudinal passageway **514** and are centered over the longitudinal axis **512** on the same side of the anchor body. The first and second distal openings **518**, **520** are spaced proximally away from the distal end **510** of the anchor body. In the example of FIGS. **42-48**, the second opening **520** is elongated longitudinally and communicates with a proximally sloping passage **521** that connects it to the interior longitudinal passageway **514**.
(118) FIG. **49** depicts the anchor **500** of FIGS. **42-48** preloaded with first and second suture threaders **600**, **610**. The first threader **600** includes a proximal grip portion **604** and a filament forming a distal loop portion **602** joined to the grip portion. The first threader includes a semi-circular clip **606** sized to snap onto the anchor body to releasably secure the threader to the anchor body. The first suture threader **600** is engaged with the anchor by inserting the distal loop portion **602** through the inferior "U"-shaped opening **559** of the proximal member **504**, through the proximal opening **516**, along the longitudinal passageway **514**, and out through the second superior opening **520**. The grip portion is clipped to the anchor body. The second threader **610** includes a proximal grip portion **614** and a filament forming a distal loop portion **612** joined to the grip portion. The second threader includes a pair of semi-circular clips **616**, **618** sized to snap onto the anchor body to releasably secure the threader to the anchor body. The second suture threader is engaged with the anchor by inserting the distal loop portion **602** through the first superior opening **518**, along the proximally sloping passage **521**, along the longitudinal passageway **514**, through the proximal opening **516**, and out the superior "U"-shaped opening **558** of the proximal member **504**. The grip portion is clipped to the anchor body with the second suture threader clips **616**, **618** straddling the first suture threader clip **606**.
(119) In the example of FIG. **49** the threaders are labeled to facilitate their use in a procedure to attach, for example, a tendon to a bone. The first suture threader **600** is labeled with a "1" and the message "TUNNEL SUTURES" to indicate that it is used, preferably first, to thread sutures extending from the bone tunnel in which the anchor will be seated through the anchor. The second suture threader **610** is labeled with a "2" and the message "TENDON SUTURES" to indicate that it is used, preferably second, to thread sutures extending from the soft tissue, tendon in this example,

through the suture anchor.
(120) FIG. **50** also depicts the anchor **500** of FIGS. **42-48** preloaded with first and second suture threaders **630**, **610**. In this example, the first threader **630** is extended and a tube **632**, like the tube **370** of FIG. **26**, is placed over the extended portion of the suture threader **630**. The tube may, for example, be used to protect, confine, separate, or otherwise aid in suture management as previously described relative to the example of FIG. **26**. In the example of FIG. **50**, the proximal end of the tube includes an enlarged cylindrical portion **634** that is sized to press over the distal end of the anchor body to releasably join the tube **632** to the anchor. The distal loop portion **636** of the first threader extends out the distal end of the tube **632**. As in the example of FIG. **26**, the tube **632** is preferably frangible. For example, the tube is preferably longitudinally splittable.
(121) FIGS. **49** and **50** are examples in which a suture anchor is provided for use without any sutures preloaded with the anchor. This provides maximum flexibility to the user to choose the type and number of sutures to be used and also allows for suture manipulation during the surgical procedure without the anchor potentially interfering with certain suture passing techniques. The threaders are pre-loaded to facilitate threading the sutures through the anchor once the sutures are selected and/or positioned in the bone and soft tissue. The configuration of the example of FIG. **49** is compact and may be more suitable for open or shallow minimally invasive surgical procedures. The configuration of the example of FIG. **50** may be more suitable for arthroscopic or otherwise deep surgical procedures in which suture management is more challenging.
(122) FIG. **51** depicts an example of suture routing through the suture anchor **500** of FIGS. **42-48** such as for example using the threaders of FIG. **49** or **50**. For example, in a transosseous soft tissue fixation procedure, one or more sutures may be extended through a bone tunnel with a first portion of the suture extending from a first opening of the bone tunnel and a second portion of the suture extending from a second opening of the bone tunnel. For example, in a rotator cuff repair procedure a first portion of suture may extend from a lateral opening of a tunnel formed in a humeral bone and a second portion of suture may extend from a medial opening at a desired attachment location for the soft tissue. The second portion may be passed through soft tissue, for example tissue of the rotator cuff, and extended away from the soft tissue.
(123) The suture may be threaded through the anchor **500** using the suture threaders. In an example, the first portion of suture **650** is threaded through the distal loop portion **602** of the first suture threader **600**. The grip portion **604** of the first suture threader is grasped and pulled to disengage the clip **606** from the anchor body and pull the first portion of suture **650** through the second superior opening **520** in the suture anchor body, proximally along the longitudinal passageway **514**, through the proximal opening **516**, and out through the inferior "U"-shaped opening **559**. The second portion of suture **652** is threaded through the distal loop portion **612** of the second suture threader **610**. The grip portion **614** of the second suture threader is grasped and pulled to disengage the clips **616**, **618** from the anchor body and pull the second portion of suture **652** through the superior "U"-shaped opening **558**, through the proximal opening **516**, distally along the longitudinal passageway **514**, and out through the first superior opening **518**.
(124) FIGS. **52-61** depict an illustrative example of a suture anchor **700**. The suture anchor **700** has an anchor body **702**, a proximal member **704** joined to the anchor body **702** by a frangible connection **706** and an interference member **770**. The frangible connection may include, for example, a thin wall (as shown), a perforated section, an intermediate material such as an adhesive, and/or other suitable frangible constructions or structures.
(125) In the illustrative example of FIGS. **52-61**, the anchor body **702** is generally cylindrical and has a sidewall **750** (FIG. **61**) defining an exterior surface, a proximal end **708**, a distal end **710**, and a longitudinal axis **712** extending between the proximal and distal ends **708**, **710**. An interior longitudinal passageway **714** extends at least partway from the proximal end **708** toward the distal end **710**. A proximal opening communicates with the longitudinal passageway nearer the proximal end **708** and a distal opening communicates with the longitudinal passageway nearer the distal end

**710**. In the illustrative embodiment of FIGS. **52-61**, the proximal opening **716** communicates through the proximal end **708** of the anchor body **702** along the axis **712** with the passageway **714**. The distal opening comprises a plurality of distal openings that communicate from the exterior surface of the anchor body **702** through the sidewall **750** to the passageway **714**.

(126) In certain embodiments, the anchor body **702** includes a set of internal helical threads **717** near the proximal end **708** of the anchor body **702**. In one embodiment, the internal helical threads **717** are in communication with the proximal opening **716**. The internal helical threads **717** may serve to engage, partially engage, interface with or communicate with an interference member **770** positioned within the longitudinal passageway **714**.

(127) In the illustrative example of FIGS. **52-61**, the distal openings include a first, more proximal superior opening **718** and a second, more distal superior opening **720**. The first superior opening **718** and second superior opening **720** are formed through the sidewall **750** to communicate with the interior longitudinal passageway **714** and centered over the longitudinal axis of the anchor body **702**. The first superior opening **718** and second superior opening **720** are spaced proximally away from the distal end **710** of the anchor body **702** and can be aligned with each other.

(128) In the illustrative example of FIGS. **52-61**, the proximal member **704** is generally cylindrical and has a sidewall **751** (FIG. **61**) defining an exterior surface, a proximal end **752**, a distal end **754**, and a longitudinal axis coaxial with the anchor body longitudinal axis **712** extending between the proximal and distal ends **752**, **754**. An axial through bore **756** extends through the proximal member **704** from the proximal end **752** to the distal end **754** and communicates with the longitudinal passageway **714** of the anchor body **702**.

(129) At least one opening formed through the sidewall **751** of the proximal member **704** and/or through the sidewall **750** of the anchor body **702** allows one or more sutures to be routed through the anchor body **702** without passing through the proximal end of the proximal member axially through the axial through bore **756**. In the illustrative example of FIGS. **52-61**, a first, superior "U"-shaped opening **758** is formed through the sidewall **751** near the distal end **754** and a second, inferior "U"-shaped opening **759** is formed through the sidewall **751** near the distal end **754** which may be opposite the first opening **758**.

(130) The "U"-shaped openings intersect the frangible connection **706**. While the proximal member **704** and anchor body **702** are joined, the "U"-shaped openings **758**, **759** each have a closed perimeter. When the proximal member **704** and anchor body **702** are separated at the frangible connection **706**, the distal perimeter of each opening **758**, **759** is removed such that separation of the proximal member **704** and anchor body **702** at the frangible connection **706** transforms the opening **758**, **759** into open, "U"-shaped slots with the open side facing distally.

(131) The proximal member **704** includes an engagement portion for engaging a driver, inserter, tensioner, or other instrument. In the illustrative example of FIGS. **52-61**, the engagement portion includes external helical threads **760** operable to engage a driver, inserter, tensioner, or other instrument for deployment of the suture anchor **700**.

(132) In the illustrative example of FIGS. **52-61**, the interference member **770** is operable to axially slide into the longitudinal passageway **714** of the anchor body **702** to secure a suture within the longitudinal passageway **714** by compressing the suture between the interference member **770** and the anchor body **702**. In certain embodiments, the interference member **770** is embodied as a set screw. In one embodiment, the interference member **770** is a set screw that may be similar, or the same, in structure, function, and construction to embodiments of a set screw recited in U.S. Pat. No. 10,682,131, issued Jun. 16, 2020, which is hereby incorporated by reference in its entirety.

(133) In the illustrative example of FIGS. **61-65**, the interference member **770** has a body **772** having a proximal end **774**, a distal end **776**, and a longitudinal axis **778** extending between the proximal and distal ends **774**, **776**. The body **772** has a dimension perpendicular to the longitudinal axis **778** less than or equal to the diameter of the longitudinal passageway **714**. Preferably the body **772** tapers distally. More preferably the body **772** tapers to a point **780**.

(134) The interference member **770** includes one or more external helical threads **782** on an external surface of the interference member **770**. In various embodiments, the interference member **770** can include a variety of thread designs, each having one or more of a number of thread pitch configurations and/or sizes. In the illustrated embodiment, the external helical threads **782** of the interference member **770** are knuckle threads. The knuckle threads may have an external helical thread pitch that differs from an internal helical thread pitch of the internal helical threads **717** of the anchor body **702**.
(135) In the illustrative example of FIGS. **52-61**, the interference member **770** can be inserted distally into the longitudinal passageway **714**. In one embodiment, one or more of the external helical threads **782** may engage or interface with one or more internal helical threads **717** of the anchor body **702** to secure a portion of a suture within the longitudinal passageway **714** by compressing the portion of the suture between the interference member **770** and the anchor body **702**. Said another way, the interference member **770** can be placed in the axial through bore **756** of the proximal member **704** at the proximal end **752** in axial sliding relationship so that the interference member **770** can exit the proximal member **704** and engage and/or interface with one or more internal helical threads **717** of the anchor body **702** to lock a suture in the anchor body **702**.
(136) Advantageously, the interference member **770** is configured to permit the interference member **770** to secure or lock a suture, or portion of a suture, in the anchor body **702** or release a suture, or portion of a suture, that is locked within the anchor body **702**. In other words, the interference member **770** can be locked or unlocked (i.e., engaged or disengaged, secured or unsecured) within the anchor body **702** by way of the external helical threads **782** of the interference member **770**, internal helical threads **717** of the anchor body **702**, and the drive recess **790**.
(137) FIG. **62** is a perspective view of the interference member of FIG. **52** according to one embodiment. FIG. **63** is a side view of the interference member of FIG. **52** according to one embodiment. FIG. **64** is a right side view of the interference member of FIG. **52** according to one embodiment.
(138) FIG. **65** illustrates an embodiment of an interference member **770** that includes a drive recess **790**. In one embodiment, the drive recess **790** is configured to accept a drive feature of a driver. For example, the drive recess **790** may be in the shape of a torx recess for receiving a corresponding torx drive feature of a driver. Alternatively, or in addition, the drive recess **790** may receive a driver having a distal end in the shape of a point and configured to move distally within the longitudinal passageway **714** and thereby press the interference member **770** into the anchor body **702**.
(139) FIG. **66** is a perspective view of a suture anchor system **800** useable with the implant of FIG. **52** according to one embodiment. The suture anchor system **800** may serve one or more different or related purposes or functions. Consequently, the suture anchor system **800** may be referred to by different names. In one embodiment, the suture anchor system **800** is referred to as a tensioner. Alternatively, or in addition, the suture anchor system **800** can be referred to as an inserter. In still another embodiment, such as the examples illustrated, the suture anchor system **800** may also be referred to as an inserter **900** that includes a tensioner **1000**.
(140) The suture anchor system **800** can be used to insert a suture anchor **700** into tissue of a patient or into a cavity, such as a bone tunnel of a patient. Alternatively, or in addition, the suture anchor system **800** can be used to tension and secure one or more sutures and/or one or more portions of sutures. In one embodiment, the one or more sutures and/or one or more portions of sutures may extend from the suture anchor **700**.
(141) Referring to FIGS. **66-70**, the inserter **900** can include a shaft **902** having a proximal end **904** and a distal end **906**, a collar **908**, and a driver **910**. The shaft **902** is operable and configured to engage the proximal member **704** of the suture anchor **700** at the distal end **906** of the shaft **902**. In one embodiment, the shaft **902** includes internal threads **912** that engage external helical threads **760** (See FIG. **54**) of the proximal member **704**. The shaft **902** can also include external threads

**914** (See FIG. **68**) at or near the proximal end **904** of the shaft **902**. The tensioner **1000** may include a carriage **1002**, a puller **1004**, and the shaft **902** and the collar **908** of the inserter **900**. The tensioner **1000** is configured to engage the proximal member **704** of the suture anchor **700** and to secure a suture that may extend from the anchor body **702**. In certain embodiments, the tensioner **1000** is operable and configured to apply tension to a suture, or portion of suture, that extends from the anchor body **702** of a suture anchor **700**.

(142) Referring to FIGS. **67-70**, in one embodiment, the shaft **902** has an elongate cylindrical body **916**. The shaft **902** may include three sections: first section **918**, second section **920**, third section **922**. The first section **918** may have a first diameter and an exterior surface. The second section **920** may have a second diameter that is the same as the first diameter. In one embodiment, the second section **920** may include one or more planar surfaces **924**. The planar surface **924** can serve to restriction rotation of the carriage **1002** about the shaft **902**. In certain embodiments, having a single planar surface **924** the planar surface **924** creates a D-shaped cross-section within the second section **920**.

(143) In the illustrated embodiment, the second section **920** includes two opposite planar surfaces **924**. In addition, the planar surfaces **924** may form one or more lips **926** or edges. The one or more lips **926** may serve to restrict movement of a carriage **1002** towards the distal end **906** of the shaft **902** past the one or more lips **926**.

(144) The third section **922** connects to and extends from the second section **920**, just as the second section **920** connects to and extends from the first section **918**. In one embodiment, the third section **922** includes a second diameter that is smaller than the first diameter. In certain embodiments, the planar surface(s) **924** can extend into the third section **922**. The extending planar surfaces **924** can form one or more lips **928** between the second section **920** and the third section **922**. These one or more lips **928** may serve to restrict movement of a puller **1004** towards the distal end **906** of the shaft **902** past the one or more lips **928**. In one embodiment, the puller **1004** is connected to the shaft **902** near a proximal end **904** of the shaft **902**.

(145) The collar **908** can include proximal end **930**, a distal end **932**, and a head **934** connected to a shank **936**. The collar **908** serves to secure the puller **1004** to the shaft **902**. The collar **908** includes longitudinal opening **938** coaxial to a longitudinal axis of the collar **908**. The shaft **902** includes a longitudinal opening **940** coaxial to a longitudinal axis of the shaft **902**. Together the longitudinal opening **938** and longitudinal opening **940** can form an inserter longitudinal passageway **941**. The inserter longitudinal passageway **941** is in communication with a longitudinal passageway **114**, **514**, **714** of the suture anchor **100**, **500**, **700**. The inserter longitudinal passageway **941** enables instruments and other components to pass through the collar **908** and shaft **902** and into the suture anchor **700** or to engage with components of the suture anchor **700**.

(146) The head **934** is cylindrical and has a larger diameter than the shank **936**. The longitudinal opening **938** pass through the head **934** and the shank **936**. At the proximal end **930**, the head **934** includes internal threads **942** within the longitudinal opening **938**. At the distal end **932**, the shank **936** includes internal threads **944** (See FIG. **70**) within the longitudinal opening **938**. The internal threads **944** are configured to engage the external threads **914** of the shaft **902**.

(147) FIGS. **71-73** illustrate a carriage **1002** of the tensioner **1000** of FIG. **66** according to one embodiment. The carriage **1002** can include a body **1006**, a first handle **1008**, and a suture grip member **1010**. The first handle **1008** is configured and sized for easy grasping and use by a user's hands and figures.

(148) The body **1006** can include an opening **1012** that passes through the body **1006** and is coaxial with a longitudinal axis of the carriage **1002**. The carriage **1002** includes a proximal end **1014** and a distal end **1016**. At the distal end **1016**, the carriage **1002** includes internal threads **1018**. The internal threads **1018** are configured to engage threads of a puller **1004**. At the proximal end **1014**, the carriage **1002** includes keyed opening **1020**. The keyed opening **1020** is configured to accept the second section **920** of the shaft **902**. In certain embodiments, FIG. **72** illustrates that the keyed

opening **1020** may have a circular cross section and include opposite planar sides that correspond to the planar surfaces **924** on the shaft **902**.
(149) FIG. **74** illustrates one example of a puller **1004**. In one embodiment, the puller **1004** includes an elongated body **1022** and a second handle **1024**. The elongated body **1022** may have a circular cross section and have a longitudinal axis that is coaxial with an opening **1026** that passes through the elongated body **1022** from a proximal end **1028** to a distal end **1030**. The opening **1026** is sized, at least on the proximal end **1028**, to allow the puller **1004** to accept the collar **908**. In one embodiment, the opening **1026** has a larger diameter on the proximal end **1028** of the puller **1004** than at, or near, the distal end **1030** of the puller **1004**. In certain embodiments, a diameter of the opening **1026** at the distal end **1030** is smaller than a diameter of the second section **920** of the shaft **902** such that the distal end **1030** can contact the one or more lips **928** but does not slide past the one or more lips **928** along the shaft **902**.
(150) In certain embodiments, the puller **1004** can include external threads **1032** at, or near, the distal end **1030** of the puller **1004**. The external threads **1032** can be configured with a suitable pitch and configuration such that the external threads **1032** can engage internal threads **1018** of the carriage **1002**. Those of skill in the art of course appreciate that the carriage **1002** can include external threads and the puller **1004** can have corresponding internal threads.
(151) FIGS. **75-78** illustrate a top view, a bottom view, a right side view, and a left side view of the system of FIG. **66** according to one embodiment. These figures illustrate that in one embodiment, the shaft **902**, carriage **1002**, and puller **1004** are coaxial with a longitudinal axis **1005**. In the illustrated embodiment, the suture anchor system **800** includes a connected suture anchor **700**. FIGS. **75** and **77** illustrate at least two sutures **1034** secured to the suture grip member **1010**, the sutures **1034** are under tension.
(152) FIGS. **79-81** illustrate a top view, a bottom view, and a front view of the carriage **1002** and puller **1004** of FIG. **66** according to one embodiment. Note, parts of the suture grip member **1010** are omitted in FIGS. **79** and **80**. In the illustrated embodiment, the carriage **1002** and puller **1004** are positioned as they would be when assembled for use. In particular, the carriage **1002** and puller **1004** are aligned along a common longitudinal axis and the external threads **1032** of the puller **1004** may be engaged with internal threads **1018** of the carriage **1002**. The carriage **1002** and/or puller **1004** can be made from a variety of materials including metal, wood, plastic, ceramic, and the like.
(153) FIGS. **79**, **81**, and **82-90** illustrate different views of different parts of a suture grip member **1010** which may be part of the tensioner **1000** according to one embodiment. The tensioner **1000** is configured, and is operable, to engage the proximal member **704** of the suture anchor **700** and secure one or more sutures **1034**, or portions of sutures. In one embodiment, the one or more sutures **1034**, or portions of sutures may extend from the anchor body. The suture grip member **1010** serves to removably, and/or adjustably, engage and/or secure a suture or portion of suture to the carriage **1002** before, during, and/or after a surgical procedure.
(154) In one embodiment, the suture grip member **1010** includes superior grip plate **1036**, an inferior grip plate **1038**, and a fastener **1040**. In certain embodiments, one or the other both the superior grip plate **1036** and the inferior grip plate **1038** can have one or more ridges **1042**.
(155) In one embodiment, the inferior grip plate **1038** can be integrated into the body **1006** of the carriage **1002**. The inferior grip plate **1038** and/or the body **1006** can include an opening **1044** that extends at least partially into the body **1006** and may or may not connect to the opening **1012**. The opening **1044** may include internal threads that are configured to engage external threads of the fastener **1040**. The inferior grip plate **1038** can have a variety of shapes such as circular, oval, ovoid, square, elliptical, rectangular, or the like. In the illustrated embodiment, the inferior grip plate **1038** has a rectangular shape with two opposite curved ends that together form a slot shape.
(156) Referring now to FIG. **81**, the suture grip member **1010** may include a boss **1046** that extends from one of the grip plates **1036**, **1038**. In certain embodiments, the boss **1046** may also include one or more ridges **1042**. In the illustrated embodiment, the boss **1046** extends from the inferior

grip plate **1038**.
(157) FIG. **82** illustrates one embodiment of a superior grip plate **1036**. As with the inferior grip plate **1038**, the superior grip plate **1036** can have a variety of shapes such as circular, oval, ovoid, square, elliptical, rectangular, or the like. In the illustrated embodiment, the superior grip plate **1036** has a rectangular shape with two opposite curved ends that together form a slot shape. The superior grip plate **1036** can include an opening **1048** that extends through the superior grip plate **1036**. The opening **1048** may be sized and shaped to receive the fastener **1040**.
(158) The superior grip plate **1036** may also include a recess **1050**. The recess **1050** may extend from an inferior surface of the superior grip plate **1036** into the superior grip plate **1036** but not extend completely through the superior grip plate **1036**. In one embodiment, the recess **1050** is sized and shaped to receive the boss **1046**. In one embodiment, the boss **1046** and recess **1050** are sized and shaped such that the boss **1046** can be inserted into the recess **1050** and have a clearance fit. In certain embodiments, the fit may be a friction fit.
(159) The superior grip plate **1036**, inferior grip plate **1038**, boss **1046**, recess **1050**, one or more ridges **1042**, and fastener **1040** cooperate to engage and secure one or more portions of suture positioned between the superior grip plate **1036** and inferior grip plate **1038**, and/or between the boss **1046** and a wall of the recess **1050**, and/or a combination of these. The fastener **1040** can compress the superior grip plate **1036** against the inferior grip plate **1038** and thereby secure a portion of a suture between the two plates and to the suture grip member **1010**.
(160) While certain embodiments, may not include one or more ridges **1042** on one or more of these components of the suture grip member **1010**, having one or more ridges **1042** can enhance the engagement of the suture grip member **1010** with the suture. Such increased and/or enhanced engagement can enable greater tension to be applied to the suture coupled to the suture grip member **1010**.
(161) Referring to FIGS. **87-90**, the fastener **1040** can be a thumb screw having a cap **1052** and a shank **1054**. The cap **1052** may have a relatively large diameter as compared to the shank **1054**. The cap **1052** may fit over a head **1056** of the shank **1054** by way of an interference or friction fit. In one embodiment, the shank **1054** may include external threads that engage within an opening **1044** of the inferior grip plate **1038** or body **1006**. In one embodiment, the shank **1054** includes a drive recess **1058**. As desired, a user may remove the cap **1052** and use a driver (not shown) to apply high torque to the shank **1054** to increase a compression force on the superior grip plate **1036** and/or inferior grip plate **1038**.
(162) FIG. **91** illustrates in a suture anchor system **800** how the fastener **1040** can pass through the superior grip plate **1036** and engage the inferior grip plate **1038**. The boss **1046** fits within the recess **1050**. The fastener **1040** may operate as a set screw to compress the superior grip plate **1036** and inferior grip plate **1038** to secure suture between the plates and/or the recess **1050** and boss **1046**.
(163) The suture anchor system **800** can include one or more sutures **1034** that may have been threaded through the suture anchor **700**. The one or more sutures **1034** have been looped or wrapped around the boss **1046** and are positioned between the superior grip plate **1036** and inferior grip plate **1038**. The one or more sutures **1034** may be under no tension and may set loose between the suture grip member **1010** and the suture anchor **700**.
(164) FIG. **92** is a perspective exploded view of the system of FIG. **66** according to one embodiment. The suture anchor system **800** can be assembled for use taking the following steps. First, the carriage **1002** can be slid along the shaft **902** from the proximal end **904** toward the distal end **906**. The proximal end **904** is passed through the opening **1012** of the carriage **1002**. Next, the carriage **1002** can be rotated such that the keyed opening **1020** accepts the second section **920** of the shaft **902**. Once the keyed opening **1020** passes into the second section **920** the carriage **1002** may be rotationally fixed relative to the shaft **902**.
(165) Next, the puller **1004** is slid along the shaft **902** from the proximal end **904** toward the distal

end **906**. The puller **1004** is slid until the distal end **1030** contacts the one or more lips **928**. Then, the collar **908** is screwed onto the shaft **902** by engaging the external threads **914** within the internal threads of the distal end **932** of the collar **908**. At this stage of assembly, the external threads **1032** of the puller **1004** may or may not engage the internal threads **1018** of the carriage **1002**. Also at this stage, the inserter **900**/tensioner **1000** is ready for use in a surgical procedure.
(166) In certain embodiments, a suture anchor **700** may be connected to the distal end **906** of the shaft **902** by way of the internal threads **912** and external helical threads **760** of the proximal member **704**. Of course, this step can also be performed during a surgical procedure.
(167) After the suture anchor system **800** is assembled, a user may insert the interference member **770** through the longitudinal opening **938** at the proximal end **930** of the collar **908** and pass the interference member **770** through the inserter longitudinal passageway **941** until the interference member **770** reaches the longitudinal passageway **714** of the suture anchor **700**. In this manner, the interference member **770** can be inserted when needed during a surgical procedure to secure suture within the suture anchor **700**.
(168) In certain embodiments, the driver **910** can be used to move the interference member **770** through the inserter longitudinal passageway **941** and into the longitudinal passageway **714**. Alternatively, or in addition, the driver **910** can be used to urge the interference member **770** into the anchor body **702**.
(169) FIGS. **93-96** are a sequence of perspective views illustrating use of the system of FIG. **66** and the implant of FIG. **52** according to one embodiment. Initially, a user, such as a surgeon, may thread one or more sutures **1034** through a suture anchor **700** having an anchor body **702** and proximal member **704** connected by a frangible connection **706**. (See FIG. **93**) Next, a user may connect an inserter **900** or tensioner **1000** or combination inserter/tensioner **900**/**1000** to the proximal member **704** by screwing the external helical threads **760** of the proximal member **704** into the internal threads **912** of the shaft **902**. (See FIG. **94**) At this stage, the one or more sutures **1034** may be loose and portions or ends of the one or more sutures **1034** may extend proximally towards the suture grip member **1010**.
(170) Next, a user may loosen the fastener **1040** such that the superior grip plate **1036** and inferior grip plate **1038** can be readily separated. In certain embodiments, the fastener **1040** can be removed and/or the superior grip plate **1036** removed. Referring now to FIG. **95**, next a user inserts the one or more sutures **1034** or portions of the one or more sutures **1034** between the superior grip plate **1036** and inferior grip plate **1038**. In certain embodiments, the user may wrap or wind the one or more sutures **1034** around the boss **1046**. At this stage, a user may then re-connect or tighten the fastener **1040** to close and/or compress the superior grip plate **1036** against the inferior grip plate **1038** and thereby secure and/or tension the one or more sutures **1034** between the anchor body **702** and the suture grip member **1010**. In one embodiment, a user may tighten the one or more sutures **1034** manually between the suture grip member **1010** and the anchor body **702** as the fastener **1040** compresses the superior grip plate **1036** against the inferior grip plate **1038**. Next, a user may rotate the puller **1004** in a direction **1070**.
(171) Rotation of the puller **1004** in direction **1070** moves the external threads **1032** into the carriage **1002** by engagement with the internal threads **1018** of the carriage **1002**. As the threads **1032**, **1018** engage, this translates and moves the carriage **1002** proximally towards the puller **1004** in direction **1072**. The translation of the carriage **1002** creates a translation force in direction **1072** which applies tension to the one or more sutures **1034**.
(172) The threads **1032**, **1018** of the puller **1004** and carriage **1002** provide a significant mechanical advantage that increases tension in the one or more sutures **1034** secured between the anchor body **702** and the suture grip member **1010**. Advantageously, reversing the rotation of the puller **1004** in a direction opposite direction **1070** loosens the one or more sutures **1034** such that a user can remove the one or more sutures **1034** or adjust the position or tension of the one or more sutures **1034**.

(173) FIG. **96** illustrates the position of the carriage **1002** relative to the puller **1004** after a desired level of tension is placed into the one or more sutures **1034**. Note that the carriage **1002** is closer to the proximal end **904** of the shaft **902** than before the one or more sutures **1034** were tightened. This causes more of the planar surface **924** of the second section **920** to be exposed. Next, a user can insert the interference member **770** distally within the inserter longitudinal passageway **941** in the direction indicated by arrow **1074**. In one embodiment, the interference member **770** is inserted with the point **780** entering the inserter longitudinal passageway **941** first. The user can then urge the interference member **770** through the inserter longitudinal passageway **941** until the interference member **770** reaches the distal end **906** of the shaft **902** and enters the bore **756** of the proximal member **704**. A user can move the interference member **770** through the inserter longitudinal passageway **941** and/or bore **756** using gravity or a tool such as a driver.
(174) FIG. **97** illustrates one example of a driver **1080** that can be used to move the interference member **770** through the inserter longitudinal passageway **941** and/or bore **756**. The driver **1080** may be cylindrical and elongated and may include a drive shaft **1082** having a proximal end **1084** and a distal end **1086**. The driver **1080** also includes a drive coupler **1088**, external drive threads **1090**, and a drive feature **1092**.
(175) The drive coupler **1088** is connected to the drive shaft **1082** at the proximal end **1084**. The drive coupler **1088** can be any of a variety of existing couplers suitable for connecting a tool that can rotate the driver **1080** about its longitudinal axis, move the driver **1080** axially, or transmit an axial force through the driver **1080**. In one embodiment, the drive coupler **1088** is a conventional Association for Osteosynthesis (AO) quick connect having a D-shaped cross section and a groove for engaging a driving mechanism. The drive mechanism (not shown) may be a manual mechanism such as a handle adapted to engage the drive coupler **1088** or a powered mechanism, such as a drill.
(176) In certain embodiments, the driver **1080** may include external drive threads **1090** in other embodiments, the driver **1080** may not include external drive threads **1090**. In one embodiment, the external drive threads **1090** can be configured to engage internal threads **942** within the longitudinal opening **938** of the collar **908** (i.e., within the inserter **900**). The external drive threads **1090** may be positioned along the drive shaft **1082** between the proximal end **1084** and distal end **1086** such that the external drive threads **1090** engage the internal threads **942** when the drive shaft **1082** is inserted within the inserter longitudinal passageway **941** far enough that the external helical threads **782** of interference member **770** can engage the internal helical threads **717** of the anchor body **702** as the external drive threads **1090** engage more of the internal threads **942**. In this manner, the external drive threads **1090** may provide a mechanical advantage to assist in driving the interference member **770** into the anchor body **702**.
(177) In embodiments without external drive threads **1090**, the drive shaft **1082** can still be used to urge the interference member **770** into the anchor body **702** (note FIGS. **97-104** are not necessarily drawn to scale). In such an embodiment, the drive shaft **1082** may press the interference member **770** towards the suture anchor **700** as the drive shaft **1082** is moved into the inserter longitudinal passageway **941**. The drive shaft **1082** is long enough that the drive shaft **1082** can press the interference member **770** into and through the bore **756** such that the point **780** extends into the longitudinal passageway **714**.
(178) The drive feature **1092** is connected to the drive shaft **1082** at the distal end **1086**. The drive feature **1092** can be configured to engage a drive recess **790** of an interference member **770**. In one embodiment, the drive feature **1092** is a torx shape sized and configured to engage a drive recess **790** that is a torx recess.
(179) FIG. **98** illustrates a stage in a sequence of using the suture anchor system **800** in another stage of the sequence illustrated in FIGS. **93-96**. At this stage, the inserter **900** is connected to the suture anchor **700** and the tensioner **1000** is positioned to apply a desired level of tension to the one or more sutures **1034**. A user has inserted the drive shaft **1082** into the inserter longitudinal passageway **941** and moved the interference member **770** until the point **780** extends into the

longitudinal passageway **714** and the drive feature **1092** engages the drive recess **790** of the interference member **770**. Next a user may attach a drive mechanism to the drive coupler **1088** and begin rotating the drive shaft **1082**. This rotation causes at least one of the external helical threads **782** to engage with an internal helical thread **717** of the anchor body **702**. Because the one or more sutures **1034** extend from the proximal opening **716** of the anchor body **702** from within the longitudinal passageway **714**, engagement of at least one external helical thread **782** with an internal helical thread **717** of the anchor body **702** secures and compresses at least a portion of the one or more sutures **1034** between the interference member **770** and the anchor body **702**. This engagement secures the one or more sutures **1034** with the same tension, or a slightly greater tension, in the one or more sutures **1034** that was present in the one or more sutures **1034** before the interference member **770** is screwed into the proximal opening **716** of the anchor body **702**.
(180) FIG. **99** is a perspective view of a driver **1080** for use within the system of FIG. **66** and the implant of FIG. **52** according to one embodiment. Specifically, FIG. **99** illustrates that the drive shaft **1082** can engage the interference member **770** as the interference member **770** is moved through the shaft **902** and into the suture anchor **700**. FIG. **99** is not necessarily drawn to scale. The driver **1080** applies a torque to the interference member **770** and the least one or more external helical threads **782** of the interference member **770** to engage and/or mesh with at least one or more internal helical threads **717** of the anchor body **702**.
(181) The drive shaft **1082** is long enough to drive the interference member **770** by way of rotation to move completely into the longitudinal passageway **714**. Rotation of the driver **1080** in a first direction causes at least one or more external helical threads **782** of the interference member **770** to engage and/or mesh with at least one or more internal helical threads **717** of the anchor body **702**. Rotation of the driver **1080** in a second direction opposite the first direction causes external helical threads **782** of the interference member **770** to disengage from one or more internal helical threads **717** of the anchor body **702**.
(182) Advantageously, the drive feature **1092** of the driver **1080** and the drive recess **790** of the interference member **770** can be used both to insert, or drive, the interference member **770** axially into the anchor body **702** and to extract, remove, or back-out the interference member **770** from the anchor body **702**. The ability to back the interference member **770** out of the anchor body **702** may be useful to a surgeon who desires to adjust tension in the one or more sutures **1034**, remove the suture anchor **700**, reposition the suture anchor **700**, reconfigure or remove the one or more sutures **1034**, or the like. This added flexibility can increase the options to a surgeon using the suture anchor **700** and can lead to move favorable surgical outcomes.
(183) In certain embodiments, the drive feature **1092** and drive recess **790** may have a configuration different from the one illustrated. For example, the drive recess **790** may be a recess that includes a lip or hook and the drive feature **1092** may include a corresponding hook or lip that engages the one on the interference member **770**. In this manner the drive feature **1092** may couple to the interference member **770** and permit one or both of axial force transmission and torque transmission from the driver **1080** to the interference member **770**. Such alternative embodiments are within the scope of the present disclosure and enable the driver **1080** to move the interference member **770** into and retract the interference member **770** out of the anchor body **702**.
(184) FIGS. **100-101** are a sequence of perspective views illustrating use of the system of FIG. **66** and the implant of FIG. **52** according to one embodiment after the stage shown in FIG. **98**. FIG. **100** shows that after the interference member **770** is secured within the longitudinal passageway **714**, the driver **1080** can be removed.
(185) At this stage, the suture anchor system **800** is prepared for disengagement/separation of the anchor body **702** from the proximal member **704**. Also at this stage, the suture anchor **700** may already be inserted/placed/deployed within a patient. Alternatively, or in addition, a user may now, at this stage, deploy or insert the suture anchor **700** into a prepare location in a patient. In such an embodiment, the user may use the inserter **900** to position and press the suture anchor **700** into the

desired location. The elongated inserter **900** and securely connected suture anchor **700** facilitate positioning and placement. In certain embodiments, the inserter **900** may be used for cannulated deployment.

(186) Referring to FIG. **101**, to separate the proximal member **704** from the anchor body **702**, a user may insert a pushrod **1100** into the longitudinal opening **938** of the collar **908** at a proximal end of the suture anchor system **800**/inserter **900**. This mounts the pushrod **1100** for axial translation within the inserter **900**. The pushrod **1100** may include many similar features and aspects as the driver **1080**. In certain embodiments, a driver **1080** can be used to serve the dual purposes of a driver **1080** and/or of a pushrod **1100**.

(187) Referring now to FIGS. **101-104**, consequently, the pushrod **1100** may be an elongated cylindrical structure having a proximal end **1110**, a distal end **1120**, a coupler **1130**, much like the drive coupler **1088** of the driver **1080**, external threads **1140**, much like the external drive threads **1090**, a shaft **1150**, much like the drive shaft **1082**, and a push feature **1160**. The coupler **1130** may be an AO quick connect coupler. In certain embodiments, the push feature **1160** is the same as the drive feature **1092**. In the illustrated embodiment, the push feature **1160** is different from the drive feature **1092**, the push feature **1160** does not include a torx or other drive shaped end. In the illustrated embodiment, the push feature **1160** includes a tapering diameter to a blunt end that fits within the drive recess **790** of the interference member **770**. In other embodiments, the push feature **1160** may have a diameter wider than the drive recess **790** can may contact a top of the interference member **770**. In another embodiment, the push feature **1160** may have a diameter or configuration that contacts the sidewall **750** of the anchor body **702**.

(188) Referring further to FIGS. **102-104**, subsequent sequences of steps can be taken after the pushrod **1100** is inserted into the inserter **900**, as shown in FIG. **101**. A user may rotate the pushrod **1100** such that the external threads **1140** may engage internal threads **942** of the collar **908**. This threaded engagement provides a mechanical force that moves/drives the push feature **1160** against the interference member **770**. In FIG. **102**, the push feature **1160** contacts the interference member **770** within the drive recess **790**.

(189) FIG. **103** shows magnified/close-up details of this contact, the push feature **1160**, the interference member **770**, and the anchor body **702**. Note the one or more sutures **1034** between the interference member **770** and the internal helical threads **717** of the anchor body **702**. FIG. **103** also illustrates that in one embodiment one or more external helical threads **782** of the interference member **770** may contact and/or engage with one or more internal helical threads **717** of the anchor body **702** while others make no contact and/or are not engaged with corresponding threads. In one embodiment, the external helical threads **782** may be knuckle threads. The knuckle threads may have an external helical thread pitch that differs from an internal helical thread pitch of the internal helical threads **717** of the anchor body **702**.

(190) In particular, FIG. **103** illustrates that the external helical threads **782** interface with internal helical threads **717** in a clearance fit. This clearance fit has a length of thread engagement (Arrow LTE) that is shorter than a length of the external helical threads **782** (Arrow EHT). Advantageously, such an interface may provide strong reliable fixation of the one or more sutures **1034** within the anchor body **702** and still prevent severing the one or more sutures **1034** within the anchor body **702**.

(191) Returning to the sequence of operations, FIG. **103** illustrates that the shaft **902** of the inserter **900** engages the proximal member **704** in an axial force transmitting relationship in a first direction **1170**. In the illustrated embodiment, the axial force transmitting relationship is that the shaft **902** holds the proximal member **704** in place and places an axial force on the proximal member **704** in direction **1170**.

(192) Once the push feature **1160** contacts the interference member **770** (or sidewall **750**) a user may next connect the coupler **1130** to a manual or powered tool and rotate the pushrod **1100** such that the external threads **1140** and internal threads **942** move past each other and move the pushrod

**1100** in second direction **1180**. This interaction is referred to herein as an axial force transmitting relationship in the second direction **1180**. In one embodiment, the user may couple the pushrod **1100** to a manual or powered mechanism that imparts an axial force, such as a pounding force towards the distal end of the inserter **900**. In such an embodiment, a user may simply pound on the pushrod **1100** with a mallet or hammer. In these embodiments, the pushrod **1100** may not include external threads **1140**.

(193) In the illustrated embodiment, the mechanical advantage of the external threads **1140** and internal threads **942** create a significant force that presses the push feature **1160** against the interference member **770** and/or the anchor body **702**. Eventually, this force causes the frangible connection **706** to break (See FIG. **104** broken frangible connection **1190**) which separates the anchor body **702** from the proximal member **704**. The anchor body **702** then remains within a patient and the one or more sutures **1034** remain under tension while the interference member **770** is deployed and the anchor body **702** is deployed.

(194) Specific examples of the present disclosure have been described. However, it will be apparent to one skilled in the art that various changes and substitutions may be made within the scope of the present disclosure defined by the claims. Likewise, it is contemplated, and within the scope of the present disclosure, that the various features of the illustrative examples may be interchanged among the illustrative examples.

(195) The following are further examples of the present disclosure.

(196) A knotless suture anchor comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal end, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a distal opening communicating with the longitudinal passageway nearer the distal end; and a first portion of a suture extending within the longitudinal passageway between the proximal opening and the distal opening, a second portion of the suture contiguous to the first portion and extending out of the anchor body, a third portion of the suture contiguous to the second portion and extending within the longitudinal passageway proximally to distally, and a fourth portion of the suture contiguous to the third portion and extending along the exterior surface distally to proximally.

(197) The knotless suture anchor of example 1 further comprising an interference member operable to axially slide into the longitudinal passageway and secure the first portion of the suture and the third portion of the suture within the longitudinal passageway by compressing the suture portions between the interference member and the anchor body.

(198) The knotless suture anchor of example 1 further comprising a proximal member joined to the anchor body by a frangible connection, a proximal member axial passage within the proximal member, the proximal member axial passage containing an interference member coaxially aligned with the longitudinal passageway.

(199) The knotless suture anchor of example 3 further comprising an interference member retainer having a retainer axial passage, the interference member retainer engaging the proximal member axial passage in axial sliding relationship, the interference member engaging the retainer axial passage in axial sliding relationship.

(200) The knotless suture anchor of example 4 further comprising an inserter operable to engage the proximal member in axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod being operable to engage the interference member in axial force transmitting relationship in a second direction opposite the first direction and expel the interference member from the proximal member into the anchor body, the pushrod being further operable to engage the interference member retainer in axial force transmitting relationship to press the interference member retainer against the anchor body and separate the anchor body and proximal member at the frangible connection.

(201) The knotless suture anchor of example 1 wherein the anchor body has a plurality of distal

openings.
(202) The knotless suture anchor of example 6 wherein the plurality of distal openings comprises a single opening on a first side of the anchor body and a pair of openings on a second side of the anchor body opposite the first side.
(203) The knotless suture anchor of example 6 wherein the plurality of distal openings comprises first and second openings through a sidewall of the anchor body nearer the distal end than the proximal end.
(204) The knotless suture anchor of example 6 wherein the first portion of the suture passes through at least one of the plurality of distal openings and the third portion of the suture passes through at least another of the plurality of distal openings.
(205) A knotless suture anchor comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal end, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a first distal opening communicating with the longitudinal passageway nearer the distal end than the proximal end; a proximal member joined to the anchor body by a frangible connection, the proximal member having a proximal member axial passage.
(206) The knotless suture anchor of example 10 further comprising an interference member held by the proximal member and coaxially aligned with the longitudinal passageway.
(207) The knotless suture anchor of example 11 wherein the interference member is mounted in axial sliding relationship within the proximal member and wherein the interference member is operable to slide axially out of the proximal member and into the longitudinal passageway of the anchor body.
(208) The knotless suture anchor of example 11 wherein the anchor body further comprises a second distal opening.
(209) The knotless suture anchor of example 13 wherein the anchor body further comprises a third distal opening, the first distal opening being on a first side of the anchor body and a the second and third openings being on a second side of the anchor body opposite the first side.
(210) The knotless suture anchor of example 13 wherein the first and second distal openings are formed through a sidewall of the anchor body nearer the distal end than the proximal end, the first and second distal openings being aligned on the same side of the anchor body and spaced axially away from one another.
(211) The knotless suture anchor of example 13 wherein the first and second distal openings have a continuous strand of suture material passing through them.
(212) The knotless suture anchor of example 11 further comprising an interference member retainer having a retainer axial passage, the interference member retainer engaging the proximal member axial passage in axial sliding relationship, the interference member engaging the retainer axial passage in axial sliding relationship.
(213) The knotless suture anchor of example 17 further comprising an inserter operable to engage the proximal member in axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod being operable to engage the interference member in axial force transmitting relationship in a second direction opposite the first direction and expel the interference member from the proximal member into the anchor body, the pushrod being further operable to engage the interference member retainer in axial force transmitting relationship to press the interference member retainer against the anchor body and separate the anchor body and proximal member at the frangible connection.
(214) The knotless suture anchor of example 10 further comprising a first portion of suture extending within the longitudinal passageway and a second portion of suture contiguous to the first portion of suture extending from the anchor body.
(215) The knotless suture anchor of example 19 further comprising a third portion of suture

contiguous to the second portion of suture and extending within the longitudinal passageway proximally to distally.
(216) The knotless suture anchor of example 20 further comprising a fourth portion of suture contiguous to the third portion and extending along the exterior surface distally to proximally.
(217) The knotless suture anchor of example 20 further comprising a second distal opening communicating with the longitudinal passageway nearer the distal end than the proximal end, wherein the first portion of suture passes through one of the first and second distal openings and the third portion of suture passes through the other of the first and second distal openings.
(218) The knotless suture anchor of example 19 further comprising a frangible elongate tube having a proximal end and a distal end, wherein the second portion of suture passes through the tube from the proximal end to the distal end.
(219) The knotless suture anchor of example 13 further comprising: a first suture threader extending within the longitudinal passageway, the first suture threader extending through the proximal opening to a first threader loop end and the first suture threader extending through the first distal opening to a first threader grip end, the first threader loop end defining a suture capture loop; and a second suture threader extending within the longitudinal passageway, the second suture threader extending through the proximal opening to a second threader grip end and the second suture threader extending through the second distal opening to a second threader loop end, the second threader loop end defining a suture capture loop.
(220) A knotless suture anchor comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal end, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a distal opening communicating with the longitudinal passageway nearer the distal end; a proximal member joined to the anchor body by a frangible connection, the proximal member having a sidewall defining a proximal member axial passage coaxial with the longitudinal passageway, the proximal member having an aperture through the sidewall adjacent to the frangible connection, the proximal member being operable to break away from the anchor body at the frangible connection causing the aperture to open distally.
(221) The knotless suture anchor of example 25 further comprising an interference member mounted in the proximal member axial passage in coaxial sliding relationship.
(222) The knotless suture anchor of example 25 wherein the anchor body has a plurality of distal openings.
(223) The knotless suture anchor of example 27 wherein the plurality of distal openings comprises a single opening on a first side of the anchor body and a pair of openings on a second side of the anchor body opposite the first side.
(224) The knotless suture anchor of example 27 wherein the plurality of distal openings comprises first and second openings through a sidewall of the anchor body nearer the distal end than the proximal end.
(225) The knotless suture anchor of example 27 wherein at least two of the plurality of distal openings have suture material passing through them.
(226) The knotless suture anchor of example 25 further comprising an interference member retainer having a retainer axial passage, the interference member retainer engaging the proximal member axial passage in axial sliding relationship, and an interference member engaging the retainer member axial passage in axial sliding relationship.
(227) The knotless suture anchor of example 31 further comprising an inserter operable to engage the proximal member in axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod being operable to engage the interference member in axial force transmitting relationship in a second direction opposite the first direction and expel the interference member from the proximal member into the anchor body,

the pushrod being further operable to engage the interference member retainer in axial force transmitting relationship to press the interference member retainer against the anchor body and separate the anchor body and proximal member at the frangible connection.
(228) A knotless suture anchor comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal end, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a plurality of distal openings communicating with the longitudinal passageway nearer the distal end, the plurality of distal openings comprising a single opening on a first side of the anchor body and a pair of openings on a second side of the anchor body opposite the first side; and an interference member receivable within the longitudinal passageway.
(229) A knotless suture anchor comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal end, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a first distal opening communicating with the longitudinal passageway nearer the distal end; a first suture extending through the longitudinal passageway with a proximal end exiting the proximal opening and a distal end exiting the first distal opening; a suture keeper joined to the first suture proximal end, the suture keeper being operable to prevent the proximal end of the first suture from passing through the proximal opening.
(230) The knotless suture anchor of example 34 wherein the proximal end of the first suture is tied to the suture keeper.
(231) The knotless suture anchor of example 34 wherein the suture keeper comprises a planar member having a portion for receiving the anchor body and releasably retaining the anchor body on the planar member.
(232) The knotless suture anchor of example 36 wherein the first suture is wrapped around the planar member.
(233) The knotless suture anchor of example 37 further comprising a second suture strand and a second distal opening, the first suture strand exiting the first distal opening and the second suture strand exiting the second distal opening, the planar member defining a first recess for receiving the first suture strand wrapped around the planar member and a second recess for receiving the second suture strand wrapped around the planar member.
(234) The knotless suture anchor of example 38 further comprising a frangible elongate tube having a proximal end and a distal end, wherein after exiting the distal openings of the anchor body, the first and second suture strands pass through the tube from the proximal end to the distal end.
(235) The knotless suture anchor of example 39 further comprising a suture threader, the suture threader including a filament forming a loop portion and a grip portion joined to the loop portion, and further wherein the anchor body comprises a third distal opening, the loop portion extending through the longitudinal passageway from the third distal opening to the proximal opening with at least part of the loop portion extending out of the proximal opening and the grip portion extending out of the third distal opening.
(236) A method of attaching a suture to a bone, comprising: passing a portion of a suture through a bone so that a first portion of the suture extends from a first opening in the bone and a second portion of the suture extends from a second opening in the bone; passing the second portion of the suture through a portion of a suture anchor body in a proximal to distal direction, the suture anchor body having a proximal end and a distal end; passing the second portion of the suture alongside an outer surface of the suture anchor body in a distal to proximal direction; and then inserting the suture anchor into the bone through one of the first and second openings, the distal end being inserted first through the opening.

(237) The method of example 41 wherein the step of passing the second portion of the suture longitudinally through a portion of a suture anchor body in a proximal to distal direction comprises engaging the second portion of the suture with a first suture threader and pulling the suture threader through the anchor, the first suture threader being preloaded on the suture anchor.
(238) The method of example 41 further comprising passing the first portion of the suture longitudinally through a portion of the suture anchor body in a distal to proximal direction.
(239) The method of example 43 wherein the step of passing the first portion of the suture longitudinally through a portion of the suture anchor body in a distal to proximal direction comprises engaging the second portion of the suture with a second suture threader and pulling the suture threader through the anchor, the second suture threader being preloaded on the suture anchor.
(240) The method of example 41 further comprising after inserting the suture anchor into a hole in the bone, advancing a locking member into the suture anchor to lock the suture to the anchor.
(241) The method of example 44 further comprising before advancing the locking member, tensioning the suture.
(242) The method of example 44 wherein a proximal member is joined to the proximal end of the anchor by a frangible connection, the method further comprising after advancing the locking member, separating the proximal member and anchor at the frangible connection.
(243) The method of example 47 wherein the proximal member includes a hole through a sidewall adjacent the frangible portion and the suture extends through the hole, further wherein separating the proximal member and anchor transforms the hole into a distally opening slot and releases the suture distally from the slot.
(244) A method of attaching a suture to a bone, comprising: disengaging a first portion of a suture extending from a distal end of a suture anchor from a suture keeper, a second portion of the suture extending from a proximal end of the suture anchor being joined to the suture keeper; then passing the first suture portion through a patient's body tissue; then inserting the suture anchor body into a hole in a bone; then separating the suture keeper from the second portion of the suture.
(245) The method of example 49 wherein the second portion includes at least first and second strands of suture, the first strand being joined to a first portion of the suture keeper and the second strand being joined to a second portion of the suture keeper, the method further comprising independently tensioning the first and second strands.
(246) The method of example 49 further comprising sliding the suture anchor over the first portion of suture away from the suture keeper while the second portion remains joined to the suture keeper.
(247) A method of attaching soft tissue to bone, comprising: passing a first portion of a suture through a bone; passing the first portion through a soft tissue; passing the first portion outside of a patient's body; tying a knot in the first portion; and pulling a second portion of the suture joined to the first portion to move the knot into the patient to a position adjacent to the soft tissue; and securing the suture to the bone.
(248) A method of attaching soft tissue to bone, comprising: passing a tube through a portal in a patient's skin, the tube having a suture passing through it; passing the suture through a soft tissue; splitting the tube to free the suture from the tube; and anchoring the suture to a bone.
(249) A method of attaching a suture to a bone, comprising: providing a suture anchor having a proximal end, a distal end, a longitudinal passage extending within the suture anchor in a proximal to distal direction, a first opening communicating with the longitudinal passage nearer the proximal end than the distal end, a second opening through the sidewall of the suture anchor nearer the distal end than the proximal end, and a third opening through the sidewall of the suture anchor nearer the distal end than the proximal end, a first suture threader extending within the longitudinal passage between the first and third openings, the first suture threader extending through the first opening to a grip portion outside of the longitudinal passage, the first suture threader extending through the third opening to a suture engaging portion outside of the longitudinal passage, a second suture

threader extending within the longitudinal passage between the first and second openings, the second suture threader extending through the first opening to a suture engaging portion outside of the longitudinal passage, the second suture threader extending through the second opening to a grip portion outside of the longitudinal passage, passing a portion of a suture through a bone so that a first portion of the suture extends from a first opening in the bone and a second portion of the suture extends from a second opening in the bone; engaging the first portion of the suture with the first suture passer; pulling on the grip portion of the first suture passer to pass the first portion of the suture through the longitudinal passage in a distal to proximal direction; engaging the second portion of the suture with the second suture passer; pulling on the grip portion of the second suture passer to pass the second portion of the suture through the longitudinal passage in a proximal to distal direction; and then inserting the suture anchor into the bone through one of the first and second openings, the distal end being inserted first through the opening.

(250) The method of example 54 further comprising: passing the second portion of the suture through soft tissue; tying a knot in the second portion of the suture outside of a patient's body; and pulling on the first portion of the suture to move the knot nearer to the soft tissue.

(251) The method of example 54 further comprising: passing the first portion of the suture through a tube; placing the tube and first portion of the suture through a portal in the patient's body; splitting the tube to free the suture laterally from the tube.

(252) The method of example 54 further comprising passing the second portion alongside an outer surface of the anchor in a distal to proximal direction.

(253) The method of example 54 further comprising advancing a locking member in the longitudinal passage to secure the suture within the longitudinal passage.

(254) The method of example 58 wherein a proximal member is joined to the proximal end of the anchor by a frangible connection, the proximal member housing the locking member, the step of advancing the locking member comprising pressing the locking member from the proximal member into the longitudinal passage, the method further comprising after advancing the locking member, separating the proximal member and anchor at the frangible connection.

(255) The method of example 59 wherein advancing the locking member comprises actuating an inserter to press the locking member in a first direction while applying a counterforce to the proximal member in a second direction opposite the first direction, and wherein separating the proximal member and anchor comprises further actuating the inserter to break the frangible connection.

(256) Any methods disclosed herein includes one or more steps or actions for performing the described method. The method steps and/or actions may be interchanged with one another. In other words, unless a specific order of steps or actions is required for proper operation of the embodiment, the order and/or use of specific steps and/or actions may be modified.

(257) Reference throughout this specification to “an embodiment” or “the embodiment” means that a particular feature, structure or characteristic described in connection with that embodiment is included in at least one embodiment. Thus, the quoted phrases, or variations thereof, as recited throughout this specification are not necessarily all referring to the same embodiment.

(258) Similarly, it should be appreciated that in the above description of embodiments, various features are sometimes grouped together in a single embodiment, Figure, or description thereof for the purpose of streamlining the disclosure. This method of disclosure, however, is not to be interpreted as reflecting an intention that any claim require more features than those expressly recited in that claim. Rather, as the following claims reflect, inventive aspects lie in a combination of fewer than all features of any single foregoing disclosed embodiment. Thus, the claims following this Detailed Description are hereby expressly incorporated into this Detailed Description, with each claim standing on its own as a separate embodiment. This disclosure includes all permutations of the independent claims with their dependent claims.

(259) As used herein, a “fastener” refers to any structure configured, designed, or engineered to

join two structures. Fasteners may be made of a variety of materials including metal, plastic, composite materials, metal alloys, plastic composites, and the like. Examples of fasteners include, but are not limited to screws, rivets, bolts, nails, snaps, hook and loop, set screws, bone screws, nuts, posts, pins, thumb screws, and the like. Examples of fasteners include, but are not limited to wires, Kirschner wires, anchors, bone anchors, plates, bone plates, intramedullary nails or rods or pins, implants, interbody cages, fusion cages, and the like.

(260) As used herein, a “set screw” refers to a type of screw generally used to secure a first object within, or against, second object, usually without using a nut. Set screws can be headless, meaning that the screw is fully threaded and has no head projecting past the thread's major diameter. If a set screw does have a head, the thread may extend to the head. A set screw can be driven by an internal-wrenching drive, such as a hex socket (Allen), star (Torx), square socket (Robertson), or a slot. A set screw can be driven by a knob on or part of a head of the set screw. The knob may be sized to facilitate rotation by a user using their fingers and may be referred to as a thumb screw. In one embodiment, the set screw passes through a threaded hole in the second object (an outer object) and is tightened against the first object (an inner object) to prevent the inner object from moving relative to the outer object. The set screw can exert a compressional and/or clamping force through an end of the set screw that projects through the threaded hole. (Search “set screw” on Wikipedia.com Aug. 17, 2020. Modified. Accessed Jan. 6, 2020.)

(261) As used herein, a “thumb screw” refers to a type of fastener or screw designed and configured to be tightened, loosened, attached or detached using a person's fingers, such as a thumb and forefinger. In certain embodiments, a thumb screw may include a knob or button or wheel configured to grasped and rotated by an operator to tighten, loosen, attach or detach the thumb screw.

(262) As used herein, “feature” refers to a distinctive attribute or aspect of something. (Search “feature” on google.com. Oxford Languages, 2021. Web. 20 Apr. 2021.) A feature may include one or more modifiers that identify one or more particular functions, attributes, advantages, or operations and/or particular structures relating to the feature. Examples of such modifiers applied to a feature, include, but are not limited to, “attachment feature,” “securing feature,” “alignment feature,” “adjustment feature,” “guide feature,” “protruding feature,” “engagement feature,” “fixation feature”, “disengagement feature,” and the like.

(263) As used herein, a “drive”, “drive feature”, or “drive recess” refers to an apparatus, instrument, structure, device, component, system, or assembly structured, organized, configured, designed, arranged, or engineered to receive a torque and transfer that torque to a structure connected or coupled to the drive. At a minimum, a drive is a set of shaped cavities and/or protrusions on a structure that allows torque to be applied to the structure. Often, a drive includes a mating tool, known as a driver. For example, cavities and/or protrusions on a head of a screw are on kind of drive and an example of a corresponding mating tool is a screwdriver, that is used to turn the screw, the drive. Examples of a drive include but are not limited to screw drives such as slotted drives, cruciform drives, square drives, multiple square drives, internal polygon, internal hex drives, penta lobular sockets, hex lobular sockets, combination drives, external drives, tamper-resistant drives, and the like. (Search ‘list of screw drives’ on Wikipedia.com Mar. 12, 2021. Modified. Accessed Mar. 19, 2021.)

(264) As used herein, a “driver” refers to a mechanical piece, component, or structure for imparting motion to another piece, component, or structure. (“driver.” Merriam-Webster.com. Merriam-Webster, 2021. Web. 6 Jan. 2021. Modified.) In certain embodiments, a driver can be a wheel configured or connected to other parts such that rotation or motion of the driver causes motion of other interconnected or intercoupled parts of a component, system, apparatus, or device.

(265) As used herein, a “shaft” refers to a long narrow structure, device, component, member, system, or assembly that is structured, organized, configured, designed, arranged, or engineered to support and/or connect a structure, device, component, member, system, connected to each end of

the shaft. Typically, a shaft is configured to provide rigid support and integrity in view of a variety of forces including tensile force, compression force, torsion force, shear force, and the like. In addition, a shaft can be configured to provide rigid structural support and integrity in view of a loads including axial loads, torsional loads, transverse loads, and the like. A shaft may be oriented and function in a variety of orientations including vertical, horizontal, or any orientation between these and in two or three dimensions. A shaft may be made from a variety of materials including, but not limited to, metal, plastic, ceramic, wood, fiberglass, acrylic, carbon, biocompatible materials, biodegradable materials or the like. A shaft may be formed of any biocompatible materials, including but not limited to biocompatible metals such as Titanium, Titanium alloys, stainless steel, carbon fiber, combinations of carbon fiber and a metallic alloy, stainless steel alloys, cobalt-chromium steel alloys, nickel-titanium alloys, shape memory alloys such as Nitinol, biocompatible ceramics, and biocompatible polymers such as Polyether ether ketone (PEEK) or a polylactide polymer (e.g. PLLA) and/or others, or any combination of these materials.

(266) As used herein, a “thread” or “screw thread” refers to a helical structure used to convert between rotational and linear movement or force and/or to connect or engage two structures. A screw thread can be a ridge that wraps around a cylinder in the form of a helix, referred to as a straight thread. A screw thread can also be a ridge that wraps around a cone shape, referred to as a tapered thread. A screw thread is a feature of a screw as a simple machine and also in use as a threaded fastener. A screw thread can provide one or both of the following functions: conversion of rotary motion or force into linear motion or force and preventing or mitigating linear motion or force without corresponding rotation motion or force. In certain implementations of screw threads that convert a rotation force or torque into linear motion, or vice versa, the screw threads may be referred to as drive threads because of the drive function rotating the threads serves to extend or retract a structure linearly.

(267) External screw threads are those formed on an external surface of a structure, such as a cylinder or cone shaped structure. Internal screw threads are those formed on an internal wall or surface of a nut, substrate, or opening. The cross-sectional shape of a thread is often called its form or threadform (also spelled thread form). The thread form may be square, triangular, trapezoidal, or other shapes. The terms form and threadform can refer to other design aspects taken together (cross-sectional shape, pitch, and diameters) in addition to cross-sectional shape, but commonly refer to the standardized geometry used by the screw. Major categories of threads include machine threads, material threads, and power threads. Generally, triangular threadforms are based on an isosceles triangle. These threadforms are usually called V-threads or vee-threads because of the shape of the letter V. For 60° V-threads, the isosceles triangle is, more specifically, equilateral. For buttress threads, the triangle is scalene.

(268) The theoretical triangle shape for the thread form can be truncated to varying degrees (that is, the tip of the triangle is cut short). A V-thread in which there is no truncation (or a minuscule amount considered negligible) is called a sharp V-thread. Truncation occurs (and is codified in standards) for practical reasons.

(269) The mechanical advantage of a screw thread depends on its lead, which is the linear distance the screw travels in one revolution. In general, the lead of a screw thread may be selected so that friction is sufficient to prevent linear motion or force from being converted to rotary, that is so the screw does not slip or disengage even when linear force is applied, as long as no external rotational force is present. A “length of thread engagement” refers to a distance that one set of threads (external or internal) engages another set of one or more threads (external or internal). The tightening of a fastener's screw thread is comparable to driving a wedge into a gap until the wedge sticks fast through friction and slight elastic deformation. (Search ‘screw thread’ on Wikipedia.com Jul. 16, 2021. Modified. Accessed Aug. 17, 2021.)

(270) As used herein, a “knuckle threads” or “round threads” refers to a type of screw thread having a rounded thread form. The rounded thread form results in a space between the rounded

crests and roots. This space provides space for material or debris to be shifted to not interfere with the thread and engaged within the space. This thread form is resistant to debris and thread damage. (Search 'knuckle thread' on Wikipedia.com Jan. 23, 2021. Modified. Accessed Aug. 17, 2021.)
(271) As used herein, a "plate" refers to a flat structure. In certain embodiments, a plate can be configured to support a load. In certain embodiments, a plate may comprise a generally planar structure. A plate can be a separate structure connected to, or integrated with, another structure. Alternatively, a plate can be connected to part of another structure. A plate can be two-dimensional or three-dimensional and can have a variety of geometric shapes and/or cross-sectional shapes, including, but not limited to a rectangle, a square, or other polygon, as well as a circle, an ellipse, an ovoid, or other circular or semi-circular shape. A plate can be made from a variety of materials including, metal, plastic, ceramic, wood, fiberglass, or the like. One plate may be distinguished from another based on where the plate is positioned within a structure, component, or apparatus. For example, an "upper plate" can include a plate positioned on, near, or integrated with, a structure such that the plate is at, or near, a top of the structure. Similarly, a "lower plate" can include a plate positioned on, near, or integrated with, a structure such that the plate is at, or near, a bottom of the structure.
(272) As used herein, a "recess" refers to hollow, pocket, void, opening, or depression formed in a surface. In certain embodiments, the recess does not pass through the structure having the surface. A recess can have a variety of cross-section shapes (e.g., ovoid, oval, round, circular, rectangular, square, or the like) and have a variety of configurations for one or more walls that define the recess. In one example, a recess can have one or more walls that connect in rounded corners. In certain embodiments, a recess is sized and shaped to receive or accept another structure.
(273) As used herein, a "boss" refers to a protruding feature on a work piece or structure. A common use or feature for a boss is to locate one object within a pocket or hole of another object. (Search 'Boss (engineering)' on Wikipedia.com Aug. 13, 2021. Modified. Accessed Aug. 18, 2021).
(274) As used herein, an "inserter" refers to an apparatus, instrument, structure, device, component, system, or assembly that is structured, organized, configured, designed, arranged, or engineered to insert or deploy one or more components, parts, or devices. In certain embodiments, an inserter can be used to insert implants and/or prosthesis into tissue, organs, or parts of a patient. In certain embodiments, an inserter can also be used to extract, retract, reposition, or remove an implant and/or prosthesis.
(275) As used herein, "ridge" refers to a narrow, raised band on a surface or a structure that extends outwards from something. One or more ridges can be configured in a uniform relationship to each other, such as being parallel or extending radially from a common point. (Search "ridge" on wordhippo.com. WordHippo, 2021. Web. Accessed 18 Aug. 2021. Modified.)
(276) As used herein, a "pushrod" refers to an instrument, structure, device, or component that is long and slender or narrow and structured, organized, configured, positioned, designed, arranged, and/or engineered to press or push against another structure, instrument, component, or device. (Search 'Valve train' on Wikipedia.com Jul. 15, 2021. Modified. Accessed Aug. 18, 2021.)
(277) As used herein, a "clearance fit" refers to a type of engineering fit. An engineering fit is used in defining geometric dimensions and tolerances when designing a part or assembly. The fit is the clearance between two mating parts, and the size of this clearance determines whether the parts can, at one end of the spectrum, move or rotate independently from each other or, at the other end, are temporarily or permanently joined together. Engineering fits are generally described as a "shaft and hole" pairing but are not limited to just round components.
(278) The three types of fit are: Clearance: The hole is larger than the shaft, enabling the two parts to slide and/or rotate when assembled, e.g., piston & valves; Location/transition: The hole is fractionally smaller than the shaft and mild force is required to assemble/disassemble e.g., Shaft key; and Interference: The hole is smaller than the shaft and high force and/or heat is required to assemble/disassemble e.g., Bearing bush.

(279) As used herein, an “axial translation” refers to motion of one or more components along a common axis.
(280) The phrases “connected to,” “coupled to” and “in communication with” refer to any form of interaction between two or more entities, including mechanical, electrical, magnetic, electromagnetic, fluid, and thermal interaction. Two components may be functionally coupled to or in communication with each other even though they are not in direct contact with each other.
(281) As used herein, “coupling” or “coupler” refers to a mechanical device, component, or structure, that is organized, configured, designed, arranged, or engineered to connect the ends of adjacent parts or objects. In certain embodiments, a coupling can be used to connect two shafts together at their ends for the purpose of transmitting power. In other embodiments, a coupling can be used to join two pieces of rotating equipment while permitting some degree of misalignment or end movement or both. Couplings do not normally allow disconnection of the two parts, such as shafts during operation. (Search “coupling” on Wikipedia.com Jul. 26, 2021. CC-BY-SA 3.0 Modified. Accessed Jul. 27, 2021.)
(282) As used herein, an “axial force transmitting relationship” refers to a functional relationship between a first structure and a second structure. In this relationship, the structures interact with each other such that a force experienced or imparted by one structure (first or second) is transferred or transmitted to the other structure (first or second) along or in relation to a shared single axis. In certain embodiments, the first structure and second structure share a common axis. In other words, the two structures are coaxial. One axis, such as a longitudinal axis, is shared by both the first structure and the second structure.
(283) As used herein, a “tensioner” refers to an apparatus, instrument, structure, device, component, system, or assembly that is structured, organized, configured, designed, arranged, or engineered to apply or increase tension in another structure, component, or device. The another structure, component, or device can be any of a variety of things including, but not limited to a thread, a suture, suture tape, a woven structure, a fibrous material, a cord, a ligament, cartilage, muscle, a ligament graft, and/or any of these in combination with each other, or the like. In certain embodiments, a tensioner can be used to release or relax tension in another structure, component, or device.
(284) Recitation in the claims of the term “first” with respect to a feature or element does not necessarily imply the existence of a second or additional such feature or element. Elements recited in means-plus-function format are intended to be construed in accordance with 35 U.S.C. § 112 Para. 6. It will be apparent to those having skill in the art that changes may be made to the details of the above-described embodiments without departing from the underlying principles of the technology.
(285) While specific embodiments and applications of the present technology have been illustrated and described, it is to be understood that the technology is not limited to the precise configuration and components disclosed herein. Various modifications, changes, and variations which will be apparent to those skilled in the art may be made in the arrangement, operation, and details of the methods and systems of the present technology disclosed herein without departing from the spirit and scope of the technology.

## Claims

1. A knotless suture anchor system comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a distal opening communicating with the longitudinal passageway nearer the distal end; an interference member insertable distally into the longitudinal passageway to secure a portion of a

suture within the longitudinal passageway by compressing the portion of the suture between the interference member and the anchor body; and a frangible connection that joins a proximal member to the anchor body.

2. The knotless suture anchor system of claim 1 further comprising a driver operable to urge the interference member into the anchor body, and operable to move the interference member out of the anchor body.

3. The knotless suture anchor system of claim 2, wherein the driver comprises: a drive shaft having a proximal end and a distal end; a drive coupler connected to the drive shaft at the proximal end; and a drive feature connected to the drive shaft at the distal end.

4. The knotless suture anchor system of claim 2, wherein the driver is configured to apply a torque to the interference member that engages at least one external helical thread of the interference member with an internal thread of the anchor body.

5. The knotless suture anchor system of claim 1, wherein the proximal end of the anchor body includes internal helical threads and the interference member comprises a set screw having external helical threads configured to interface with the internal helical threads in a clearance fit having a length of thread engagement shorter than a length of the external helical threads.

6. The knotless suture anchor system of claim 5, wherein the external helical threads of the set screw comprise knuckle threads having an external helical thread pitch different from an internal helical thread pitch of the internal helical threads.

7. The knotless suture anchor system of claim 1, further comprising a tensioner operable to engage the proximal member and secure and tension a suture extending from the anchor body.

8. The knotless suture anchor system of claim 7, the tensioner comprising: a shaft having a proximal end and a distal end, the shaft operable to engage the proximal member at the distal end of the shaft; a carriage having a suture grip member that removably secures a portion of the suture to the carriage, the carriage having first threads; a puller connected to the shaft near the proximal end of the shaft, the puller having second threads that engage the first threads; and wherein the shaft, carriage, and puller are coaxial with the longitudinal axis and include an inserter longitudinal passageway in communication with the longitudinal passageway of the anchor body.

9. The knotless suture anchor system of claim 8, wherein the suture grip member comprises: a superior grip plate having ridges; an inferior grip plate having ridges; and a fastener that compresses the superior grip plate against the inferior grip plate and secure a portion of the suture between the superior grip plate and inferior grip plate.

10. The knotless suture anchor system of claim 9, wherein the fastener comprises a thumb screw and the superior grip plate comprises a recess that accepts a boss of the inferior grip plate, the boss having ridges.

11. The knotless suture anchor system of claim 1 further comprising an inserter operable to engage the proximal member in an axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod operable to engage one of the interference member and the anchor body in an axial force transmitting relationship in a second direction opposite the first direction and break the frangible connection between the proximal member and the anchor body in response to axial translation of the pushrod relative to the inserter.

12. A knotless suture anchor system comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a first distal opening communicating with the longitudinal passageway nearer the distal end; and a tensioner connected to the anchor body and operable to engage the proximal end, secure a suture extending from the anchor body, and apply tension to the suture; and a proximal member connected to the proximal end of the anchor body by a frangible connection.

13. The knotless suture anchor system of claim 12 further comprising an interference member insertable distally into the longitudinal passageway to secure a portion of a suture within the longitudinal passageway by compressing the portion of the suture between the interference member and the anchor body.
14. The knotless suture anchor system of claim 13, further comprising an inserter operable to engage the proximal member in an axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod operable to engage the interference member in an axial force transmitting relationship in a second direction opposite the first direction and break the frangible connection between the proximal member and the anchor body in response to axial translation of the pushrod relative to the inserter.
15. The knotless suture anchor system of claim 14 wherein the inserter comprises a shaft having a proximal end and a distal end, the shaft operable to engage the proximal member at the distal end of the shaft, the shaft coupled to a tensioner comprising: a carriage having a suture grip member that removably secures a portion of the suture to the carriage, the carriage having first threads; a puller connected to the shaft near the proximal end of the shaft, the puller having second threads that engage the first threads; and wherein the shaft, carriage, and puller are coaxial with the longitudinal axis and include an inserter longitudinal passageway in communication with the longitudinal passageway of the anchor body.
16. The knotless suture anchor system of claim 15 wherein the proximal member comprises external helical threads configured to engage internal helical threads of the shaft.
17. A knotless suture anchor system comprising: an anchor body having an exterior surface, a proximal end, a distal end, a longitudinal axis extending between the proximal and distal ends, an interior longitudinal passageway extending at least partway from the proximal end toward the distal end, a proximal opening communicating with the longitudinal passageway nearer the proximal end, and a first distal opening communicating with the longitudinal passageway nearer the distal end; a proximal member joined to the anchor body, the proximal member having external threads at a proximal end of the proximal member; a set screw insertable distally into the longitudinal passageway to releasably secure a first portion of a suture within the longitudinal passageway by compressing the first portion of the suture between external knuckle threads of the set screw and internal helical threads at the proximal end of the anchor body; a frangible connection that joins the proximal member to the anchor body; and a tensioner connected to an inserter operable to engage the proximal member, the tensioner operable to secure a second portion of the suture contiguous to the first portion and extending from the anchor body, the tensioner also operable to apply tension to the second portion of the suture.
18. The knotless suture anchor system of claim 17 wherein the inserter is operable to engage the proximal member in an axial force transmitting relationship in a first direction, the inserter having a pushrod mounted for axial translation within the inserter, the pushrod operable to engage the set screw in an axial force transmitting relationship in a second direction opposite the first direction and break the frangible connection to separate the anchor body from the proximal member in response to axial translation of the pushrod relative to the inserter.
19. The knotless suture anchor system of claim 17 further comprising: a driver operable to engage the set screw and to urge the set screw into the anchor body; and wherein the driver comprises: a drive shaft having a proximal end and a distal end; a drive coupler connected to the drive shaft at the proximal end; a drive feature connected to the drive shaft at the distal end; and external drive threads between the proximal end and the distal end, the external drive threads configured to engage internal drive threads of the inserter.