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Suturing device and methods of use thereof

Abstract

The present disclosure includes a suturing device including: a fixed arm having a fixed jaw including a first grasping slot configured to receive a needle; a movable arm coupled to a movable jaw including a second grasping slot configured to receive the needle, the movable arm configured to pivot relative to the fixed arm to pivot the movable jaw relative to the fixed jaw until the needle is received in the first grasping slot and the second grasping slot; and a needle transfer mechanism configured to grasp the needle in the first grasping slot or the second grasping slot. In some aspects, the suturing device includes a safety member configured to control when the movable arm moves. The present disclosure includes a loading apparatus including a loading slot configured to receive a fixed jaw and a slider configured to move the needle towards into the fixed jaw.

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Background/Summary

RELATED APPLICATIONS (1) This application is a continuation application of U.S. application Ser. No. 18/371,975, filed Sep. 22, 2023, which is a continuation application of U.S. application Ser. No. 18/114,874, filed on Feb. 27, 2023, now U.S. Pat. No. 11,903,576, which is a continuation application of PCT Application PCT/TR2022/050959, filed on Sep. 7, 2022, which claims the benefit of and priority to Turkish Patent Application 2021/017512, filed on Nov. 10, 2021, and Turkish Patent Application 2021/014052, filed on Sep. 7, 2021, each of which are hereby incorporated herein by reference in their entireties.

FIELD
(1) This disclosure relates to suturing devices used in surgical operations, a suture loading apparatus for loading a suture into a suturing device, and methods of their use.
BACKGROUND
(2) Urinary incontinence (UI) refers to the unintentional loss of urine. The disease comes in three different forms: Stress UI, Urge UI and Mixed UI. The most common is Stress UI, which happens

when physical movement or activity—such as coughing, sneezing, running or heavy lifting—puts pressure (e.g., stress) on the bladder.
(3) Abdominal colposuspension based on native tissue repair for Stress UI is based on elevation of the vaginal wall towards bilateral strong pelvic floor supportive structures such as Arcus Tendineus Fascia Pelvis (ATFP), iliopectineal ligament. However, native tissue repair is invasive and difficult because it is intensive and is a major surgery (abdominal). Transvaginal surgery is based on mesh repair for SUI. It involves the placement of tension-free mesh (sling). This method often involves placing artificial implants such as a synthetic sling or mesh.
(4) Pelvic organ prolapse refers to the prolapse (drop) of pelvic organs from their normal position. The pelvic organs include the vagina, cervix, uterus, bladder, urethra, and rectum.
(5) Surgical treatment of POP can be done through the abdomen or the vagina. Abdominal surgeries to repair POP can be done either based on native tissue repair or by placing artificial mesh. Transvaginal surgeries too can be either done based on native tissue repair or by placing artificial mesh. Native tissue repair done through the vagina is based on the elevation of vaginal wall or cervix (if the patient's uterus has been removed for another reason) towards strong pelvic floor supportive structures such as the Sacrospinous ligament, Sacro-uterine ligament, and Arcus Tendineus Fascia Pelvis (ATFP).
SUMMARY
(6) In some aspects, the techniques described herein relate to a suturing device including: a fixed arm **7** integral with a fixed jaw **5** including a first grasping slot **103** configured to receive a needle **201**; a movable jaw **6** including a second grasping slot **104** configured to receive the needle **201**, the movable jaw **6** configured to pivot about a reference location **9** on the fixed arm **7** and relative to the fixed jaw **5** while the fixed jaw **5** remains immovable; a movable arm **8** coupled to the movable jaw **6**, the movable arm **8** configured to pivot about the reference location **9** and relative to the fixed arm **7** while the fixed arm **7** remains immovable, the movable arm **8** configured to pivot away from the fixed arm **7** to move the movable jaw **6** away from the fixed jaw **5**, the movable arm **8** configured to pivot towards the fixed arm **7** to move the movable jaw **6** towards the fixed jaw **5** until the needle **201** is disposed in the first grasping slot **103** and the second grasping slot **104**; and a needle transfer mechanism **4** configured to secure the needle **201** in the first grasping slot **103** or the second grasping slot **104**.
(7) In some aspects, the techniques described herein relate to a suturing device, wherein the fixed arm **7** further includes an arm joint **101** located in the reference location **9**, wherein the arm joint **101** is coupled to the movable arm **8**, and wherein the movable arm **8** is configured to pivot about the arm joint **101** and relative to the fixed arm **7**.
(8) In some aspects, the techniques described herein relate to a suturing device, wherein the fixed arm **7** further includes a jaw joint **100** located in the reference location **9**, wherein the jaw joint **100** is coupled to the movable jaw **6**, and wherein the movable jaw **6** is configured to pivot about the jaw joint **100** and relative to the fixed jaw **5**.
(9) In some aspects, the techniques described herein relate to a suturing device, wherein the suturing device further includes a connecting joint **102** located in the reference location **9**, wherein the connecting joint **102** is configured to link the movable arm **8** and the movable jaw **6**, wherein the movable arm **8** is configured to move the connecting joint **102** to cause the movable jaw **6** to pivot about the jaw joint **100**.
(10) In some aspects, the techniques described herein relate to a suturing device, wherein the suturing device further includes an attachment member **1105** configured to be attached to the fixed jaw **5** or the movable jaw **6**, the attachment member **1105** including the needle **201**.
(11) In some aspects, the techniques described herein relate to a suturing device, wherein the needle transfer mechanism **4** further includes: a first control bar **505**A configured to advance towards a first notch **207**A of the needle **201** disposed in the first grasping slot **103** to grasp the needle **201** in the first grasping slot **103** or retract from the first notch **207**A to release the needle **201** from the

first grasping slot **103**; and a second control bar **505**B configured to advance towards a second notch **207**B of the needle **201** disposed in the second grasping slot **104** to grasp the needle **201** in the second grasping slot **104** or retract from the second notch **207**B to release the needle **201** from the second grasping slot **104**.

(12) In some aspects, the techniques described herein relate to a suturing device, wherein the needle transfer mechanism **4** further includes: a first control bar **505**A configured to advance a first grasping member **510**A towards a first notch **207**A of the needle **201** disposed in the first grasping slot **103** to grasp the needle **201** in the first grasping slot **103** or retract the first grasping member **510**A from the first notch **207**A to release the needle **201** from the first grasping slot **103**; and a second control bar **505**B configured to advance a second grasping member **510**B towards a second notch **207**B of the needle **201** disposed in the second grasping slot **104** to grasp the needle **201** in the second grasping slot **104** or retract the second grasping member **510**B from the second notch **207**B to release the needle **201** from the second grasping slot **104**.

(13) In some aspects, the techniques described herein relate to a suturing device, wherein the needle transfer mechanism **4** further includes: a first cable **3001**A configured to advance to release a first spring **3002**A to advance a first piston **3003**A towards a first notch **207**A of the needle **201** disposed in the first grasping slot **103** to grasp the needle **201** in the first grasping slot **103**, the first cable **3001**A further configured to pull the first piston **3003**A to compress the first spring **3002**A to retract the first piston **3003**A from the first notch **207**A to release the needle **201** from the first grasping slot **103**; and a second cable **3001**B configured to advance to release a second spring **3002**B to advance a second piston **3003**B towards a second notch **207**B of the needle **201** disposed in the second grasping slot **104** to grasp the needle **201** in the second grasping slot **104**, the second cable **3001**B further configured to pull the second piston **3003**B to compress the second spring **3002**B to retract the second piston **3003**B from the second notch **207**B to release the needle **201** from the second grasping slot **104**.

(14) In some aspects, the techniques described herein relate to a suturing device, further including a lever **3** configured to move among: a first position **110**A to advance the first control bar **505**A to grasp the needle **201** in the first grasping slot **103** and retract the second control bar **505**B to release the needle **201** from the second grasping slot **104**, a second position **110**B to retract the first control bar **505**A to release the needle **201** from the first grasping slot **103** and retract the second control bar **505**B to release the needle **201** from the second grasping slot **104**, and a third position **110**C to retract the first control bar **505**A to release the needle **201** from the first grasping slot **103** and advance the second control bar **505**B to grasp the needle **201** in the second grasping slot **104**.

(15) In some aspects, the techniques described herein relate to a suturing device, further including a lever **3** configured to move among: a first position **110**A to advance the first cable **3001**A to release the first spring **3002**A to advance the first piston **3003**A to grasp the needle **201** in the first grasping slot **103** and to pull the second cable **3001**B to pull the second piston **3003**B to compress the second spring **3002**B to retract the second piston **3003**B to release the needle **201** from the second grasping slot **104**, a second position **1101**B to pull the first cable **3001**A to pull the first piston **3003**A to semi-compress the first spring **3002**A to semi-retract the first piston **3003**A to release the needle **201** from the first grasping slot **103** and to pull the second cable **3001**B to pull the second piston **3003**B to semi-compress the second spring **3002**B to semi-retract the second piston **3003**B to release the needle **201** from the second grasping slot **104**, and a third position **110**C to pull the first cable **3001**A to pull the first piston **3003**A to compress the first spring **3002**A to retract the first piston **3003**A to release the needle **201** from the first grasping slot **103** and to advance the second cable **3001**B to release the second spring **3002**B to advance the second piston **3003**B to grasp the needle **201** in the second grasping slot **104**.

(16) In some aspects, the techniques described herein relate to a suturing device, further including a lever **3** configured to move among: a first position **110**A to advance the first cable **3001**A to release the first spring **3002**A to advance the first piston **3003**A to grasp the needle **201** in the first grasping

slot **103** and to pull the second cable **3001**B to pull the second piston **3003**B to compress the second spring **3002**B to retract the second piston **3003**B to release the needle **201** from the second grasping slot **104**, a second position **110**B to semi-pull the first cable **3001**A to pull the first piston **3003**A to semi-compress the first spring **3002**A to semi-retract the first piston **3003**A to grasp the needle **201** in the first grasping slot **103** and to semi-pull the second cable **3001**B to pull the second piston **3003**B to semi-compress the second spring **3002**B to semi-retract the second piston **3003**B to grasp the needle **201** in the second grasping slot **104**, and a third position **110**C to pull the first cable **3001**A to pull the first piston **3003**A to compress the first spring **3002**A to retract the first piston **3003**A to release the needle **201** from the first grasping slot **103** and to advance the second cable **3001**B to release the second spring **3002**B to advance the second piston **3003**B to grasp the needle **201** in the second grasping slot **104**.

(17) In some aspects, the techniques described herein relate to a suturing device, further including a cover **108** partially disposed over the lever **3**, the cover **108** including indicators corresponding to movements of the lever **3** to the first position **110**A, the second position **110**B, and the third position **110**C.

(18) In some aspects, the techniques described herein relate to a suturing device, further including a switching joint **106** coupled to the first control bar **505**A and the second control bar **505**B.

(19) In some aspects, the techniques described herein relate to a suturing device, wherein the lever **3** is coupled to the switching joint **106**, wherein the lever **3** is configured to rotate the switching joint **106** to move the first control bar **505**A and the second control bar **505**B.

(20) In some aspects, the techniques described herein relate to a suturing device, further including a switching joint **106** coupled to the first cable **3001**A and the second cable **3001**B.

(21) In some aspects, the techniques described herein relate to a suturing device, wherein the lever **3** is coupled to the switching joint **106**, wherein the lever **3** is configured to rotate the switching joint **106** to pull or advance the first cable **3001**A and the second cable **3001**B.

(22) In some aspects, the techniques described herein relate to a suturing device, wherein the movable arm **8** includes a stopper **605**, and wherein the second control bar **505**B includes a safety member **610** configured to interlock with the stopper **605** when the lever **3** is in the second position **110**B to prevent the movable arm **8** from moving to prevent the needle **201** from falling out.

(23) In some aspects, the techniques described herein relate to a suturing device, wherein the stopper **605** is configured to slide into an activated position on the movable arm **8** to secure the stopper **605** adjacent to the safety member **610** to enable the stopper **605** and the safety member **610** to interlock.

(24) In some aspects, the techniques described herein relate to a suturing device, wherein the stopper **605** is configured to slide into a deactivated position on the movable arm **8** to secure the stopper **605** away from the safety member **610** to prevent the stopper **605** and the safety member **610** from interlocking.

(25) In some aspects, the techniques described herein relate to a loading apparatus **10** including: a first loading slot **13** disposed in the loading apparatus **10**, the first loading slot **13** configured to receive a fixed jaw **5**; and a slider **12** including a slot **15** configured to hold a needle **201**, the slider **12** configured to move within a loading channel **320** to move the slot **15** holding the needle **201** towards the first loading slot **13** and into a first grasping slot **103** of the fixed jaw **5**.

(26) In some aspects, the techniques described herein relate to a loading apparatus **10**, further including a pulley **11** including a thread **16** coupled to the needle **201**, wherein the pulley **11** is configured to rotate such that the thread **16** moves when the first grasping slot **103** of the fixed jaw **5** exits the first loading slot **13**.

(27) In some aspects, the techniques described herein relate to a loading apparatus **10**, further including a second loading slot **14** disposed in the loading apparatus **10**, the second loading slot **14** configured to receive a movable jaw **6**, wherein the slider **12** is configured to move within the loading channel **320** to move the slot **15** holding the needle **201** towards the second loading slot **14**

and into a second grasping slot **104** of the movable jaw **6**.

(28) In some aspects, the techniques described herein relate to a method including: moving a movable arm **8** of a suturing device away from a fixed arm **7** of the suturing device and about a reference location on the fixed arm **7** while the fixed arm **7** remains immovable, moving the movable arm **8** away causes a movable jaw **6** of the suturing device to pivot about the reference location and move away from a fixed jaw **5** extending from the fixed arm **7** that remains immovable and touching a cavity tissue; moving the movable arm **8** about the reference location and towards the fixed arm **7** to pivot the movable jaw **6** about the reference location and towards the fixed jaw **5** until a needle **201** secured in the fixed jaw **5** pierces through a target tissue between the fixed jaw **5** and the movable jaw **6** until the needle **201** is disposed in the movable jaw **6**; actuating a needle transfer mechanism **4** of the suturing device to transfer the needle **201** from the fixed jaw **5** to the movable jaw **6**; and moving the movable arm **8** about the reference location and away from the fixed arm **7** to pivot the movable jaw **6** with the needle **201** about the reference location and away from the fixed jaw **5** to move the needle **201** through the target tissue.

(29) In some aspects, the techniques described herein relate to a method, further including pivoting the movable arm **8** relative to the fixed arm **7** and about an arm joint **101**, the arm joint **101** coupled to the movable arm **8** and located in the reference location, pivoting the movable arm **8** causes the movable jaw **6** to pivot relative to the fixed jaw **5** and about a jaw joint **100** located in the reference location and coupled to the fixed arm **7**.

(30) In some aspects, the techniques described herein relate to a method, further including moving the movable arm **8** to move a connecting joint **102** configured to link the movable arm **8** and the movable jaw **6** to cause the movable jaw **6** to pivot about the jaw joint **100**.

(31) In some aspects, the techniques described herein relate to a method, further including attaching an attachment member **1105** to the fixed jaw **5** or the movable jaw **6**, the attachment member **1105** including the needle **201**.

(32) In some aspects, the techniques described herein relate to a method, wherein actuating the needle transfer mechanism **4** includes: retracting a first control bar **505**A from a first notch **207**A of the needle **201** disposed in a first grasping slot **103** of the fixed jaw **5** to release the needle **201** from the first grasping slot **103** of the fixed jaw **5**; and advancing a second control bar **505**B towards a second notch **207**B of the needle **201** disposed in a second grasping slot **104** of the movable jaw **6** to grasp the needle **201** in the second grasping slot **104** of the movable jaw **6**.

(33) In some aspects, the techniques described herein relate to a method, wherein subsequent to the needle **201** secured in the movable jaw **6** moving through the target tissue, further including: advancing a first control bar **505**A towards a first notch **207**A of the needle **201** disposed in a first grasping slot **103** of the fixed jaw **5** to grasp the needle **201** in the first grasping slot **103** of the fixed jaw **5**; and retracting a second control bar **505**B from a second notch **207**B of the needle **201** disposed in a second grasping slot **104** of the movable jaw **6** to release the needle **201** from the second grasping slot **104** of the movable jaw **6**.

(34) In some aspects, the techniques described herein relate to a method, further including: moving a lever **3** of the suturing device to a first position **110**A to advance a first control bar **505**A from a first notch **207**A of the needle **201** disposed in a first grasping slot **103** of the fixed jaw **5** to grasp the needle **201** in the first grasping slot **103** and retract a second control bar **505**B from a second notch **207**B of the needle **201** disposed in a second grasping slot **104** of the movable jaw **6** to release the needle **201** from the second grasping slot **104**; moving the lever **3** of the suturing device to a second position **1101**B to retract the first control bar **505**A from the first notch **207**A of the needle **201** disposed in the first grasping slot **103** of the fixed jaw **5** to release the needle **201** from the first grasping slot **103** and retract the second control bar **505**B from the second notch **207**B of the needle **201** disposed in the second grasping slot **104** of the movable jaw **6** to release the needle **201** from the second grasping slot **104**; and moving the lever **3** of the suturing device to a third position **110**C to retract the first control bar **505**A from the first notch **207**A of the needle **201**

disposed in the first grasping slot **103** of the fixed jaw **5** to release the needle **201** from the first grasping slot **103** and retract the second control bar **505**B from the second notch **207**B of the needle **201** disposed in the second grasping slot **104** of the movable jaw **6** to release the needle **201** from the second grasping slot **104**.

(35) In some aspects, the techniques described herein relate to a method, further including a switching joint **106** coupled to the first control bar **505**A and the second control bar **505**B, wherein the lever **3** is coupled to the switching joint **106**, and wherein the lever **3** is configured to rotate the switching joint **106** to pull or advance the first control bar **505**A and the second control bar **505**B.

(36) In some aspects, the techniques described herein relate to a method, further including sliding a stopper **605** on the movable arm **8** into an activated position on the movable arm **8** to secure the stopper **605** adjacent to a safety member **610** of the second control bar **505**B configured to interlock with the stopper **605** when the lever **3** is in the second position **110**B to prevent the movable arm **8** from moving to prevent the needle **201** from falling out.

(37) In some aspects, the techniques described herein relate to a method, further including sliding the stopper **605** into a deactivated position on the movable arm **8** to secure the stopper **605** away from the safety member **610** to prevent the stopper **605** and the safety member **610** from interlocking.

(38) In some aspects, the techniques described herein relate to a method, wherein actuating the needle transfer mechanism **4** includes: retracting a first control bar **505**A to retract a first grasping member **510**A from a first notch **207**A of the needle **201** disposed in a first grasping slot **103** of the fixed jaw **5** to release the needle **201** from the first grasping slot **103** of the fixed jaw **5**; and advancing a second control bar **505**B to advance a second grasping member **510**B towards a second notch **207**B of the needle **201** disposed in a second grasping slot **104** of the movable jaw **6** to grasp the needle **201** in the second grasping slot **104** of the movable jaw **6**.

(39) In some aspects, the techniques described herein relate to a method, wherein actuating the needle transfer mechanism **4** includes: pulling a first cable **3001**A to pull a first piston **3003**A to compress a first spring **3002**A to retract the first piston **3003**A from a first notch **207**A of the needle **201** disposed in a first grasping slot **103** of the fixed jaw **5** to release the needle **201** from the first grasping slot **103** of the fixed jaw **5**; and advancing a second cable **3001**B to release a second spring **3002**B to advance a second piston **3003**B towards a second notch **207**B of the needle **201** disposed in a second grasping slot **104** of the movable jaw **6** to grasp the needle **201** in the second grasping slot **104** of the movable jaw **6**.

(40) In some aspects, the techniques described herein relate to a method, further including: moving a lever **3** of the suturing device to a first position **110**A to advance a first cable **3001**A to release a first spring **3002**A to advance a first piston **3003**A to grasp the needle **201** in a first grasping slot **103** of the fixed jaw **5** and to pull a second cable **3001**B to pull a second piston **3003**B to compress a second spring **3002**B to retract the second piston **3003**B to release the needle **201** from a second grasping slot **104** of the movable jaw **6**; moving the lever **3** of the suturing device to a second position **110**B to pull the first cable **3001**A to pull the first piston **3003**A to semi-compress the first spring **3002**A to semi-retract the first piston **3003**A to release the needle **201** from the first grasping slot **103** and to pull the second cable **3001**B to pull the second piston **3003**B to semi-compress the second spring **3002**B to semi-retract the second piston **3003**B to release the needle **201** from the second grasping slot **104**; and moving the lever **3** of the suturing device to a third position **110**C to pull the first cable **3001**A to pull the first piston **3003**A to compress the first spring **3002**A to retract the first piston **3003**A to release the needle **201** from the first grasping slot **103** and to advance the second cable **3001**B to release the second spring **3002**B to advance the second piston **3003**B to grasp the needle **201** in the second grasping slot **104**.

(41) In some aspects, the techniques described herein relate to a method, further including a switching joint **106** coupled to the first cable **3001**A and the second cable **3001**B, wherein the lever **3** is coupled to the switching joint **106**, and wherein the lever **3** is configured to rotate the switching

joint **106** to pull or advance the first cable **3001**A and the second cable **3001**B.
(42) In some aspects, the techniques described herein relate to a method, further including: moving a lever **3** of the suturing device to a first position **110**A to advance a first cable **3001**A to release a first spring **3002**A to advance a first piston **3003**A to grasp the needle **201** in a first grasping slot **103** of the fixed jaw **5** and to pull a second cable **3001**B to pull a second piston **3003**B to compress a second spring **3002**B to retract the second piston **3003**B to release the needle **201** from a second grasping slot **104** of the movable jaw **6**; moving the lever **3** of the suturing device to a second position **1101**B to semi-pull the first cable **3001**A to pull the first piston **3003**A to semi-compress the first spring **3002**A to semi-retract the first piston **3003**A to grasp the needle **201** in the first grasping slot **103** and to semi-pull the second cable **3001**B to pull the second piston **3003**B to semi-compress the second spring **3002**B to semi-retract the second piston **3003**B to grasp the needle **201** in the second grasping slot **104**; and moving the lever **3** of the suturing device to a third position **110**C to pull the first cable **3001**A to pull the first piston **3003**A to compress the first spring **3002**A to retract the first piston **3003**A to release the needle **201** from the first grasping slot **103** and to advance the second cable **3001**B to release the second spring **3002**B to advance the second piston **3003**B to grasp the needle **201** in the second grasping slot **104**.
(43) In some aspects, the techniques described herein relate to a method, further including a switching joint **106** coupled to the first cable **3001**A and the second cable **3001**B, wherein the lever **3** is coupled to the switching joint **106**, and wherein the lever **3** is configured to rotate the switching joint **106** to pull or advance the first cable **3001**A and the second cable **3001**B.
(44) In some aspects, the techniques described herein relate to a method, further including: inserting the fixed jaw **5** of the suturing device into a first loading slot **13** disposed in a loading apparatus **10**; and moving a slider **12** including a slot **15** configured to hold the needle **201** within a loading channel **320** of the loading apparatus **10** to move the slot **15** holding the needle **201** towards the first loading slot **13** and into a first grasping slot **103** of the fixed jaw **5**.
(45) In some aspects, the techniques described herein relate to a method, further including upon actuating the needle transfer mechanism **4**, removing the suturing device and pulling on a curved needle **18** attached to a first end of a thread **16** that is opposite a second end of the thread **16** attached to the needle **201**.
(46) In some aspects, the techniques described herein relate to a method, wherein subsequent to moving the movable arm **8** away from the fixed arm **7** to pivot the movable jaw **6** away from the fixed jaw **5** to move the needle **201** through the target tissue, the method further includes: moving the movable arm **8** about the reference location and towards the fixed arm **7** to pivot the movable jaw **6** about the reference location and towards the fixed jaw **5** until the needle **201** secured in the movable jaw **6** pierces through a different section of the target tissue until the needle **201** is disposed in the fixed jaw **5**; and actuating the needle transfer mechanism **4** to transfer the needle **201** from the movable jaw **6** to the fixed jaw **5**.
(47) In some aspects, the techniques described herein relate to a system including: a mesh **2302** extending between a first positioning thread **16**A and a second positioning thread **16**B, the first positioning thread **16**A attached to a first positioning needle **201**A and the second positioning thread **16**B attached to a second positioning needle **201**B; a first loading slot **13**A and a second loading slot **13**B disposed in a sling loader **2315**, the first loading slot **13**A and the second loading slot **13**B configured to receive a fixed jaw **5** of a suturing device; a first slider **12**A attached to the sling loader **2315**, the first slider **12**A including a first slot **15**A configured to hold the first positioning needle **201**A, the first slider **12**A configured to move within a first loading channel **320**A of the sling loader **2315** to move the first slot **15**A holding the first positioning needle **201**A towards the first loading slot **13**A and into a first grasping slot **103** of the fixed jaw **5**; and a second slider **12**B attached to the sling loader **2315**, the second slider **12**B including a second slot **15**B configured to hold the second positioning needle **201**B, the second slider **12**B configured to move within a second loading channel **320**B of the sling loader **2315** to move the second slot **15**B

holding the second positioning needle **201**B towards the second loading slot **13**B and into the first grasping slot **103** of the fixed jaw **5**.

(48) In some aspects, the techniques described herein relate to a system, further including a first adjustment thread **2308**A, a second adjustment thread **2308**B, and a third adjustment thread **2308**C each extending from the mesh **2302**, the second adjustment thread **2308**B extending between the first adjustment thread **2308**A and the third adjustment thread **2308**C.

(49) In some aspects, the techniques described herein relate to a system, wherein each end of the first adjustment thread **2308**A includes a first curved needle **2310**A and a second curved needle **2310**B, each end of the second adjustment thread **2308**B includes a third curved needle **2310**C and a fourth curved needle **2310**D, and each end of the third adjustment thread **2308**C includes a fifth curved needle **2310**E and a sixth curved needle **2310**F.

(50) In some aspects, the techniques described herein relate to a method including: moving a first slider **12**A of a loading apparatus **2315** within a first sliding channel **320**A of a first loading slot **13**A to move a first needle **201**A disposed in a first slot **15**A of the first slider **12**A into a first grasping slot **103** of a fixed jaw **5** extending from a fixed arm **7** of a suturing device loaded in the first loading slot **13**A, the first needle **201**A attached to a first thread **16**A attached to a mesh **2302**; actuating a lever **3** of the suturing device to secure the first needle **201**A in the first grasping slot **103**; moving a movable arm **8** of the suturing device away from the fixed arm **7** and about a reference location on the fixed arm **7** while the fixed arm **7** remains immovable, moving the movable arm **8** away causes a movable jaw **6** of the suturing device to pivot about the reference location and move away from the fixed jaw **5** while the fixed jaw **5** remains immovable; moving the movable arm **8** about the reference location and towards the fixed arm **7** to pivot the movable jaw **6** about the reference location and towards the fixed jaw **5** until the first needle **201**A secured in the first grasping slot **103** pierces through a first portion of a palpated tissue between the fixed jaw **5** and the movable jaw **6** and the first needle **201**A is received in a second grasping slot **104** of the movable jaw **6**; removing the suturing device from a pelvic cavity **2208** and actuating a needle transfer mechanism **4** of the suturing device to release the first needle **201**A from the second grasping slot **104**; moving a second slider **12**B of the loading apparatus **2315** within a second sliding channel **320**B of a second loading slot **13**B of the loading apparatus **2315** to move a second needle **201**B disposed in a second slot **15**B of the second slider **12**B into the first grasping slot **103** of the fixed jaw **5** loaded in the second loading slot **13**B, the second needle **201**B attached to a second thread **16**B attached to the mesh **2302**; actuating the lever **3** of the suturing device to secure the second needle **201**B in the first grasping slot **103**; moving the movable arm **8** about the reference location and towards the fixed arm **7** to pivot the movable jaw **6** about the reference location and towards the fixed jaw **5** until the second needle **201**B secured in the first grasping slot **103** pierces through a second portion of the palpated tissue on an other side of the first portion of the palpated tissue between the fixed jaw **5** and the movable jaw **6** and is received in the second grasping slot **104** to place the mesh **2302** in the pelvic cavity **2208**; removing the suturing device from the pelvic cavity **2208** and cutting off the first thread **16**A, the second thread **16**B, and a portion of the mesh **2302**; attaching a first adjustment suture **2305**A, a second adjustment suture **2305**B, and a third adjustment suture **2305**C to the mesh **2302**, the first adjustment suture **2305**A and the third adjustment suture **2305**C attached to each end of the mesh **2302** for tensioning, the second adjustment suture **2305**B attached to a middle of the mesh **2302** for loosening the mesh **2302**; cutting off curved needles **2310** coupled to each of the adjustment sutures **2305** to make knots **2720** of threads **2308** of the adjustment sutures **2305** to form loops and place the knots **2720** into a housing **2725** and leaving the knots **2720** secured in the housing **2725** inside a vaginal cavity **2205** of a patient and closing an incision **2206** in the vaginal cavity **2205**; and pulling on adjustment sutures **2305** coupled to the mesh **2302** to adjust a tension of the mesh **2302** during early post-operative check-up of the patient in an office set up without needing a new operation.

(51) In some aspects, the techniques described herein relate to a method, wherein pulling the

adjustment sutures **2305** includes pulling the knots **2720** disposed in the housing **2725** attached to the adjustment sutures **2305** to adjust the tension of the mesh **2302**, and once the tensioning is finished, cut the loops and take away the housing **2725** and the adjustment sutures **2305**.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The present disclosure is further described in the detailed description which follows, in reference to the noted plurality of drawings by way of non-limiting examples of exemplary embodiments, in which like reference numerals represent similar parts throughout the several views of the drawings, and wherein:

(2) FIG. **1**A and FIG. **1**B depict an embodiment of the suturing device.

(3) FIG. **2**A and FIG. **2**B depict an embodiment of the grasping slots of the suturing device.

(4) FIG. **3**A and FIG. **3**B depict an embodiment of the suturing device including movement of the movable arm and the movable jaw while the needle is secured in the fixed jaw.

(5) FIG. **3**C and FIG. **3**D depict an embodiment of the suturing device including the needle transfer mechanism transferring the needle.

(6) FIG. **3**E depict an embodiment of the suturing device including movement of the movable arm and the movable jaw while the needle is secured in the movable jaw.

(7) FIG. **4**A, FIG. **4**B, FIG. **4**C depict an embodiment of the suturing device including joints for facilitating movement of the movable arm and the movable jaw.

(8) FIG. **5**A depicts an embodiment of a concave needle for the suturing device.

(9) FIG. **5**B, FIG. **5**C, FIG. **5**D, and FIG. **5**E depict an embodiment of a straight needle for the suturing device.

(10) FIG. **5**F, FIG. **5**G, FIG. **5**H, FIG. **5**I depict an embodiment of a needle having an open channel feature-based joining of needle and thread.

(11) FIG. **5**J depicts an embodiment of the suturing device including mechanisms for securing and releasing the needle.

(12) FIG. **5**K, FIG. **5**L, and FIG. **5**M depict an exploded view of an embodiment of the control bars and the grasping members.

(13) FIG. **5**N, FIG. **5**O, and FIG. **5**P depicts an embodiment of the suturing device including mechanisms for securing and releasing the needle.

(14) FIG. **6**A, FIG. **6**B, and FIG. **6**C depict an embodiment of the suturing device including the stopper in an activated position.

(15) FIG. **7**A and FIG. **7**B depict an embodiment of the suturing device including the activated stopper and the safety member preventing movement of the movable arm and the movable jaw when the needle is unsecured.

(16) FIG. **8**A and FIG. **8**B depict an embodiment of the suturing device including the activated stopper allowing movement of the movable arm and the movable jaw when the needle is secured in the first grasping slot.

(17) FIG. **8**C and FIG. **8**D depict an embodiment of the suturing device including the activated stopper allowing movement of the movable arm and the movable jaw when the needle is secured in the second grasping slot.

(18) FIG. **9**A depicts an embodiment of the suturing device including the stopper transitioning from an active position to a deactivated position.

(19) FIG. **9**B, and FIG. **9**C depict exploded views of the stopper and the movable arm.

(20) FIG. **9**D and FIG. **9**E depict an embodiment of the suturing device including the stopper in the deactivated position.

(21) FIG. **10**A and FIG. **10**B depict an embodiment of the suturing device including the stopper in

the deactivated position to allow the movable arm to move even when the needle is unsecured.
(22) FIG. **11**A depicts an exploded view of an embodiment of the suturing device.
(23) FIG. **11**B and FIG. **11**C depict an embodiment of the suturing device with an attachment member.
(24) FIG. **12**A and FIG. **12**B depict embodiments of shapes of suturing devices.
(25) FIG. **13**A and FIG. **13**B depict an embodiment of the suturing device.
(26) FIG. **13**C depicts an exploded view of an embodiment of the suturing device.
(27) FIG. **14**A, FIG. **14**B, and FIG. **14**C depict an embodiment of the loading apparatus and the needle.
(28) FIG. **15** depicts a back view of an embodiment of the loading apparatus.
(29) FIG. **16** depicts an embodiment of the loading apparatus with thread.
(30) FIG. **17** depicts an embodiment of the suturing device loaded with thread from the loading apparatus.
(31) FIG. **18** depicts a flow chart of a method for using the suturing device and the loading apparatus.
(32) FIG. **19** depicts an embodiment of the suturing device loaded onto the loading apparatus.
(33) FIGS. **20**A-**20**I depict use of the loading apparatus to load a suture into the suturing device.
(34) FIG. **21** depicts the suturing device securing the needle loaded by the loading apparatus.
(35) FIG. **22**A, FIG. **22**B, FIG. **22**C, FIG. **22**D, FIG. **22**E, FIG. **22**F, and FIG. **22**G depict the suturing device maneuvering in the cavity.
(36) FIG. **22**DD depicts an embodiment of an operator holding the suturing device for palpating during suturing operations.
(37) FIG. **23**A and FIG. **23**B depicts an embodiment of a mini sling.
(38) FIG. **24** depicts a close up view of an embodiment of a mini sling including adjustment sutures.
(39) FIG. **25** depicts an embodiment of the sling loader for the mini sling.
(40) FIG. **26** depicts an embodiment of the mini sling placed on the sling loader.
(41) FIG. **27**A-**27**J depicts an embodiment of inserting the mini sling.
(42) While the above-identified drawings set forth presently disclosed embodiments, other embodiments are also contemplated, as noted in the discussion. This disclosure presents illustrative embodiments by way of representation and not limitation. Numerous other modifications and embodiments can be devised by those skilled in the art which fall within the scope and spirit of the principles of the presently disclosed embodiments.

REFERENCE LIST

(43) **1**A-B Suturing device **2**A First Handle **2**B Second Handle **3** Lever **4** Needle transfer mechanism **5** Fixed jaw **6** Movable jaw **7** Fixed arm **8** Movable arm **9** Reference location **10** Loading apparatus **11** Pulley **12** Slider **12**A First Slider **12**B Second Slider **13** First loading slot **14** Second loading slot **15** Slot **15**A First slot **15**B Second slot **16** Thread **16**A First Thread **16**B Second Thread **17** Fixing wall **18** Curved needle **100** Jaw joint **101** Arm joint **102** Connecting joint **103** First grasping slot **104** Second grasping slot **105** Arm movement **106** Switching joint **107** Jaw movement **108** Cover **110**A First position **110**B Second position **110**C Third position **112**A-B-C Safety positions **121**A-B Safety notches **122**A-B Notches **123**A-B Protrusions **201** Needle **201**A First needle **201**B Second needle **201**C-D-E Embodiments of the needle **201 207**A First notch **207**B Second notch **208** Hole **209** Channel **301**A-B First Fasteners **302**A-B Second Fasteners **320** Loading channel **505**A First Control bar **505**B Second control bar **510**A First grasping member **510**B Second grasping member **515**A-B-C Security notches **605** Stopper **606** Lid **607** Flap **608** Protrusion **610** Safety member **615** Base region **616**A-B Notches **617** Sliding channel **1105**A-B Attachment members **1205**A-B Lengths **1800** Method **1802** Step of Method **1800 1804** Step of Method **1800 1806** Step of Method **1800 1808** Step of Method **1800 1810** Step of Method **1800 1812** Step of Method **1800 1814** Step of Method **1800 2205** Vaginal cavity **2206** Incision **2207**

Vaginal wall **2208** Pelvic cavity **2208**A Pelvic cavity **2208**B Pelvic cavity **2209**A-B-C-D-E-F Pierce points **2210** Stop area **2211** Index finger **2300** Mini sling **2302** Mesh **2305**A-B-C Adjustment sutures **2308**A-B-C Threads of Adjustment Sutures **2310**A-B-C-D-E-F Curved needles **2315** Sling loader **2705** Urethra **2710** Excess portion **2720**A-B-C Knots **2725**A-B-C Housing **3001**A-B Cables **3002**A-B Springs **3003**A-B Pistons **3004**A-B Stubs **3005**A-B Geometric features **3006**A-B Geometric features **3007**A-B Geometric features **3008**A-B Machine elements

DETAILED DESCRIPTION

(44) The present disclosure includes an improved suturing device, suture loader, tension-free mid-urethral sling, and methods of their use. The suture loader can load the threaded needle into the suturing device. The suturing device can be inserted into a cavity to reach a tissue to be sutured. The suturing device can include a fixed jaw and a movable jaw between which the tissue is placed for suturing. The fixed jaw stays in position while the movable jaw moves the threaded needle to suture the tissue. The suturing device includes a needle transfer mechanism that passes the needle between the jaws while suturing the tissue. A stopper and a safety member can control the movement of the movable jaw to prevent the needle from falling out when the needle is transferred between the jaws. When the suturing is complete, the suturing device can be removed from the cavity with the needle.

(45) Section A: Suturing Devices

(46) Now referring generally to FIG. **1**A and FIG. **1**B, the suturing device **1**A can be scissor-shaped and ergonomically sized to reach target tissues in a tight space. The suturing device **1**A can include a fixed arm **7** integral with a fixed jaw **5**. In some embodiments, a distal end of the fixed arm **7** includes the fixed jaw **5**. The suturing device **1**A can include a movable arm **8** coupled to a movable jaw **6**.

(47) The fixed jaw **5** and the moveable jaw **6** can both receive and grasp a needle, and the suturing device **1**A can also include a needle transfer mechanism **4** to transfer the needle between the fixed jaw **5** and the movable jaw **6**. The needle transfer mechanism **4** may include a lever **3** for controlling the transfer of the needle between the fixed jaw **5** and the moveable jaw **6**. In some embodiments, the lever **3** extends from the fixed arm **7**.

(48) In some embodiments, the suturing device **1**A can include a first handle **2**A coupled to the fixed arm **7** and a second handle **2**B coupled to the movable arm **8**. The handle **2**A and the handle **2**B can aid the user in moving the moveable arm **8** relative to the fixed arm **7**. The handle **2**A and the handle **2**B can be disposed at the end of the suturing device **1**A that remains outside of the cavity during the operation such that the operator can control the suturing device **1**A.

(49) FIG. **2**A and FIG. **2**B depict an embodiment of the suturing device **1**A. In some embodiments, the fixed jaw **5** includes a first grasping slot **103** that can receive the needle **201** (further described in reference to FIG. **5**B). In some embodiments, the movable jaw **6** includes a second grasping slot **104** that can receive the needle **201**. In some embodiments, the grasping slots are channel sized and shaped to receive the needle. For example, the grasping slots can define a round channel or a round hole for receiving and grasping the needle.

(50) In some embodiments, the needle transfer mechanism **4** can transfer the needle between the first grasping slot **103** and the second grasping slot **104**. To that end, the needle transfer mechanism can secure the needle in the first grasping slot **103** or the second grasping slot **104**, or to release the needle from the first grasping slot **103** or the second grasping slot **104**.

(51) FIGS. **3**A-**3**E show an embodiment of a mechanism for moving the movable arm **8** to pivot relative to the fixed arm **7** to pivot the movable jaw **6** relative to the fixed jaw **5**. As shown in FIG. **3**A, the movable arm **8** can have an arm movement **105** along which the movable arm **8** pivots away or towards the fixed arm **7**. For example, the arm movement **105** can be caused by a surgeon's manual movement of handle **2**A to open and close the device **1**A. This control can be advantageous while operating in invisible areas to make sure that movement of the device **1**A can be under the operator's control. In some embodiments, the arm movement **105** can be caused by additional

mechanical force elements such as a spring.
(52) The fixed arm **7** can remain immovable relative to the movable arm **8** while the movable arm **8** moves. The movable arm **8** can pivot relative to the fixed arm **7** to pivot the movable jaw **6** relative to the fixed jaw **5**. The movement of the moveable arm **8** relative to the fixed arm **7** can enable the movable jaw **6** to have a jaw movement **107** along which the movable jaw **6** can pivot away or towards the fixed jaw **5**. The fixed jaw **5** can remain immovable relative to the movable jaw **6** while the movable jaw **6** moves. In some embodiments, the movable arm **8** and the movable jaw **6** move relative to the fixed arm **7**. In some embodiments, the movable arm **8** and the movable jaw **6** move relative to the fixed jaw **5**. In some embodiments, the movable arm **8** and the movable jaw **6** move relative to each other. In some embodiments, the fixed arm **7** and the fixed jaw **5** do not move. In some embodiments, the fixed jaw **5** cannot move independently of the fixed arm **7** because the fixed arm **7** is integral with the fixed jaw **5**.
(53) The fixed jaw **5** can make it easier to work safely in narrow spaces because having the fixed jaw **5** remain stationary with respect to the target tissue allows the sutures to be placed while staying in a safe area. For example, when an operator moves the movable jaw **6** relative to the fixed jaw **5**, the operator would know the location of the fixed jaw **5**. When the target tissue is referenced with the fixed jaw **5** at an operating place that is difficult to see or not visible at all, the fixed jaw **7** enables the suture to pass through the targeted tissue. The fixed jaw **5** and the movable jaw **6** can come together at a constant or predictable location with respect to the tissue such that the location and distance does not need to be predicted continuously to center the tissue. Thus, the fixed jaw **5** enables suturing in areas that are difficult to see.
(54) As shown in FIG. **3**B, in some embodiments, the movable arm **8** can be pivoted relative to the fixed arm **7** to pivot the movable jaw **6** relative to the fixed jaw **5**. The movable arm **8** can pivot the movable jaw **6** relative to the fixed jaw **5** until the needle **201** is received in both the first grasping slot **103** and the second grasping slot **104** to exchange the needle between the slots.
(55) As shown in FIGS. **3**A-**3**E, in some embodiments, the lever **3** can move among a first position **110**A, a second position **110**B, or a third position **110**C to control the securing and releasing of both the first grasping slot **103** and the second grasping slot **104**. For example, the lever **3** can be a shifter, grip, or switch that can be moved by the operator. In the first position **110**A, the needle **201** is secured in the first grasping slot **103** of the fixed jaw **5**. As shown in FIG. **3**A, when the movable arm **8** is moving or open, the needle transfer mechanism **4** can grasp of the needle **201** in the fixed jaw **5** while keeping the grasping inactive in the movable jaw **6**. As shown in FIG. **3**B, when the movable arm **8** is adjacent to the fixed arm **7**, the needle transfer mechanism **4** can grasp the needle **201** in the fixed jaw **5** while keeping the grasping inactive in the movable jaw **6** by keeping the lever **3** in the first position **110**A.
(56) As shown in FIG. **3**C, the lever **3** can then be moved to the second position **110**B, so the needle **201** is released from the first grasping slot **103**, while still unsecure in the second grasping slot **104**. As shown in FIG. **3**C, the needle transfer mechanism **4** can be inactive in both the fixed jaw **5** and the movable jaw **6** to release the needle **201**.
(57) As shown in FIG. **3**D, in the third position **110**C, the needle **201** is secured in the second grasping slot **104**. As shown in FIG. **3**D, the needle transfer mechanism **4** can grasp of the needle **201** in the movable jaw **6** while keeping the grasping inactive in the fixed jaw **5**. As shown in FIG. **3**E, when the moveable jaw **6** pivots away from the fixed jaw **5** by the movement of the moveable arm **8**, the needle is secured in the moveable jaw **6**, thus completing the transfer of the needle between the fixed jaw **5** and the moveable jaw **6**. As shown in FIG. **3**E, when the movable arm **8** is moving or open, the needle transfer mechanism **4** can grasp of the needle **201** in the movable jaw **6** while keeping the grasping inactive in the fixed jaw **5**.
(58) Referring generally to FIGS. **3**A-**3**E, in some embodiments, the suturing device **1**A further includes a cover **108** partially disposed over the lever **3**. The lever **3** can move among the positions to set the first position **110**A, the second position **110**B, or the third position **110**C. In some

embodiments, the cover **108** includes ticks, indents, or indicators corresponding to movements of the lever **3** to the first position **110**A, the second position **110**B, or the third position **110**C.

(59) FIGS. **4**A-**4**C depict an embodiment mechanism of the suturing device **1**A for the movement of the moveable arm **8** relative to the fixed arm **7** to enable the movable jaw **6** to have the jaw movement **107** along which the movable jaw **6** pivots away or towards the fixed jaw **5**. In some embodiments, the fixed arm **7** can include an arm joint **101** to couple the fixed arm **7** to the movable arm **8**. For example, the arm joint **101** can be a mechanical joint for connecting two components and allowing them to move relative to each other. In some embodiments, the arm joint **101** enables the movement of the moveable arm **8** relative to the fixed arm **7**. For example, the movable arm **8** can pivot about the arm joint **101** and relative to the fixed arm **7**. In another example, the arm joint **101** can allow the movable arm **8** to pivot relative to the fixed arm **7** in one degree of freedom. In yet another example, the arm joint **101** can restrict some movement of the movable arm **8**, such as to prevent the movable arm **8** from breaking or exerting excessive force on the movable jaw **6**, the slots, or any other component described herein.

(60) In some embodiments, the fixed arm **7** includes a jaw joint **100**. In some embodiments, the fixed jaw **5** includes the jaw joint **100**. The jaw joint **100** is coupled to the movable jaw **6** so that the movable jaw **6** can pivot relative to the fixed jaw **5**. For example, the jaw joint **100** can be a mechanical joint for connecting two components and allowing them to move relative to each other. In some embodiments, the movable jaw **6** can pivot about the jaw joint **100** and relative to the fixed jaw **5**. For example, the jaw joint **100** can allow the movable jaw **6** to pivot relative to the fixed jaw **5** in one degree of freedom. In another example, the jaw joint **100** can restrict some movement of the movable jaw **6**, such as to prevent the movable jaw **6** from breaking or exerting excessive force on the fixed jaw **5**, the slots, or any other component described herein.

(61) In some embodiments, the suturing device **1**A further includes a connecting joint **102** coupled to the movable arm **8** and the movable jaw **6**. The connecting joint **102** can be positioned between the jaw joint **100** and the arm joint **101** such that the jaw joint **100** and the arm joint **101** are decoupled and mechanically independent from each other. The connecting joint **102** can allow movement of the movable arm **8** to pivot the movable jaw **6**. For example, the connecting joint **102** can be a mechanical joint for connecting two components and allowing them to move relative to each other. In some embodiments, the movable arm **8** can physically move the connecting joint **102** to cause the movable jaw **6** to pivot about the jaw joint **100**. Movement of the movable arm **8** can move the connecting joint **102** to pivot the movable jaw **6** about the jaw joint **100**. For example, as shown in FIG. **4**B and FIG. **4**C, movement of the movable arm **8** away from the fixed arm **7** causes the connecting joint **102** to move across the width of the fixed arm **7**. The connecting joint **102** pulls on the movable jaw **6**, which causes the movable jaw **6** to pivot about the jaw joint **100** and away from the fixed jaw **5**.

(62) In some embodiments, the connecting joint **102** can restrict some movement of the movable jaw **6** and the movable arm **8**, such as to prevent them from disconnecting or exerting excessive force on the slots or any other component described herein. For example, the connecting joint **102** can be restricted to movements along the width of the fixed arm **7**, which would prevent from excessive movements of the movable jaw **6** and the movable arm **8**. In some embodiments, the part of the fixed arm **7** between the jaw joint **100** and the arm joint **101** can remain in a fixed position while the movable jaw **6** moves inside the pelvic cavity and the movable arm **8** moves outside the vaginal cavity. Such movements can advantageously reduce the profile of the movable jaw **6** and the movable arm **8**.

(63) In some embodiments, the fixed arm **7** includes a reference location **9** comprising the jaw joint **100**, the arm joint **101**, and the connecting joint **102**. The pivoting movements of the movable arm **8** and the movable jaw **6** about the reference location **9** enable the suturing device **1**A to move like a scissors-type mechanism. For example, the suturing device **1**A can be comprised of 3 rigid metal parts (e.g., (1) fixed jaw **7** integral with the fixed jaw **5**, (2) the movable arm **8**, and (3) the movable

jaw **6**) that are attached to each other with the three joints **100**-**102**. The movable jaw **6** and the movable arm **8** can move with respect to each other and the fixed arm **7** and fixed jaw **5** about the reference location **9** in 2D space as described above. In some embodiments, the movable arm **8** pivots about the reference location **9** and relative to the fixed arm **7**. In some embodiments, the movable jaw **6** pivots about the reference location **9** and relative to the fixed arm **5**.

(64) For example, during the operation of the suturing device **1**A inside the pelvic cavity, in order to perform the stitching at the correct location, the fixed arm **7**, whose outer contour can be designed accordingly, can be aligned with the specific area of the pelvic cavity and becomes fixed with respect to this specific area of the pelvic cavity while the jaw joint **100**, the arm joint **101**, and the connecting joint **102** enable the operator to move the handle **2**A to move the movable arm **8** to move the movable jaw **6**. By keeping the fixed arm **7** fixed in position, the jaws **5** and **6** can be correctly positioned for suturing.

(65) FIGS. **5**A-**5**I depict embodiments of the needle **201**. The needle **201**C, the needle **201**D, and the needle **201**E (generally referred to as needle **201**) can include a first notch **207**A and a second notch **207**B. The position of the first notch **207**A and the second notch **207**B on the needle **201** enable the needle **201** to be grasped within the first grasping slot **103** or the second grasping slot **104**, or both. For example, the first notch **207**A can be attached to the fixed jaw **5** and the second notch **207**B can be attached to the movable jaw **6**.

(66) As shown in FIG. **5**A, the needle **201** can be a needle **201**C that has a concave shape. FIG. **5**B, FIG. **5**C, FIG. **5**D, and FIG. **5**E depict an embodiment of a needle **201**D that has a straight shape. In some embodiments, the needle **201**C and the needle **201**D can include a hole **208**. In some embodiments, the hole **208** can be used for needle-thread joining by drilling a hole in the middle of the needle **201**C or the needle **201**D, inserting the thread (e.g., thread **16**) into the hole **208**, and deforming the hole **208** with the help of a suitable die geometry attached to a press. In some embodiments, the needle **201** and the thread **16** can be joined by using a proper adhesive instead of deforming the hole **208**.

(67) FIG. **5**F, FIG. **5**G, FIG. **5**H, and FIG. **5**I depict an embodiment of a needle **201**E that includes a channel **209**. The channel **209** can be an open channel feature-based joining of the needle **201** and thread **16**. The channel **209** can be opened in the middle region of the needle **201**E. A thread can be placed within the channel **209**, and the channel **209** can be deformed onto the thread with the help of a suitable die geometry attached to a press. In some embodiments, the needle **201** and the thread **16** can be joined by using a proper adhesive instead of deforming the channel **209**.

(68) FIG. **5**J depicts an embodiment of the needle transfer mechanism **4** of the suturing device **1**A. The needle transfer mechanism **4** can enable the needle **201** to be retained in or released from the jaws **5** and **6** with the help of back and forth moving flexible plates (e.g., the first control bar **505**A and the second control bar **505**B and/or the first grasping member **510**A and the second grasping member **510**B). These plates can be pulled or pushed by a control lever (e.g., lever **3**) attached to the plates. In some embodiments, the first control bar **505**A, the second control bar **505**B, the first grasping member **510**A, and the second grasping member **510**B can be located in the fixed arm **7**. In some embodiments, the first control bar **505**A, the second control bar **505**B, the first grasping member **510**A, and the second grasping member **510**B can be located in the fixed jaw **5** and the fixed arm **7**.

(69) In reference to FIG. **5**J, the needle transfer mechanism **4** includes the first control bar **505**A and the second control bar **505**B. In some embodiments, the first control bar **505**A and the second control bar **505**B extend within respective channels in the fixed arm **7**. In some embodiments, the first control bar **505**A extends within a channel through the fixed jaw **5**. In some embodiments, the second control bar **505**B extends within a channel through the movable jaw **6**.

(70) The control bars can advance or retract independently within their respective channels. In some embodiments, the first control bar **505**A can advance towards the first grasping slot **103** and towards the first notch **207**A or the second notch **207**B of the needle **201** disposed in the first

grasping slot **103** to secure the needle **201** in the first grasping slot **103**. In some embodiments, the first control bar **505**A can retract from the first grasping slot **103** and the first notch **207**A or the second notch **207**B to release the needle **201** from the first grasping slot **103**. In some embodiments, the second control bar **505**B can advance towards the second grasping slot **104** and towards the first notch **207**A or the second notch **207**B of the needle **201** disposed in the second grasping slot **104** to secure the needle **201** in the second grasping slot **104**. In some embodiments, the second control bar **505**B can retract from the second grasping slot **104** and the first notch **207**A or the second notch **207**B to release the needle **201** from the second grasping slot **104**. For example, the control bars can be pulled within their respective channels.

(71) The needle transfer mechanism **4** can include a switching joint **106** that is coupled to the lever **3**, the first control bar **505**A, and the second control bar **505**B. In some embodiments, the switching joint **106** is disposed on the fixed arm **7**. Movement of the lever **3** can cause movement of the switching joint **106**, which can cause movement of the first control bar **505**A and the second control bar **505**B to secure or release the needle **201** in the first grasping slot **103** or the second grasping slot **104**. For example, the switching joint **106** can be a mechanical joint for connecting two components and allowing them to move relative to each other.

(72) In some embodiments, the lever **3** can rotate or move the switching joint **106** to move the first control bar **505**A and the second control bar **505**B. For example, the lever **3** can spin the switching joint **106** and thus push or pull the control bars connected to the switching joint **106**. In this manner, the movement of the lever **3** can advance the first control bar **505**A towards the first grasping slot **103** while retracting the second control bar **505**B from the second grasping slot **104** or retract the first control bar **505**A away from the first grasping slot **103** while advancing the second control bar **505**B towards the second grasping slot **104**. For example, the switching joint **106** is rotated clockwise by the lever **3** such that the first control bar **505**A is retracted away from the first grasping slot **103** and the second control bar **505**B is advanced towards the second grasping slot **104**. In another example, the switching joint **106** is rotated counterclockwise by the lever **3** such that the first control bar **505**A is advanced towards the first grasping slot **103** and the second control bar **505**B is retracted away from the second grasping slot **104**.

(73) FIG. **5**K, FIG. **5**L, and FIG. **5**M depict an exploded view of an embodiment of the first control bar **505**A and the second control bar **505**B, and the first grasping member **510**A and the second grasping member **510**B. In some embodiments, the first grasping member **510**A and the second grasping member **510**B extend within respective channels in the fixed arm **7**. In some embodiments, the first grasping member **510**A extends within a channel in the fixed jaw **5**. In some embodiments, the first grasping member **510**A extends within a channel in the movable jaw **6**.

(74) In some embodiments, the control bars are linked or over molded onto a respective grasping member. For example, the first control bar **505**A and the first grasping member **510**A can be one bar such that the first grasping member **510**A is an extension of the first control bar **505**A. While not shown, in another example, it is contemplated that the first control bar **505**A and the first grasping member **510**A can be separate bars such that the first grasping member **510**A is coupled to the first control bar **505**A. As shown in FIG. **5**M, the first grasping member **510**A (or the second grasping member **510**B) can bend relative to the first control bar **505**A (or the second control bar **505**B). The highly elastic nature of the first grasping member **510**A and the second grasping member **510**B allows them to move and function in the angled channels of the jaws **5** and **6**.

(75) Referring back to FIG. **5**J, in some embodiments, the first control bar **505**A can advance the first grasping member **510**A towards the first notch **207**A or the second notch **207**B of the needle **201** disposed in the first grasping slot **103** to secure the needle **201** in the first grasping slot **103**. For example, the first control bar **505**A can be pushed towards the first grasping slot **103**. In this manner, the movement of the first control bar **505**A can cause the first grasping member **510**A to grasp the first notch **207**A or the second notch **207**B to grasp the needle **201** in the first grasping slot **103**.

(76) In some embodiments, the first control bar **505**A can retract the first grasping member **510**A from the first notch **207**A or the second notch **207**B to release the needle **201** from the first grasping slot **103**. For example, the first control bar **505**A can be pulled away from the first grasping slot **103**. In this manner, the movement of the first control bar **505**A can cause the first grasping member **510**A to release the first notch **207**A or the second notch **207**B to release the needle **201** from the first grasping slot **103**.
(77) In some embodiments, the second control bar **505**B can advance the second grasping member **510**B towards the first notch **207**A or the second notch **207**B of the needle **201** disposed in the second grasping slot **104** to grasp the needle **201** in the second grasping slot **104**. For example, the second control bar **505**B can be pushed towards the second grasping slot **104**. In this manner, the movement of the second control bar **505**B can cause the second grasping member **510**B to grasp the first notch **207**A or the second notch **207**B of the needle **201** to grasp the needle **201** in the second grasping slot **104**.
(78) In some embodiments, the second control bar **505**B can retract the second grasping member **510**B from the first notch **207**A or the second notch **207**B to release the needle **201** from the second grasping slot **104**. For example, the second control bar **505**B can be pulled away from the second grasping slot **104**. In this manner, the movement of the second control bar **505**B can cause the second grasping member **510**B to release the first notch **207**A or the second notch **207**B to release the needle **201** from the second grasping slot **104**. In some embodiments, the control bars or the grasping members have different lengths. For example, the first grasping member **510**A or the first control bar **505**A can be longer than the second grasping member **510**B or the second control bar **505**B because they must extend a greater distance to reach the first grasping slot **103**. In another example, the second grasping member **510**B or the second control bar **505**B can be longer than the first grasping member **510**A or the first control bar **505**A because they must be able to bend with the movable jaw **6** that comprises the second grasping slot **104**.
(79) The lever **3** can move to the first position **110**A to move the switching joint **106** to advance the first control bar **505**A to advance the first grasping member **510**A to grasp the needle **201** in the first grasping slot **103** and to retract the second control bar **505**B to retract the second grasping member **510**B to release the needle **201** from the second grasping slot **104**. For example, as shown in FIG. **5**J, the lever **3** can rotate the switching joint **106** counterclockwise to move into the first position **110**A. In some embodiments, the lever **3** can move to the first position **110**A to move the switching joint **106** to advance the first control bar **505**A to advance the first grasping member **510**A to grasp the needle **201** in the first grasping slot **103**. For example, as shown in FIG. **5**J, by moving the lever **3** to the first position **110**A, the switching joint **106** can be rotated in the counterclockwise direction, which can advance the first control bar **505**A to the left and retract the second control bar **505**B to the right such that the first control bar **505**A causes the first grasping member **510**A to grasp the needle **201** in the first grasping slot **103** and the second control bar **505**B causes the second grasping member **510**B to release the needle **201** from the second grasping slot **104**. The lever **3** can include the security notch **515**A of the suturing device **1** to maintain the lever **3** in the first position **110**A so that the lever **3** is not accidently moved to a different position during use (e.g., during surgery).
(80) The lever **3** can move to the second position **110**B to move the switching joint **106** to retract the first control bar **505**A to retract the first grasping member **510**A to release the needle **201** from the first grasping slot **103** and to retract the second control bar **505**B to retract the second grasping member **510**B to release the needle **201** from the second grasping slot **104**. In some embodiments, the lever **3** can move to the second position **1101**B to move the switching joint **106** to retract the first control bar **505**A to retract the first grasping member **510**A to release the needle **201** from the first grasping slot **103**.
(81) For example, as shown in FIG. **5**J, if the lever **3** is moved to second position **110**B from the first position **110**A, the switching joint **106** can be rotated in the clockwise direction, which can

partially retract the first control bar **505**A to the right and partially advance the second control bar **505**B to the left such that the first control bar **505**A and the second control bar **505**B are in an inactive position that prevents the first grasping slot **103** and the second grasping slot **104** from grasping the needle **201**.

(82) In another example, as shown in FIG. **5**J, if the lever **3** is moved to the second position **1101**B from the third position **110**C, the switching joint **106** can be rotated in the counterclockwise direction, which can partially advance the first control bar **505**A to the left and partially retract the second control bar **505**B to the right such that the first control bar **505**A and the second control bar **505**B are in an inactive position that prevents the first grasping slot **103** and the second grasping slot **104** from grasping the needle **201**. The lever **3** can include the security notch **515**B of the suturing device **1** to maintain the lever **3** in second position **110**B so that the lever **3** is not accidently moved to a different position during use (e.g., during surgery).

(83) The lever **3** can move to the third position **110**C to move the switching joint **106** to advance the second control bar **505**B to advance the second grasping member **510**B to grasp the needle **201** in the second grasping slot **104** and to retract the first control bar **505**A to retract the first grasping member **510**A to release the needle from the first grasping slot **103**. In some embodiments, the lever **3** can move to the third position **110**C to move the switching joint **106** to advance the second control bar **505**B to advance the second grasping member **510**B to grasp the needle in the second grasping slot **104**. For example, as shown in FIG. **5**J, by moving the lever **3** to the third position **110**C from the second position **110**B, the switching joint **106** can be rotated in the clockwise direction, which can retract the first control bar **505**A to the right and advance the second control bar **505**B to the left such that the first control bar **505**A causes the first grasping member **510**A to release the needle **201** from the first grasping slot **103** and the second control bar **505**B causes the second grasping member **510**B to grasp the needle **201** in the second grasping slot **104**. The lever **3** can include the security notch **515**C of the suturing device **1** to maintain the lever **3** in the third position **110**C so that the lever **3** is not accidently moved to a different position during use (e.g., during surgery).

(84) Now referring to FIG. **5**N, FIG. **5**O, and FIG. **5**P, in some embodiments, the needle transfer mechanism **4** includes a cable **3001**A, a cable **3001**B, a spring **3002**A, and a spring **3002**B. The cable **3001**A and the cable **3001**B can be attached to the lever **3** with the stub **3004**A and stub **3004**B at the end of the cable **3001**A and the cable **3001**B. In some embodiments, the cable **3001**A and the cable **3001**B extend within respective channels in the fixed arm **7**. In some embodiments, the cable **3001**A extends within a channel in the fixed jaw **5**. In some embodiments, the cable **3001**B extends within a channel in the movable jaw **6**. In some embodiments, the spring **3002**A is located within the fixed jaw **5**. In some embodiments, the spring **3002**B is located within the movable jaw **6**.

(85) The lever **3** can be rotated along the switching joint **106**. There can be 3 distinct positions in which the lever **3** can be rotated. The lever **3** can be designed so that a predetermined amount of user-applied force is needed to change positions of the lever **3**. In some embodiments, the predetermined amount of user-applied force is based on the tension of the cable **3001**A and the cable **3001**B. The geometric features **3005**A, **3005**B, **3007**A, **3007**B, **3006**A, and **3006**B of the fixed arm **7** can be used to route the cable **3001**A and the cable **3001**B in an optimal path. The spring **3002**A and the spring **3002**B can be placed on the cylindrical piston **3003**A and the cylindrical piston **3003**B and retained by machine elements (e.g., machine element **3008**B retains spring **3002**B), which can include rings, pins, etc. or structural features such as protrusions. In some embodiments, the cylindrical piston **3003**A is located within the fixed jaw **5**. In some embodiments, the cylindrical piston **3003**B is located within the movable jaw **6**.

(86) In some embodiments, a proximal end (e.g., proximal to the operator) of the pistons **3003**A and **3003**B are attached to the cables **3001**A and **3001**B, respectively. In some embodiments, a distal end of the pistons **3003**A and **3003**B can be designed and shaped to engage and grasp the

needle **201**. In some embodiments, the distal end of the piston **3003**A can be advanced to engage and grasp the needle **201** in the fixed jaw **5**. In some embodiments, the distal end of the piston **3003**A can be retracted to disengage and release the needle **201** in the fixed jaw **5**. In some embodiments, the distal end of the piston **3003**B can be advanced to engage and grasp the needle **201** in the movable jaw **6**. In some embodiments, the distal end of the piston **3003**B can be retracted to disengage and release the needle **201** in the movable jaw **6**.

(87) In some embodiments, the lever **3** can be in a middle position (e.g., similar to the second position **110**B) as shown in FIG. **5**N and FIG. **5**O. In the middle position, both cables **3001**A and **3001**B can be semi-pulled, both springs **3002**A and **3002**B can be semi-compressed and both pistons **3003**A and **3003**B can be semi-retracted. In some embodiments, when the pistons **3003**A and **3003**B are semi-retracted, the pistons **3003**A and **3003**B are disengaged from the needle **201** such that the needle **201** can be released from both the fixed jaw **5** and the movable jaw **6**. In some embodiments, when the pistons **3003**A and **3003**B are semi-retracted, the pistons **3003**A and **3003**B engage the needle **201** such that the needle **201** is secured in both the fixed jaw **5** and the movable jaw **6**. In some embodiments, with the jaws **5** and **6** in the closed position (e.g., moveable jaw **6** moved towards the fixed jaw **5**), the needle **201** can be retained by both jaws **5** and **6** and the suturing device (e.g., device **1**A or **1**B) can be locked.

(88) In some embodiments, the lever **3** can be in a forward position (e.g., similar to the first position **110**A). In the forward position, the lever **3** can cause the spring **3002**A corresponding to the fixed jaw **5** to be fully released by the cable **3001**A, which can cause the piston **3003**A to move forward from the spring force, and the needle **201** can be retained in the fixed jaw **5**. At the same time, the lever **3** can cause the spring **3002**B corresponding to the movable jaw **6** to be pulled by the cable **3001**B and fully compress, which can cause the piston **3003**B to be pulled by the cable **3001**B, and the needle **201** to be released from the movable jaw **6**.

(89) In some embodiments, the lever **3** can be in a backward position (e.g., similar to the third position **110**C). In the backward position, the lever **3** can cause the spring **3002**B corresponding to the movable jaw **6** to be fully released by the cable **3001**B, which can cause the piston **3003**B to move forward from the spring force, and the needle **201** can be retained by the movable jaw **6**. At the same time, the lever **3** can cause the spring **3002**A corresponding to the fixed jaw **5** to be pulled by the cable **3001**A and fully compressed, which can cause the piston **3003**A to be pulled by the cable **3001**A, and the needle **201** to be released from the fixed jaw **5**.

(90) FIG. **6**A, FIG. **6**B, and FIG. **6**C depict an embodiment of the suturing device **1**A including a stopper **605** in an activated position. In terms of safety, if the movable jaw **6** moves when the lever **3** is in the second position **110**B, the needle **201** might fall out because the needle **201** is not secured in either the first grasping slot **103** or the second grasping slot **104**. To address this problem, the suturing device **1**A includes the stopper **605** to control, based on the position of the lever **3**, when the movable arm **8** can move and thus when the movable jaw **6** can move. For example, the stopper **605** can physically impede the movable arm **8** from moving to prevent the needle **201** from falling out.

(91) As shown in FIG. **6**A and FIG. **6**B, the stopper **605** can be disposed on the movable arm **8** to control when the movable arm **8** can move relative to the fixed arm **7**. For example, the stopper **605** can grasp or secure the fixed arm **7** to prevent the movable arm **8** from moving to prevent the needle **201** from falling out. The stopper **605** can be disposed on the movable arm **8** and adjacent to the lever **3** on the fixed arm **7** to control the movable arm **8** based on the position of the lever **3**. In some embodiments, the stopper **605** is covered by a lid **606** to protect the stopper **605**.

(92) The stopper **605** can slide on the movable arm **8** between an activated position and a deactivated position. The stopper **605** can control the movement of movable arm **8** when the stopper **605** is in the activated position. In the activated position, the stopper **605** can be positioned closer to the movable arm **8** to be adjacent to the fixed arm **7** to grasp a portion of the fixed arm **7** to control the movement of the movable arm **8** relative to the fixed arm **7**.

(93) The stopper **605** can slide on the movable arm **8** from the activated position to the deactivated position in which the stopper **605** does not control the movement of the movable arm **8**. For example, the stopper **605** can be a plastic or metal cap that slides on the movable arm **8**. In the deactivated position, the stopper **605** can be positioned farther away from the movable arm **8** to avoid grasping the fixed arm **7** and thus avoid controlling the movement of the movable arm **8** relative to the fixed arm **7**. The stopper **605** can slide on the movable arm **8** towards the fixed arm **7** and into the activated position to grasp the fixed arm **7** to control the movable arm **8**.
(94) As shown in FIG. **6**B and FIG. **6**C, the stopper **605** can include a flap **607** to secure the stopper **605** in the activated position. For example, the flap **607** can be a bendable extension of the stopper **605**. The flap **607** can be snap onto and over an edge of the movable arm **8** to secure the stopper **605** in the activated position. The flap **607** can bend away from the movable arm **8** to release the stopper **605** from the activated position. As shown in FIG. **6**C, the operator can bend the flap **607** to release the stopper **605** from the activated position.
(95) FIG. **7**A and FIG. **7**B depict an embodiment of the suturing device **1**A including the stopper **605** in the activated position and a safety member **610** preventing movement of the movable arm **8** and the movable jaw **6** when the needle **201** is unsecured because the lever **3** is in the second position **110**B. In some embodiments, FIG. **7**A shows a cross sectional view of the stopper **605** without the lid **606**. In some embodiments, the stopper **605** does not have the lid.
(96) Because the stopper **605** is disposed on the movable arm **8**, the stopper **605** would move when the movable arm **8** moves. Because the safety member **610** disposed on the fixed arm **7**, the stopper **605** would move relative to the safety member **610** when the movable arm **8** moves. Interlocking of the safety member **610** and the stopper **605** would thus prevent the stopper **605** from moving and thus prevent the movable arm **8** from moving to prevent the needle **201** from falling out.
(97) The safety member **610** and the stopper **605** can interlock if the stopper **605** protrudes against the safety member **610**. In the activated position, the stopper **605** is positioned to interlock with the safety member **610**. For example, the stopper **605** can block or grasp the safety member **610**. In some embodiments, when the lever **3** is in the second position **110**B (e.g., needle **201** unsecured) and the jaws are closed, the stopper **605** and the safety member **610** interlock to prevent the movable jaw **8** from opening. In some embodiments, when the lever **3** is in the first position **110**A or the third position **110**C (needle **201** is secured) and the jaws are open, the stopper **605** and the safety member **610** can interlock to prevent the lever **3** from moving to the second position **110**B to release the needle **201**.
(98) By positioning the stopper **605** and the safety member **610** to interlock when the lever **3** is in the second position **110**B and the jaws are closed, the needle **201** would not fall out when it is not secured in neither the first grasping slot **103** or the second grasping slot **104** but the movable arm **8** could move when the needle **201** is secured in either the first grasping slot **103** or the second grasping slot **104**. The safety member **610** and the stopper **605** can interlock because the stopper **605** in the activated position protrudes against the safety member **610** when the lever **3** is in the second position **110**B. By protruding against the stopper **605**, the safety member **610** prevents the movable arm **8** and thus the movable jaw **6** from moving when the lever **3** is in the second position **110**B to prevent the needle **201** from falling out.
(99) To position the stopper **605** and the safety member **610** to interlock based on the position of the lever **3**, the safety member **610** can be disposed on the second control bar **505**B. Since the lever **3** moves the second control bar **505**B, the position of the lever **3** determines the position of the safety member **610**. The lever **3** in the second position **110**B causes the safety member **610** to be in safety position **112**A such that the safety member **610** interlocks with the stopper **605** to prevent the movable arm **8** from moving relative to the fixed arm **7** to prevent the needle **201** from falling out.
(100) As shown in FIG. **8**A and FIG. **8**B depict an embodiment of the suturing device **1**A including the stopper **605** in the activated position and the safety member **610** allowing movement of the movable arm **8** and the movable jaw **6** when the needle **201** is secured in the first grasping slot **103**.

The lever **3** in the first position **110**A causes the safety member **610** to be in safety position **112**B, which would enable the safety member **610** to bypass the stopper **605** so that the movable arm **8** can move.

(101) FIG. **8**B depicts the movable arm **8** moving when the lever **3** is in the first position **110**A. In the activated position when the movable arm **8** and the movable jaw **6** are open, the stopper **605** can prevent the lever **3** from moving to second position **110**B (in which the needle **201** is unsecured) from the first position **110**A (in which the needle **201** is secured) to prevent the needle **201** from falling out.

(102) FIG. **8**C and FIG. **8**D depict an embodiment of the suturing device **1**A including the stopper **605** in the activated position allowing movement of the movable arm **8** and the movable jaw **6** when the needle **201** is secured in the second grasping slot **104**. The lever **3** in the third position **110**C causes the safety member **610** to be in safety position **112**C, which would enable the safety member **610** to bypass the stopper **605** so that the movable arm **8** can move.

(103) FIG. **8**D depicts the movable arm **8** moving when the lever **3** is in the third position **110**C. In the activated position when the movable arm **8** and the movable jaw **6** are open, the stopper **605** can prevent the lever **3** from moving to second position **110**B (in which the needle **201** is unsecured) from the third position **110**C (in which the needle **201** is secured) to prevent the needle **201** from falling out.

(104) As shown in FIG. **9**A, the stopper **605** transitions from an active position to a deactivated position. The operator can bend the flap **607** to release the stopper **605** from the activated position. The operator can pull the stopper **605** away from the safety member **610**. The stopper **605** can slide on the movable arm **8** and away from the fixed arm **7** and into the deactivated position. In some embodiments, the operator can keep sliding the stopper **605** until it is removed from the movable arm **8**.

(105) FIG. **9**B and FIG. **9**C depict exploded views of the stopper **605** and the movable arm **8**. As shown in FIG. **9**B, the movable arm **8** can include a base region **615**. The base region **615** can be integral to the movable arm **8**. The base region **615** can be aligned with the lever **3** or the switching joint **106**. The position of the stopper **605** relative to the base region **615** can determine whether the stopper **605** is in the activated or deactivated position. In the activated position, the stopper **605** can be positioned closer to the movable arm **8** to be adjacent to the fixed arm **7** to grasp a portion of the fixed arm **7** or interlock with safety member **610** to control the movement of the movable arm **8** relative to the fixed arm **7**. In the deactivated position, the stopper **605** can be positioned farther away from the movable arm **8** to avoid grasping the fixed arm **7** and thus avoid controlling the movement of the movable arm **8** relative to the fixed arm **7**.

(106) The base region **615** can include a notch **616**A and a notch **616**B positioned in a sliding channel **617** configured to receive the stopper **605**. The notch **616**A and the notch **616**B can be indents or incisions on the base region **615**. The notch **616**A can secure the stopper **605** in the activated position and the notch **616**B can secure the stopper **605** in the deactivated position. The notch **616**A can be disposed away from the side edge of the movable arm **8** to secure the stopper **605** closer to the movable arm **8** in the activated position. The notch **616**B can be disposed closer to the side edge of the movable arm **8** to secure the stopper **605** further away from the movable arm **8** in the deactivated position.

(107) As shown in FIG. **9**C, the stopper **605** can include a protrusion **608** that can be secured in the notch **616**A or the notch **616**B. For example, the protrusion **608** can be a bump or tube that protrudes from the stopper **605**. The protrusion **608** can slide or snap into the notch **616**A or the notch **616**B to be secured. The protrusion **608** can slide into the notch **616**A to secure the stopper **605** in the activated position. The protrusion **608** can slide into the notch **616**B to secure the stopper **605** in the deactivated position.

(108) As shown in FIG. **9**D and FIG. **9**E, in the deactivated position, the stopper **605** is positioned away from the fixed arm **7** and the safety member **610** such that the stopper **605** and the safety

member **610** cannot interlock. Regardless of the position of the lever **3** and thus the safety member **610**, the safety member **610** can be positioned to not protrude against the stopper **605** when the stopper **605** is in the deactivated position.

(109) FIG. **10**A and FIG. **10**B depict an embodiment of the suturing device **1**A including the stopper **605** in the deactivated position to allow the movable arm **8** to move even when the needle **201** is unsecured. When the stopper **605** is in the deactivated position, the movable arm **8** can move when the lever **3** is in the second position **110**B and the needle **201** is not secured in either the first grasping slot **103** or the second grasping slot **104**. By allowing the movable arm **8** to move when the lever **3** is in the second position **110**B, the needle **201** can be released, such as at the end of a suturing operation. In the deactivated position, the stopper **605** can allow the lever **3** to move to the second position **110**B from the first position **110**A or the third position **110**C, such as to load, unload, and reload the needle **201** in the loading apparatus **10** described below.

(110) FIG. **11**A depicts an embodiment of the suturing device **1**A. In some embodiments, the first handle **2**A is coupled to the movable arm **8** with a set of first fasteners **301**A and **301**B. In some embodiments, the second handle **2**B is coupled to the fixed arm **7** with a set of second fasteners **302**A and **302**B.

(111) FIG. **11**B and FIG. **11**C depict an embodiment of the suturing device **1**A with attachment member **1105**A and attachment member **1105**B. In some embodiments, the attachment member **1105**A or **1105**B has the needle **201** already preloaded. As shown in FIG. **11**B, the attachment member **1105**A can be configured to be attached to the movable jaw **6** that is configured to receive the attachment member **1105**A. As shown in FIG. **11**C, the attachment member **1105**B can be configured to be attached to the fixed jaw **5** that is configured to receive the attachment member **1105**B. For example, instead of having to load the needle **201** into the second grasping slot **104**, the attachment member **1105**A with the needle **201** can be attached to the movable jaw **6** of the suturing device **1**A. In another example, instead of having to load the needle **201** into the first grasping slot **103**, the attachment member **1105**B with the needle **201** can be attached to the fixed jaw **5** of the suturing device **1**A. In some embodiments, at the conclusion of a suturing operation, the attachment member **1105**A or the attachment member **1105**B can be removed with the needle **201**, and another attachment member **1105**A or the attachment member **1105**B with a replacement needle **201** can be attached to the fixed jaw **5** or the movable jaw **6**. In some embodiments, the operator can use the same needle **201** for suturing for more than one suture. For example, if the procedure requires so, the operator can also make suture after suture (sequential) with the same needle **201**, which is called Z-suture or 8-figure suture.

(112) FIG. **12**A and FIG. **12**B depict embodiments of shapes of suturing devices (e.g., suturing device **1**A or suturing device **1**B). The suturing devices can be in various sizes, shapes, and angles that are optimized based on the anatomy for which the suturing devices are to be used. The suturing devices can have sizes and angles optimized for the repair of pelvic floor disorders safely due to positional accuracy and in a minimally invasive way.

(113) The size and angles of the devices can be selected according to the target ligament each device is designed to reach for suturing and according to the pathway each device needs to travel in order to reach the target ligament. For example, the pathway can have obstacles such as hard-bony tissues and soft tissues. The sizes and angles can ensure that the surgical methods for using the suturing devices can maneuver the suturing devices through the pathway such that the devices are delivered to their target ligament in the least invasive way. For example, the area of the pathway can be in the pelvic cavity, which can be very similar from patient to patient with minimal standard deviation. As such, the calculation can be accurate across patients even though they might have different bodily parameters (e.g., height, weight, etc.). The sizes and angles can be selected according to the target ligament. For example, once the device is delivered to the target ligament, the outer contour of the fixed jaw **5** can be used for positional accuracy.

(114) The suturing devices can have a length such that during operation of the suturing device, the

handle **2**A and **2**B can be positioned outside the cavity while the length defines a portion of the suturing device that can be positioned inside the cavity. For example, the suturing devices can have a length and angles for transvaginal approaches or procedures. As shown in FIG. **12**A, the fixed jaw **5** can extend relative to the fixed arm **7** at an angle of 77.2 degrees. A length **1205**A can be measured from the tip of the fixed jaw **5** and the fixed arm **7**. As shown in FIG. **12**B, the fixed arm **7** can have a distal portion that extends relative a proximal portion at an angle of 15.88 degrees. The fixed jaw **5** can extend relative to the fixed arm **7** at angle of 130 degrees. The fixed jaw **5** and the fixed arm **7** can have a length **1205**B. It is contemplated that the suturing devices can be modified to modify the sizes, shapes, and angles to optimize the suturing device for specific cavities and operations.

(115) FIG. **13**A, FIG. **13**B, and FIG. **13**C depict an embodiment of the suturing device **1**B. The suturing device **1**B can be similar to the suturing device **1**A but differs in that its components have a different angle, size, and shape to optimize the suturing device **1**B for the anatomy for which the suturing device **1**B is to be used. FIG. **13**C depicts an exploded view of an embodiment of the suturing device **1**B. In some embodiments, the first handle **2**A is coupled to the fixed arm **7** with a set of first fasteners **301**A-**301**B. In some embodiments, the second handle **2**B is coupled to the movable arm **8** with a set of second fasteners **302**A-**302**B. In some embodiments, the suturing device **1**B can use the attachment member **1105**A or the attachment member **1105**B as described in reference to FIG. **11**B and FIG. **11**C. For example, the attachment member **1105**A can be configured to be attached to the movable jaw **6** that is configured to receive the attachment member **1105**A. In another example, the attachment member **1105**B can be configured to be attached to the fixed jaw **5** that is configured to receive the attachment member **1105**B.

(116) Section B: Suture Loader

(117) FIGS. **14**A-**14**C, FIG. **15**, and FIG. **16** depict embodiments of the loading apparatus **10** for loading the needle **201** into the suturing device **1**A or **1**B in a practical and standardized manner. FIG. **15** depicts a back side of an embodiment of the loading apparatus **10**. In some embodiments, the loading apparatus **10** includes a first loading slot **13** disposed in the loading apparatus **10**. In some embodiments, the first loading slot **13** can receive the fixed jaw **5**. For example, the first loading slot **13** can form a channel in the loading apparatus **10**. The channel can be sized and angled to receive the fixed jaw **5** such that the fixed jaw **5** can securely fit into the first loading slot **13** to receive the needle **201**. The channel be defined by one or more side walls within which the fixed jaw **5** can be positioned. The fixing wall **17** can allow the fixed jaw **5** to maintain its position in the first loading slot **13** of the loading apparatus **10** while receiving the needle **201**.

(118) As shown in FIG. **14**C, in some embodiments, the loading apparatus **10** includes a slider **12** that includes a slot **15** to hold the needle **201**. The slot **15** can be sized and shaped to hold the needle **201**. For example, the slot **15** can include a round hole or define a channel sized to receive the needle **201**. The needle **201** can be placed into the slot **15** to secure the needle **201** in the slot **15**. The slider **12** can move the needle **201** in the slot **15** while the needle **201** stays coupled to the thread **16**.

(119) The slider **12** can insert the needle **201** into the first grasping slot **103**. In some embodiments, the slider **12** can move within a loading channel **320** to move the slot **15** holding the needle **201** towards the first loading slot **13** and into the first grasping slot **103** of the fixed jaw **5**. For example, the loading channel **320** can define a space in which the slider **12** can move. The loading channel **320** and the slider **12** can be sized so that the slider **12** slides within the loading channel **320** but does not fall out of the channel. For example, the slider **12** can be moved to two separate positions for the needle **201** to engage the fixed jaw **5**: one to advance the needle **201** into the first grasping slot **103** and another to retract the slider **12** after the needle **201** is secured in the first grasping slot **103**.

(120) In some embodiments, the loading apparatus **10** includes the pulley **11** that includes the thread **16** coupled to the needle **201**. The thread **16** can be wound or wrapped around the pulley **11**.

In some embodiments, the pulley **11** can rotate such that the thread **16** moves when the first grasping slot of the fixed jaw **6** exits the first loading slot **13**. For example, the pulley **11** can be shaped like a wheel with a grooved rim around which the thread **16** is wound. In some embodiments, the thread **16** can be wound about the pulley **11** for the needle **201** to be loaded back into the loading apparatus **10** after being loaded to the suturing device **1**A or the suturing device **1**B. For example, this feature may be useful at many instances during a procedure, such as, after passing the first suture, the operator might decide to make a Z-suture with the same needle **201**, therefore being able to load it back to the loading apparatus **10** and from there load the needle **201** to the suturing device **1**A or the suturing device **1**B.

(121) In some embodiments, the loading apparatus **10** includes the second loading slot **14** disposed in the loading apparatus **10**. In some embodiments, the second loading slot **14** can receive the movable jaw **6**. The second loading slot **14** can form a channel in the loading apparatus **10**. The channel can be sized and angled to receive the movable jaw **6** such that the movable jaw **6** can securely fit into the second loading slot **14** while the fixed jaw **6** is in the first loading slot **13**. For example, the loading channel **320** be defined by one or more side walls within which the fixed jaw **5** can be positioned. While not shown, in some embodiments, the slider **12** can move within the loading channel **320** to move the slot holding the needle **201** towards the second loading slot **14** and into the second grasping slot **104** of the movable jaw **6**. For example, the slider **12** can be moved to two separate positions: one to advance the needle **201** into the second grasping slot **104** and another to retract the slider **12** after the needle **201** is secured in the second grasping slot **104**. In another example, the slider **12** can be moved to three separate positions: one to advance the needle **201** into the second grasping slot **104**, another to retract the slider **12** after the needle **201** is secured in the second grasping slot **104**, and another to advance the needle **201** into the first grasping slot **103**. In some embodiments, the pulley **11** can rotate such that the thread **16** moves through the second loading slot **14** when the second grasping slot **104** of the movable jaw **6** exits the second loading slot **14**.

(122) FIG. **17** depicts an embodiment of the thread **16** with a curved needle **18** to secure the thread **16** into the loading apparatus **10**. The thread **16** can be coupled to the needle **201** at one end, and the curved needle **18** can be at the other end of the thread **16**. The curved needle **18** can be replaced, if necessary. For example, the thread **16** can be tied or untied from the curved needle **18**. The curved needle **18** can have a sharp end to hook, attach, or wrap around the pulley **11** to secure the curved needle **18**. The curved needle **18** can be mounted onto the pulley **11** such that the curved needle **18** enables the pulley **11** to wind the thread **16**. The pulley **11** allows the thread **16** to be unwound in a controlled manner after the suturing device **1** is removed from the loading apparatus **10** to prevent the thread **16** from being loose and forming knots or clumps.

(123) Section C: Method

(124) FIG. **18** depicts a flow chart of a method **1800** for using the suturing device **1**A and the loading apparatus **10** for suturing. The method **1800** can include providing the suturing device **1**A or suturing device **1**B (STEP **1802**). It is contemplated that method **1800** can be performed with any other embodiment of the suturing devices. The shape of the suturing device and the angle between the jaws and arms can be optimal for certain procedures or ligaments. For example, the angles can be optimized for safety to prevent hurting other tissues such as bladder. The operator can select the suturing device **1**A or the suturing device **1**B based on the treatment site to be sutured. For example, the operator can select among suturing devices based on the ligament to be sutured.

(125) The method **1800** can include inserting the suturing device **1**A or **1**B into the loading device **10** (STEP **1804**). The lever **3** can be pulled towards the handle **2** to be in second position **110**B to receive the needle **201** in the fixed jaw **5**. Before placing the suturing device **1**A into the loading apparatus **10**, the stopper **605** can be moved to the deactivated position to be able to be move the lever **3** to second position **110**B from the first position **110**A or the third position **110**C. As shown

in FIG. **19**, the movable jaw **6** of the suturing device **1**A can be opened relative to the fixed jaw **5**. The suturing device **1**A can be placed on the suture loading apparatus **10** in such a way that the fixed jaw **5** fits into the first loading slot **13** and the movable jaw **6** fits into the second loading slot **14**.

(126) The method **1800** can include loading the needle **201** into the suturing device **1**A (STEP **1806**). FIG. **20**A is a front view and FIG. **20**B is a rear view of the slider **12** in an initial (e.g., default) position when the needle **201** is loaded into the slider **12**. FIG. **20**C is a front view and FIG. **20**D is a rear view of the slider **12** moved along the loading channel **320** to move the needle **201** into the fixed jaw **5**. The needle slider **12** can be moved in the direction of the fixed jaw **5**. The slider **12** can be driven in the loading channel **320** to load the needle **201** into the fixed jaw **5**. The needle **201** can be loaded into the first grasping slot **103**.

(127) As shown in FIGS. **20**A-**20**I, in some embodiments, the slider **12** includes safety notches **121**A-**122**B in the loading channel **320** and protrusions **123**A-**123**B on the slider **12** for making a click effect to inform the operator that the needle **201** is loaded successfully. The safety notches **121**A-**122**B and protrusions **123**A-**123**B can provide a click effect informing the operator that the needle **201** is loaded successfully based on the notches **121**A and **121**B or unloaded successfully based on the notches **122**A and **122**B. FIG. **20**E and FIG. **20**F show closer views of the slider **12** showed in FIG. **20**B and FIG. **20**D, respectively. FIG. **20**G, FIG. **20**H, and FIG. **20**I show details of the slider **12** from a different view. FIG. **20**I shows front views of slider **12** according to the FIG. **20**E. FIG. **20**G shows a back view of the slider according to the FIG. **20**E. FIG. **20**H shows perspective view of the slider **12** according to the FIG. **20**E.

(128) FIG. **21** shows the needle **201** from the loading apparatus **10** being secured in the first grasping slot **103** of the fixed jaw **5**. After the slider **12** loads the needle **201** into the first grasping slot **103**, the lever **3** can be moved to the first position **110**A to grasp the needle **201** in the first grasping slot **103** of the fixed jaw **5**. As shown in FIG. **21**, the lever **3** can be pulled upwards and into the first position **110**A. For example, the lever **3** can be moved to the first position **110**A from the second position **110**B. The stopper **605** can be in the deactivated position to be able to be move the lever **3** to the second position **110**B from the first position **110**A or the third position **110**C. After securing the needle **201** in the first grasping slot of the fixed jaw **5**, the slider **12** can be moved away from the fixed jaw **5** while the needle **201** is secured in the first grasping slot of the fixed jaw **5**.

(129) After receiving the needle **201**, the suturing device **1**A can be separated from the loading apparatus **10** and the needle **201** pulls on the thread **16** that is wound on the pulley **11**. The suture thread **16** can be pulled from the pulley **11** and thus from the loading apparatus **10**. One end of the thread **16** can remain attached to the curved needle **18** that remains attached to the pulley **11**.

(130) In some embodiments, instead of STEP **1804** and STEP **1806**, the attachment member **1105**A or the attachment member **1105**B that has a needle **201** already preloaded can be attached to the suturing device **1**A or the suturing device **1**B. The attachment can be attached to the fixed jaw **5** or the movable jaw **6** as shown in FIG. **11**B and FIG. **1**C. For example, instead of having to load the needle **201** with the loading apparatus **10**, the operator can attach the attachment to the suturing device **1**A or the suturing device **1**B for suturing with the attachment. At the conclusion of the suturing operation, the attachment can be removed with the needle **201**, and another attachment with a replacement needle **201** can be attached to the fixed jaw **5** or the movable jaw **6**.

(131) The method **1800** can include moving the suturing device **1**A into a vaginal cavity (STEP **1808**). As shown in FIG. **22**A, the suturing device **1**A can be inserted into the vaginal cavity **2205**. The operator can cut an incision **2206** (e.g., 3 cm incision) in the wall of the vagina to insert the suturing device **1**A through the incision **2206** to reach the pelvic cavity **2208** (e.g., Retzius Space) where the suturing operation is to be performed (e.g., the ATFP is in this cavity) and the sutures are delivered to the pelvic cavity. As shown in FIG. **22**B, the suturing device **1**A can be inserted into the vaginal cavity **2205**. As shown in FIG. **22**C, the suturing device **1**A can be inserted into the

pelvic cavity **2208** through the vaginal cavity **2205** such that no incision in the abdomen is opened to insert the suturing device **1**A. The operator can move the suturing device **1**A into the vaginal cavity **2205** while the movable jaw **6** is closed relative to the fixed jaw **5**.

(132) As shown in FIG. **22**D, the operator can move the suturing device **1**A until the fixed jaw **5** or the movable jaw **6** touches a target tissue inside the pelvic cavity **2208**, which allows the operator to safely position the suturing device **1**A. For example, the operator can determine the place of target tissue (e.g., ATFP for SUI operations) by palpating the target tissue and then the operator can move the suturing device **1**A until the fixed jaw **5** or the movable jaw **6** touches the palpated ligament in a closed position. Once the fixed jaw **5** or the movable jaw **6** touches the palpated tissue, the operator can infer that the suturing device **1**A is properly positioned. For example, the suturing device **1**A can be inserted into the pelvic cavity **2208**, which can be the operation site, through the incision **2206** opened at the wall of vagina.

(133) The suturing device **1**A can be designed based on the length of the cavity into which the suturing device **1**A is expected to be inserted. The area of points on the suturing device **1**A that remains outside the cavity when the operator stops inserting the suturing device **1**A can be known as a stop area **2210**. For example, the stop area **2210** can be near the arm joint **101**. In another example, during operation of the suturing device **1**A, the arm joint **101** can be positioned outside the vaginal cavity **2205** while a portion of the suturing device **1**A can be positioned inside the vaginal cavity **2205**. In another example, the stop area **2210** is closer to the handle **2**A and the handle **2**B such that the suturing device **1**A is inserted further into the vaginal cavity **2205**.

(134) As shown in FIG. **22**DD, in some embodiments, the shape of the suturing device **1**B can be advantageous for palpating during suturing operations. During POP operations, the operator can use their index finger **2211** to locate the ligament where the suture will be placed and determine the safe area on the ligament where to place the suture. The operator can take the suturing device **1**B to this safe area and pass the suture. In some embodiments, the shape of suturing device **1**B can match the shape of the index finger **2211** during palpation and the size of the suturing device **1**B can conform to be moved together with the index finger **2211** of the operator during palpation. The shape and size of the suturing device **1**B and the fixed jaw **5** being fixed enable the operator to place the suturing device **1**B under their index finger **2211** and in one step, do the palpation and pass the suture. The suturing device **1**B, with its size, shape, and fixed jaw **5**, can conform to the shape of the index finger **2211** and work together in harmony with the index finger **2211** of the operator.

(135) Referring back to FIG. **18**, the method **1800** can include opening the movable arm **8** relative to the fixed arm **7** to open the movable jaw **6** until the tissue in the pelvic cavity **2208** is between the fixed jaw **5** and the movable jaw **6** (STEP **1810**). As shown in FIG. **22**E, the operator can pull the suturing device **1**A away from the tissue to create a safe distance to open the movable jaw **6** relative to the fixed jaw **5**. After opening the movable jaw **6**, the operator can position the fixed jaw **5** on-the tissue to be sutured.

(136) The widening of the suturing device **1**A caused by the opening of the handle **2**A and the handle **2**B can remain outside of the vaginal cavity **2205**. The movement of the movable arm **8** in the vaginal cavity **2205** can cause the movable jaw **6** to pivot about the jaw joint **100** inside the pelvic cavity **2208**. Since the movable arm **8** can cause the movable jaw **6** to move while the fixed jaw **5** and the fixed arm **7** can stay in the same position, the operator can predict where the needle **201** would be suturing, which allows the operator to more safely suture tissue that is difficult to see or not visible at all.

(137) The method **1800** can include closing the movable arm **8** relative to the fixed arm **7** to close the movable jaw **6** to move the needle **201** through the tissue (STEP **1812**). As shown in FIG. **22**E and FIG. **22**F, while the movable jaw **6** moves, the fixed jaw **5** can provide a fixed reference, and the tissue inside the pelvic cavity **2208** to be sutured can be placed between the fixed jaw **5** and the movable jaw **6**. By moving the movable jaw **6** relative to the fixed jaw **5**, the needle **201** is passed

through the tissue. While the location where the suturing is required might be in a narrow, deep, and area that is difficult to see or not visible at all for the operator, the needle **201** can suture in the desired location because the movement of the movable jaw **6** is predictable and precise while the fixed jaw **5** remains stationary with respect to the target tissue. As shown in FIG. **22**F, the operator can close the movable arm **8** relative to the fixed arm **7** to close the movable jaw **6** relative to the fixed jaw **5**.

(138) The method **1800** can include actuating the needle transfer mechanism **4** to transfer the needle **201** from the fixed jaw **5** to the movable jaw **6** to pass the suture (STEP **1814**). The operator can move the lever **3** to transfer the needle **201** from the fixed jaw **5** to the movable jaw **6**. By pulling the lever **3** in the direction of the handle **2** and into the third position **110**C, the needle **201** is transferred and secured in the movable jaw **6**. The needle **201** can be transferred from the first grasping slot **103** of the fixed jaw **5** to the second grasping slot **104** of the movable jaw **6**. Having the fixed jaw **5** stay in a fixed location while transferring the needle **201** can enable safe transfer of the needle **201** when the tissue is difficult to see or not visible at all.

(139) As shown in FIG. **22**G, the needle **201** has been transferred to the movable jaw **6**. The movable jaw **6** can move away with the needle **201** and open relative to the fixed jaw **5** to position for another suture. As shown in FIG. **22**A-**22**G, the needle **201** was first loaded into the fixed jaw **5** so the needle **201** was transferred from the fixed jaw **5** to the movable jaw **6**. However, it is contemplated that the needle **201** can be first loaded into the movable jaw **6** (e.g., second grasping slot **104**). The movable jaw **6** and the needle **201** can pierce through the tissue and move towards the fixed jaw **5** until the needle **201** is disposed in the fixed jaw **5** (e.g., first grasping slot **103**).

(140) Since the suturing devices described herein can transfer the needle **201** between the jaws, the operator can reach the treatment site and suture with the same device instead of relying on one device to maneuver the treatment site and another device to suture. Moreover, the transfer of the needle **201** between the jaws enables sequential suturing. For example, if the procedure requires so, the operator can also make suture after suture (sequential) with the same needle **201**, which is called Z-suture or 8-figure suture.

(141) After making the suture, the suturing device **1**A can be removed from the pelvic cavity **2208**. The stopper **605** can be moved into the deactivated position, and the lever **3** can be moved into the second position **110**B to release the needle **201** from both the fixed jaw **5** and the movable jaw **6**. Since the needle **201** is attached to the thread **16**, which itself is attached to the curved needle **18**, the operator can release the needle **201** to remove the suturing device **1**A but keep the thread **16** sutured in the pelvic cavity **2208**.

(142) For example, for a stress urinary incontinence operations, the operator can load the device four times to pass four sutures with the needle **201**. Two of these sutures can be made on the left ATFP and two sutures can be made on the right ATFP. For example, there are 2 ATFPs in the pelvis that are symmetrically situated; one on the left side and the other on the right side of the pelvis. These sutures can be made by inserting the suturing device into the pelvic cavity **2208** via the incision **2206** in the vaginal cavity **2205**, and by turning the jaws of the device to the right and to the left respectively. It is contemplated that the operation can be performed with **2** stitches or a different number of sequential stitches depending on the operation, the suturing devices, and the preferences of the operator. For example, an operation with suturing device **1**B may use only 1 suture or 2 sutures at the same side.

(143) After each suture is completed, the operator can move the suturing device **1**A out of the pelvic cavity **2208**. The operator can release, from the suturing device **1**A, the used needle **201** with the thread **16** attached to the curved needle **18** such that the thread **16** remains sutured in the pelvic cavity **2208**. The operator can re-load the suturing device **1**A with another needle until four such sutures are passed. After making the four sutures, the four threads **16** and their respective curved needles **18** remain attached and sticking out of the pelvic cavity **2208**.

(144) After completing 4 sutures with needle **201**, the operator can pass or pull the 4 sutures by

pulling the curved needle **18** attached to each thread **16**. These sutures can be placed on the vaginal wall to form a loop with the sutures passed on ATFP with needle **201**. For example, the operator can pull the end of each suture towards one another, which has the effect of bringing the wall of the vagina closer to the ATFP at each side (e.g., Left and Right) as well as lifting the vaginal wall, the bladder and urethra, thus restoring their anatomical position. The operator can tie each loop (e.g., 4 in total) with knots and cut off the extra thread **16** and thus the needle **201** and the curved needle **18**.

(145) In some embodiments, the operator can make the loop without the curved needle **18** attached to the other end of the thread **16**. For example, the operator can pass the suture from the vaginal tissue in the vaginal cavity **2205** by pulling on the needle **201** to pull the thread **16** and tie the loop with the thread **16**.

(146) The operator can use a standard suture to close the incision **2206** that was opened to place the suturing device **1**A into the cavity. For example, the operator can use with standard sutures and standard suturing devices such as a needle holder and thumb forceps. In another example, the operator can use a needle holder and thumb forceps to perform suture patterns.

(147) In some embodiments, the suturing device **1**A and the suturing device **1**B can be used for native tissue repair without a synthetic implant (e.g., by using a sling or mesh or instead of mid-urethral sling operations for SUI, mesh operations for POP). For example, the suturing devices can also be used to assist the placement of an “adjustable single incision sling” in the pelvic cavity **2208** (e.g., mini sling that can tighten and loosen as needed to treat stress urinary incontinence). Each end of the mini sling can include a needle **201**, and the needle **201** can be loaded into a specialized loading apparatus to form a kit for placing the mini sling. The suturing devices can use the specialized loading apparatus to load each needle and suture each needle at different ends of the pelvic cavity **2208** to place the mini sling **2300** along the pelvic cavity **2208**.

(148) FIG. **23**A depicts an embodiment of a mini sling **2300**. The mini sling **2300** can be an adjustable, tension-free single incision mid-urethral sling. The mini sling **2300** can have a rectangular shape that tapers to the edges to allow an a-traumatic placement. The suturing device can be for the placement of an adjustable, tension-free “single incision mid-urethral sling (mini sling)” in addition to the placement of suture that was described in this patent. The tension of the mini sling **2300** can be adjustable. The mini sling **2300** can be tension-free by not having to be fixated to the tissue by anchors. This can be advantageous over slings that only allow the operator to adjust the tension of the sling during the operation, which means that once the tension is adjusted, the mini sling is fixated in the tissue with anchors.

(149) The mini sling **2300** can include a mesh **2302** narrowing from the middle towards the edges. For example, the mesh **2302** (e.g., the rectangular part) can be 6 cm long. One edge is attached to a thread **16**A that itself is attached to a needle **201**A, and another edge is attached to a thread **16**B that itself is attached to a needle **201**B. FIG. **23**B depicts a close up view of the needle **201**B. The operator can use the needle **201**A and the needle **201**B to load the mini sling **2300** into the suturing device **1**A or the suturing device **1**B to deliver the mini sling **2300** into the pelvic cavity **2208** for placement. Since the needle **201**A and the needle **201**B are disposed at opposite ends, the needles **201**A and **201**B can enable each end of the mini sling **2300** to be loaded into the suturing device **1**A or **1**B, after which the suturing device **1**A or **1**B can move the mini sling **2300** to the target location for placement of the mini sling **2300** in the pelvic cavity **2208**.

(150) FIG. **24** depicts a close up view of an embodiment of the mini sling **2300** including adjustment sutures **2305**A-**2305**C. For example, the mini sling **2300** can include 3 adjustment sutures **2305**A-**2305**C. While not shown, the mini sling **2300** can include fewer or additional adjustment sutures. Each of the adjustment sutures **2305**A-**2305**C can include threads **2308**A-**2308**C. Each of the threads **2308**A-**2308**C can be attached to the mesh **2302** by the operator after placing the mesh **2302** in the pelvic cavity **2208**. Each of the adjustment sutures **2305**A-**2305**C can include curved needles **2310**A-**2310**F attached to each end of the threads **2308**A-**2308**C such that

the curved needles **2310**A-**2310**F extend from the mesh **2302** and outside of the pelvic cavity **2208** after the adjustment sutures **2305**A-**2305**C are attached to the mesh **2302** by the operator. The curved needles **2310**A-**2310**F can be pulled on outside of the pelvic cavity **2208** to enable adjustment of the tension of the mesh **2302** of the mini sling **2300**.

(151) The adjustment suture **2305**B can be disposed in the middle of the mesh **2302** for loosening the mesh **2302**. The adjustment suture **2305**A and the adjustment suture **2305**B can be disposed towards ends of the mesh **2302** (e.g., points where the mesh **2302** was cut at each end) for tightening the mesh **2302**. The curved needles **2310**A-**2310**F can be brought into the vaginal cavity **2205** by piercing through the vaginal wall **2207** and cut off. The remaining threads **2308**A-**2308**C can be knotted and stored in a housing to be later used for adjustment.

(152) FIG. **25** depicts an embodiment of the sling loader **2315** for the mini sling **2300**. The sling loader **2315** can be similar to and include the functionality of the loading apparatus **10**, but the sling loader **2315** can be specially designed for the mini sling **2300**. In some embodiments, the mini sling **2300** can be pre-loaded into the sling loader **2315**. For example, the mini sling **2300** and the sling loader **2315** can be a kit. The sling loader **2315** can include a first loading slot **13**A and **13**B configured to receive the fixed jaw **5**. The sling loader **2315** can include a second loading slot **14**A and **14**B configured to receive the movable jaw **6**.

(153) The sling loader **2315** can receive both the needle **201**A and needle **201**B of the mini sling **2300** to load the mini sling **2300** into the suturing device **1**A. The sling loader **2315** can include a slider **12**A disposed in a slot **15**A that can hold the needle **201**A of the mini sling **2300**. The sling loader **2315** can include a slider **12**B disposed in a slot **15**B that can hold the needle **201**B of the mini sling **2300**.

(154) FIG. **26** and FIGS. **27**A-**27**J depict an embodiment of using the mini sling **2300** to treat urinary incontinence. For example, the mini sling **2300** can be positioned such that the mesh **2302** is positioned under the urethra **2705** to treat urinary incontinence. The mini sling **2300** can be positioned by using the suturing device **1**A to pass the needle **201**A and the needle **201**B through the target tissue in the pelvic cavity **2208** (where ATFP adheres to the pubic bone) as described herein in mesh repair. The thread **16**A and the thread **16**B of the mini sling **2300** can be passed through the incision **2206** (e.g., vaginal wall) in the vaginal cavity **2205**. The thread **16**A and thread **16**B on the ends of the mini sling **2300** can be pulled simultaneously to position the mesh **2302** of the mini sling **2300**. In some embodiments, it is contemplated that suturing device **1**B can be used to position the mini sling **2300**.

(155) As shown in FIG. **26**, the mini sling **2300** can be loaded into the sling loader **2315**. In some embodiments, the slider **12**A and slider **12**B are symmetrically positioned to symmetrically load the needle **201**A and needle **201**B of the mini sling **2300**. The mini sling **2300** can be loaded at the ends by the needle **201**A and needle **201**B into the suturing device **1**A or the suturing device **1**B via the sling loader **2315**. As shown in FIG. **27**A, the needle **201**A has been loaded into the suturing device **1**A by the sling loader **2315**.

(156) As shown in FIG. **27**B and as described in FIGS. **22**A-**22**G, the suturing device **1**A can be used to pass the needle **201**A through the target tissue in the pelvic cavity **2208**A to place one end of the mini sling **2300**. The needle **201**A can be inserted into the vaginal cavity **2205** and through the incision **2206** to reach the pelvic cavity **2208**A. For example, a sharp and blunt dissection (e.g., 3 cm incision) is advanced from under the vesicovaginal fascia towards the junction of the pubic ramus and symphysis pubis, and the arcus tendinous fascia pelvis is detected. The thread **16**A follows the needle **201**A through the incision **2206**, and the mesh **2302** follows the thread **16**A into the pelvic cavity **2208**A such that the mesh **2302** can be positioned in the pelvic cavity **2208**.

(157) As shown in FIG. **27**C and as described in FIGS. **22**A-**22**G, the suturing device **1**A can be used to pass the needle **201**B through the target tissue in the pelvic cavity **2208**B to place the other end of the mini sling **2300**. For example, the suturing device **1**A can release the needle **201**A, and then the needle **201**B can be loaded into the suturing device **1**A by the sling loader **2315**. The mini

sling **2300** can thus be positioned relative to the urethra **2705** by using the suturing device **1**A to pass the needle **201**A through the pelvic cavity **2208**A, and the needle **201**B through the pelvic cavity **2208**B. The thread **16**A and the thread **16**B of the mini sling **2300** can be passed through the incision **2206** (e.g., vaginal wall) in the vaginal cavity **2205**.

(158) The device **1**A can position thread **16**A and thread **16**B to position the mini sling **2300** to where it should be placed in the pelvic cavity **2208**A and **2208**B, respectively. The device **1**A can pass the needle **201** through the tissue at the target place, but no stitching is done, such that the thread **16**A is not tied in a knot **2720**A but only passes through the tissue to pass the end of the mini sling **2300** through the tissue. For example, the ends (e.g., **16**A and **16**B) of the mini sling **2300** are not secured by stitching because the mini sling **2300** is placed tension-free.

(159) As shown in FIG. **27**D, the thread **16**A and thread **16**B on the ends of the mini sling **2300** can be pulled simultaneously to position the mesh **2302** relative to the urethra **2705**. For example, after delivering the mini sling **2300**, the mesh **2302** can be elevated up towards the urethra **2705** as both ends of the mini sling **2300** can be pulled by the thread **16**A and thread **16**B. For example, both the thread **16**A and the thread **16**B can be pulled simultaneously. The mesh **2302** of the mini sling **2300** can rise under and towards the urethra **2705** when the thread **16**A and the thread **16**B are pulled.

(160) As shown in FIG. **27**E, the thread **16**A and thread **16**B can be pulled such that the mesh **2302** can be placed tension free into the pelvic cavity **2208** instead of fixating in the tissue with anchors. The thread **16**A and thread **16**B can be pulled until the thread **16**A and the thread **16**B attached to the mesh **2302** are visible to the operator through the incision **2206**. For example, the thread **16**A and the thread **16**B can be pulled out of the incision towards the vaginal cavity **2205** for the surgeon to be able to cut them as well as the extra portion of the mesh **2302** at its ends and make sure that only the targeted length of mesh **2302** stays in the pelvic cavity **2208**.

(161) As shown in FIG. **27**F, in some embodiments, the excess portion **2710**, which can include each excess end of the mesh **2302** attached to the thread **16**A and thread **16**B with the needle **201**A and needle **201**B, can be cut after positioning the mesh **2302**. As shown in FIG. **27**G, the mesh **2302** can be positioned in the pelvic cavity **2208**A and **2208**B after the excess portion **2710** containing the mesh **2302** attached to the thread **16**A and thread **16**B and the needle **201**A and needle **201**B attached thereof are cut off.

(162) As shown in FIG. **27**H, after positioning the mesh **2302**, if the operator decides to have the post-operative adjustment, then during the operation, the operator can attach the adjustment sutures **2305**A-**2305**C to the mesh **2302**. For example, the operator can insert the adjustment sutures **2305**A-**2305**C through the incision **2206** in the vagina. Each of the adjustment sutures **2305**A-**2305**C can include curved needles **2310**A-**2310**F attached to each end of the threads **2308**A-**2308**C.

(163) The operator can attach the adjustment suture **2305**A and the adjustment suture **2305**C towards ends of the mesh **2302** (e.g., points where the mesh **2302** was cut at each end) for tensioning the mesh **2302**. In some embodiments, the curved needles of the adjustment suture **2305**A and the adjustment suture **2305**C can be inserted through the incision **2206** and then brought out by piercing the vaginal wall **2207** to bring them back into the vaginal cavity **2205**. The operator can attach the adjustment suture **2305**B in the middle of the mesh **2302** for loosening the mesh **2302**.

(164) In some embodiments, after the operator attaches the adjustment sutures **2305**A-**2305**C to the mesh **2302**, each end of the adjustment threads **2308**A-**2308**C, which is attached to respective curved needles **2310**A-**2310**F, can be brought into the vaginal cavity **2205** by piercing through the vaginal wall **2207** by the curved needles **2310**A-**2310**F attached to each end of the adjustment thread **2308**.

(165) As shown in FIG. **27**I, in some embodiments, the curved needles **2310**A-**2310**F pierce through the vaginal wall **2207** at pierce points **2209**A-**2209**F. For example, the 6 curved needles **2310**A-**2310**F can create 6 pierce points **2209**A-**2209**F through which the 6 ends of the 3 adjustment threads **2308**A-**2308**C can be pulled out of the pelvic cavity **2208** and into the vaginal

cavity **2205**. The curved needles **2310**A-**2310**F can be pulled to pull the adjustment sutures **2305**A-**2305**C through the pierce points **2209**A-**2209**F. For example, each of the adjustment threads **2308**A-**2308**C has 2 ends with curved needles **2310**A-**2310**F attached to both ends, and both ends of each of the adjustment threads **2308**A-**2308**C can be brought to the vaginal cavity **2205** through the vaginal wall **2207**.

(166) As shown in FIG. **27**I, the operator can cut off part of the threads **2308**A-**2308**C to remove the curved needles **2310**A-**2310**F from the operating site. In some embodiments, the curved needles **2310**A-**2310**F can be brought out from the outside of the incision **2206** (e.g., not through the incision **2206**) by piercing through the vaginal wall **2207** to be removed by cutting the curved needles **2310**A-**2310**F. For example, the mesh **2302** can be left positioned relative to the urethra **2705** and the curved needles **2310**A-**2310**C attached thereof can be cut off.

(167) After the curved needles **2310**A-**2310**F are cut off, the operator can make knots **2720**A-**2720**C of the threads **2308**A-**2308**C at their respective ends. The operator can use the knots **2720**A-**2720**C to adjust the tension of the mesh **2302** because the remaining threads **2308**A-**2308**C remain attached to the mesh **2302**. The operator can cut the curved needles **2310**A-**2310**F off and make knots **2720**A-**2720**C of the remaining threads **2308** to form a loop and secures the knots **2720**A-**2720**C in the housings **2725**A-**2725**C. The knots **2720**A-**2720**C, the threads **2308**, and the housings **2725** do not stick out of the vagina. For example, during the post-operative period, the patient does not see them because they stay in the vaginal cavity **2205**.

(168) As shown in FIG. **27**J, the knots **2720**A-**2720**C can be stored in housings **2725**A-**2725**C. The housings **2725**A-**2725**C can be containers or enclosures for the knots **2720**A-**2720**C. The housings **2725**A-**2725**C can be used to secure the knots **2720**A-**2720**C in the vaginal cavity **2205** of the patient after the operation until the patient's post-operative check-up for adjustment. The housings **2725**A-**2725**C can keep the knots **2720**A-**2720**C intact and keep them from contamination during this period of time. By maintaining the knots **2720**A-**2720**C in the housings **2725**A-**2725**C, the operator can adjust the tension of the mesh **2302** relative to the urethra **2705** after the procedure. For example, the knots **2720**A-**2720**C can be kept in the housings **2725**A-**2725**C for one week following the operation, in case adjustment of the mesh **2302** is needed. In another example, one week after the operation, the patient may report difficulty voiding or incontinence, and both can be remedied by adjusting the tension of the mesh **2302** relative to the urethra **2705**. After the tension is readjusted post-operatively, the adjustment sutures **2305**A-**2305**C can be cut off and taken away from the mesh **2302**. This possibility of adjusting the mesh **2302** after the operation is advantageous by avoiding the need for a second operation to reinsert the mesh **2302** or additional adjustments sutures.

(169) After the operation (e.g., 1 week), when the operator checks the patient for adjustment, the operator reaches the knots **2720**A-**2720**C secured in the housings **2725** in the vaginal cavity **2205** of the patient and adjusts the tension of the mesh **2302**. For example, this adjustment can be done after the operation, does not require a new operation, and can be done in the outpatient clinic or office set up. The operator can pull the knots **2720**A-**2720**C to pull the threads **2308**A-**2308**C attached to the mesh **2302**.

(170) In some embodiments, at the post-operative check-up done in office setting or outpatient clinic, the operator can pull on the knots **2720**A-**2720**C of the adjustment suture **2305**A and the adjustment suture **2305**C to pull the mesh **2302** towards the urethra **2705** to tighten the mesh **2302**. For example, the operator can pull on the knots **2720**A-**2720**C secured in the housings **2725**A-**2725**C of the adjustment suture **2305**A and of the adjustment suture **2305**C to pull the mesh **2302** towards the urethra **2705** to tighten the mesh **2302**. In some embodiments, the operator can pull the knots **2720**A and **2720**C to increase the tension of the mesh **2302**. For example, the knots **2720**A and **2720**C on the sides of the mesh **2302** can be used for increasing the tension after the operation. The operator can pull the knots **2720**A and **2720**C at the edges to pull the mesh **2302** towards the urethra **2705** to tighten the mesh **2302**.

(171) In some embodiments, the operator can pull the knot **2720**B to loosen the mesh **2302**. The operator can pull the knot **2720**B in the middle to pull the mesh **2302** away from the urethra **2705** to loosen the mesh **2302**. In some embodiments, the operator can pull on the knot **2720**B secured in the housing **2725**B of the adjustment suture **2305**B to pull the mesh **2302** away from the urethra **2705** to loosen the mesh **2302**. For example, the operator can pull on the knot **2720**B secured in the housing **2725**B of the adjustment suture **2305**B in the middle of the mesh **2302** to pull the mesh **2302** away from the urethra **2705** to loosen the mesh **2302**. After the operator completes the adjustment, the operator can cut the loop, discard the housings **2725**, and pull on the adjustment thread **2308** to take the thread away.
(172) Now referring generally to the suturing device **1**A and the suturing device **1**B. The suturing devices can be used for pelvic floor disorders' treatment, such as the treatment of SUI and POP. For example, the suturing devices can be angled for transvaginal approaches or procedures. In another example, the suturing devices can be a minimally invasive operation device of the vaginal wall or uterine prolapse in women. The suturing devices can include various sizes, shapes, and angles calculated and optimized based on the pelvis anatomy for which the suturing device is to be used. The optimal size and shape enable the suturing devices to safely access target tissues for each device for their specified surgeries. The angled design of the suturing devices enables the tip of the devices to reach the target pelvic structures to be sutured via vaginal route. The angled design and sizes prevent unintended contact with other tissues. The shape of the suturing devices can improve performance and provides safety and ease of reach to target tissues by preventing unintended tissue injuries. The suturing devices can be minimally invasive, disposable, sterile, and for single use.
(173) The suturing devices can be a transvaginal device to place sutures in tissues at the operative site during the pelvic floor surgery in women (e.g., to treat stress urinary incontinence or pelvic organ prolapse, which is the bulging of pelvic organs such as bladder, rectum and uterus into the vagina and past the vaginal opening). The suturing devices can be transvaginal devices used with a single incision, which can be advantageous over abdominal and a plurality of incisions. The suturing devices can be used for consistent placement of sutures in difficult to access locations, such as those that are narrow and not visible. The suturing devices can be a one-step suturing device with an operating mechanism that enables the needle to be caught safely at the opposite jaw.
(174) The suturing devices can suture the specified ligament to vesicovaginal fascia at the level of bladder neck to elevate the bladder outlet to its normal position. The suturing devices can be ergonomic and shaped to perform the vaginal native tissue repair procedure for stress urinary incontinence. The suturing devices can be designed for the surgical treatment of stress urinary incontinence in women to facilitate the consistent placement of sutures in difficult to access locations (narrow and not visible). The suturing devices can be designed for regaining anterior vaginal support or vaginal colposuspension procedure. The suturing devices can be used in difficult to access general suturing applications during urogynecological procedures, including but not limited to stress urinary incontinence procedures, to assist in the placement of sutures at the operative site.
(175) The suturing devices can enable the operator to perform surgery via the vagina (e.g., transvaginal route as opposed to abdominal operations) in a minimally invasive way (e.g., single vaginal incision only). The suturing devices can be used for single vaginal incision native tissue repair via stitching vaginal wall to the pelvic floor supportive structures (to assist the placement of sutures in ligaments on to the pelvic floor supportive structures). The suturing devices can be used by an operator (e.g., surgeon) with sensory and/or direct visual control. The suturing device can be designed to enable the operator to perform a native tissue repair, without the placement of an artificial implant (as opposed to mid-urethral sling technique which requires the placement of a synthetic sling/mesh or transvaginal mesh operations).
(176) The suturing devices can be designed to be safely inserted into the cavity. The safety of the suturing devices can be derived from the length of the suturing devices. For example, the lengths

(of the arms **7** and **8** and jaws **5** and **6**) and angles of the suturing devices can contribute to safety outcomes described herein, and as such the lengths and angles can be designed to not damage the vagina or the incision. In another example, because the entrance point of the suturing device into the body is through the vagina but the entrance to the operating site is through the incision which is opened at the wall of the vagina, the operator can insert the suturing device into the pelvic cavity where the ATFP is located. For example, for stress incontinence operations done with the suturing device, the suturing device does not need to be inserted beyond the ATFP, which is the anatomical landmark used to determine the length of the suturing device. Even if the suturing device is positioned in the vagina past the arm joint **101**, the length of the suturing devices enables the widening of the suturing device caused by the opening of the handle to not affect the incision.
(177) The suturing devices can facilitate the consistent and sequential placement of sutures (e.g., making multiple sutures with the same needle; also called Z-suture or 8-figure suture) onto the pelvic floor structures, which are in difficult to access locations during pelvic floor surgery. The suturing devices can be designed to facilitate the consistent placement of sutures in difficult to access locations (deep, narrow, and not visible operating site) during transvaginal prolapse surgery (as opposed to abdominal surgery). The suturing devices can suture the specified ligament to the apical vaginal wall or cervix uteri in order to provide vaginal apex elevation.
(178) The suturing devices can be used for a transvaginal minimally invasive procedure. The suturing devices can be designed for vaginal wall or uterine prolapse surgery based on native tissue repair in women with pelvic organ prolapse (sagging of pelvic organs such as bladder, uterus or bowel into the vagina). The suturing devices can be designed to enable the operator to perform a native tissue repair, without the placement of an artificial implant (as opposed to operations requiring the placement of synthetic mesh). The suturing devices can enable operators to perform surgery via the vagina in a minimally invasive way, such as with just a single incision. The suturing devices can be used in difficult to access general suturing applications during urogynecological procedures, including but not limited to transvaginal pelvic organ prolapse procedures, to assist in the placement of sutures at the operative site. The suturing devices can be used with sensory and/or direct visual control.
(179) The suturing devices **1**A and **1**B can be used for the positioning of the tension-free single incision mid-urethral sling (mini sling **2300**) whose tension can be adjusted post-operatively.
(180) While one or more embodiments of the present disclosure have been described, it is understood that these embodiments are illustrative only, and not restrictive, and that many modifications may become apparent to those of ordinary skill in the art, including that various embodiments of the inventive methodologies, the illustrative systems and platforms, and the illustrative devices described herein can be utilized in any combination with each other. Further still, the various steps may be carried out in any desired order (and any desired steps may be added, and/or any desired steps may be eliminated).

Claims

1. A loading apparatus comprising: a base; a first loading slot disposed on the base, the first loading slot configured to receive a first arm of a suturing apparatus; a suture housing disposed on the base and configured to house a suture; and a slider configured to hold a needle coupled to the suture, the slider being slidable on the base from a neutral position away from the first loading slot toward the first loading slot to a first insertion position to insert the needle into the first arm.
2. The loading apparatus of claim 1, wherein the first loading slot comprises one or more side walls that are sized and angled to securely fit the first arm into the first loading slot.
3. The loading apparatus of claim 1, further comprising a fixing wall configured to maintain an end of a first arm in the first loading slot while receiving the needle.
4. The loading apparatus of claim 1, further comprising a second loading slot disposed on the base

away from the first loading slot, the second loading slot configured to receive a second arm of a suturing apparatus.
5. The loading apparatus of claim 4, wherein the slider is further configured to slide toward the second loading slot to a second insertion position to insert the needle into the second arm.
6. The loading apparatus of claim 4, wherein the second loading slot comprises one or more side walls that are sized and angled to securely fit the second arm into the second loading slot while the first arm is in the first loading slot.
7. The loading apparatus of claim 1, wherein the suture housing comprises a rotatable pulley, wherein the rotatable pulley is configured to rotate in a first direction to release the suture when the slider slides between the neutral position and the first insertion position or a second insertion position.
8. The loading apparatus of claim 7, wherein the rotatable pulley is configured such that rotation of the rotatable pulley in a second direction winds the suture for the needle to be loaded back into rotatable pulley after being loaded to the suturing apparatus.
9. The loading apparatus of claim 1, wherein the slider comprises a slot sized to receive and secure the needle.
10. The loading apparatus of claim 1, further comprising a loading channel, the loading channel defining a space within which the slider can move, and wherein the loading channel is sized so that the slider slides within the loading channel but does not fall out of the loading channel.
11. The loading apparatus of claim 10, wherein the slider comprises at least one safety notch in the loading channel and at least one protrusion on the slider for informing an operator that the needle has been loaded.
12. The loading apparatus of claim 1, wherein the suture is preloaded into the suture housing.
13. The loading apparatus of claim 1, wherein the needle comprises at least one notch configured to be grasped by a grasping slot of the first arm.
14. A loading apparatus comprising: a base; a first loader disposed on the base, the first loader comprising: a first loading slot configured to receive a first arm of a first suturing apparatus; and a first slider configured to hold a first needle coupled to a first suture, the first slider being slidable on the base from a first neutral position away from the first loading slot toward the first loading slot to a first insertion position to insert the needle into the first arm; and a second loader disposed on the base away from the first loader, the second loader comprising: an opposing first loading slot configured to receive a first arm of a second suturing apparatus; and a second slider configured to hold a second needle coupled to a second suture, the second slider being slidable on the base from a second neutral position away from the opposing first loading slot toward the opposing first loading slot to a second insertion position to insert the second needle into the first arm of the second suturing apparatus.
15. The loading apparatus of claim 14, wherein the first slider is symmetrically positioned relative to the second slider.
16. The loading apparatus of claim 14, wherein each of the first suture and the second suture is connected to a mesh.
17. The loading apparatus of claim 16, wherein the mesh is one or more of adjustable and tension-free.
18. The loading apparatus of claim 16, wherein the mesh comprises a rectangular shape with tapered edges.
19. The loading apparatus of claim 16, wherein the mesh comprises one or more adjustment sutures.