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Resuscitation base pelvic binder

Abstract

A device used for stabilizing the pelvis of a patient is provided. The device can include a first strap, a second strap, a fastening mechanism, a first supporting member, a second supporting member, and a first opening. The first strap can be configured to substantially surround the patient at a first location. The second strap can be configured to substantially surround the patient at a second location below the first strap. The first supporting member and second supporting member are coupled between the first strap and the second strap and can be configured to be positioned adjacent a first side and a second, opposite side, respectively, of the patient adjacent the anterior superior iliac spine. The first opening can be defined between the first strap, the second strap, the first supporting member, and the fastening mechanism to permit access to one of the femoral artery and the femoral vein.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS (1) This application represents the national stage filing of PCT/US2019/063753, filed Nov. 27, 2019, which claims the benefit of U.S. Provisional Patent Application No. 62/772,972 filed on Nov. 29, 2018, the entire contents of which are incorporated herein by reference.

FIELD

(1) The present application is directed to systems and methods for pelvic stabilization, including but not limited to a resuscitation base pelvic binder that permits access for surgical procedures, endovascular procedures, and/or attachment points for splinting while maintaining pelvic stabilization.

BACKGROUND

(2) Pelvic stabilization is essential in blunt trauma cases because an unstable pelvic fracture can lead to complications such as internal bleeding, organ damage, and infection. For example, bleeding from pelvic fractures (often venous bleeding) can be severe and life threatening. Pelvic binders are therefore used in cases of trauma to stabilize the pelvis and prevent further fractures of the pelvic bone. Pelvic binders can help decrease potential movement of the pelvis and also help tamponade any bleeding. Currently, most pelvic binders for stabilizing the pelvis include a belt fastened with a required amount of force around a patient. The belt surrounds the pelvic bones to provide stability and compression.

(3) In pelvic fracture cases, additional injuries are common and often require additional resuscitation strategies. For example, common surgical procedures in severe pelvic fracture cases include REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta), exploratory laparotomy, preperitoneal pelvic packing, Foley catheter insertion, and placement of lower extremity splints for femur fractures. Such procedures generally require access to the patient's lower extremities, lower abdomen, and/or femoral vessels. However, these body parts are generally blocked by currently available pelvic binders, thus making such interventions difficult or impossible with the pelvic binder in place. As a result, medical professionals often must remove the pelvic binder altogether or modify the pelvic binder by cutting and removing a portion of the binder to gain access to necessary body parts. But modifying a pelvic binder in this manner (or removing it altogether) can compromise the stability provided to pelvis and potentially increase bleeding. Furthermore, in some cases, cutting a pelvic binder can compromise sterility in the operating environment.

(4) Therefore, it would be desirable to provide a pelvic binder that allows access to at least the femoral vessels and anterior abdomen while maintaining stability of the pelvis.

SUMMARY

(5) Embodiments of the present invention overcome the drawbacks of previous systems and methods by providing systems and methods for stabilizing pelvic fractures in a way that permits access to at least the femoral vessels and anterior abdomen for surgical procedures.

(6) In one aspect, the present disclosure provides a device used for stabilizing the pelvis of a patient. The device can comprise a first strap, a second strap, and a third strap. The first strap and the second strap can each include a first horizontal section and a second angled section. The first horizontal section can be configured to be positioned adjacent a back side of the patient. The second angled section can be configured to be positioned adjacent the front side of the patient. The

third strap can be coupled to the second angled section of the first strap and the second strap.

(7) In another aspect, the present disclosure provides a device used for stabilizing the pelvis of a patient. The device can comprise a first strap, a second strap, a fastening mechanism, a first supporting member, a second supporting member, and a first opening. The first strap can be configured to substantially surround the patient at a first location. The second strap can be configured to substantially surround the patient at a second location below the first strap. The first supporting member and second supporting member are coupled between the first strap and the second strap and can be configured to be positioned adjacent a first side and a second, opposite side, respectively, of the patient adjacent the anterior superior iliac spine. The first opening can be defined between the first strap, the second strap, the first supporting member, and the fastening mechanism to permit access to one of the femoral artery and the femoral vein.

(8) Additional objectives, advantages and novel features will be set forth in the description which follows or will become apparent to those skilled in the art upon examination of the drawings and detailed description which follows.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. 1 is a perspective view of a pelvic binder according to some embodiments.

(2) FIG. 2 is a perspective view of the pelvic binder of FIG. 1 around a pelvis of a patient, showing a portion of the patient's skeleton to illustrate a location of the pelvic binder during use.

(3) FIG. 3 is a perspective view of another pelvic binder according to some embodiments.

(4) FIG. 4 is a perspective view of the pelvic binder of FIG. 3 around a pelvis of a patient, showing a portion of the patient's skeleton to illustrate a location of the pelvic binder during use.

(5) FIG. 5 is a perspective view of another pelvic binder according to some embodiments.

(6) FIG. 6 is a perspective view of the pelvic binder of FIG. 5 around a pelvis of a patient, showing a portion of the patient's skeleton to illustrate a location of the pelvic binder during use.

(7) FIG. 7 is another perspective view of the pelvic binder of FIG. 5, according to some embodiments.

(8) Corresponding reference characters indicate corresponding elements among the view of the drawings. The headings used in the figures should not be interpreted to limit the scope of the claims.

DETAILED DESCRIPTION

(9) Before any embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of “including,” “comprising,” or “having” and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, “connected” and “coupled” are not restricted to physical or mechanical connections or couplings.

(10) The following discussion is presented to enable a person skilled in the art to make and use embodiments of the invention. Various modifications to the illustrated embodiments will be readily apparent to those skilled in the art, and the generic principles herein can be applied to other embodiments and applications without departing from embodiments of the invention. Thus,

embodiments of the invention are not intended to be limited to embodiments shown, but are to be accorded the widest scope consistent with the principles and features disclosed herein. The following detailed description is to be read with reference to the figures, in which like elements in different figures have like reference numerals. The figures, which are not necessarily to scale, depict selected embodiments and are not intended to limit the scope of embodiments of the invention. Skilled artisans will recognize the examples provided herein have many useful alternatives and fall within the scope of embodiments of the invention.

(11) As used herein, unless otherwise specified or limited, “at least one of A, B, and C,” and similar other phrases, are meant to indicate A, or B, or C, or any combination of A, B, and/or C. As such, this phrase, and similar other phrases can include single or multiple instances of A, B, and/or C, and, in the case that any of A, B, and/or C indicates a category of elements, single or multiple instances of any of the elements of the categories A, B, and/or C.

(12) Disclosed herein is a resuscitation base pelvic binder for stabilizing a pelvis of a patient. Embodiments of the pelvic binder as illustrated in the figures are configured to for use in cases of trauma. In other embodiments, however, it should be appreciated that a pelvic binder can be configured for use for other medical cases which do not include trauma and which may include additional features not described herein. In still other embodiments, a pelvic binder could be used with alternate types of medical devices.

(13) Generally, the pelvic binder of some embodiments may be worn by a patient (that is, positioned around the pelvis of the patient) to stabilize a pelvic fracture of the patient in a surgical environment, emergency environment, or non-surgical environment by a healthcare provider. The healthcare provider may be a surgeon, nurse, first responder, or other trained personnel. Furthermore, the pelvic binder of some embodiments may be used to stabilize a pelvic fracture to promote hemostasis without interfering with other resuscitative measures that may be needed, such as femoral vessel access, laparotomy, splinting, or preperitoneal pelvic packing. As one example, the pelvic binder can be fastened around the patient to stabilize the pelvis and can include angled straps and/or one or more openings to allow access to a plurality of locations on the patient, including the femoral vessels (e.g., the common femoral artery (CFA) or common femoral vein (CFV)), midline and anterior abdomen, and/or lower extremities, without binder removal or modification. The accessible region of the abdomen can include a region adjacent the pubic symphysis to permit access for surgical procedures such as a laparotomy and preperitoneal packing. In some embodiments, the pelvic binder can also include attachment mechanisms and can serve as a base to attach, for example, lower extremity long bone traction splints, restraints (e.g., for neurologically altered or combative patients), vascular access devices, or other attachments.

(14) Referring now to the Figures, and more particularly to FIG. 1, a pelvic binder **10** according to some embodiments is illustrated. FIG. 2 also illustrates the pelvic binder **10** of FIG. 1 around a pelvis **200** of a patient (e.g., showing a portion of the patient's skeleton to illustrate a location of the pelvic binder **10** during use). Generally, in some embodiments, the pelvic binder **10** may comprise a first strap **12**, a second strap **14**, a third strap **16**, a first supporting member **18**, and a second supporting member **20**. The first strap **12** can be configured to substantially surround the patient at a first location **13** adjacent to the pelvis **200**. For example, as shown in FIGS. 1 and 2, the first strap **12** can be configured to extend around the patient at or near the anterior superior iliac spine (ASIS) **22**. Furthermore, the second strap **14** can be configured to surround the patient at a second location **15** adjacent to the pelvis (e.g., below the first strap **12**), as shown in FIGS. 1 and 2. In some embodiments, the straps **12**, **14** can be routed through a back panel.

(15) In some embodiments, the first strap **12** can include a first horizontal section **24** and a second angled section **26**. The first horizontal section **24** can be configured to be positioned adjacent a back side of the patient, and the second angled section **26** can be configured to be positioned adjacent a front side of the patient. As such, the first horizontal section **24** and the second angled section **26** can meet at points adjacent to a first and second side **28**, **30** of the patient. Additionally,

in some embodiments, the first horizontal section **24** and the second angled section **26** can form a single integral strap, or can be composed of two or more separate straps coupled together at the patient's sides **28, 30** (and/or other locations). Similarly, the second strap **14** can include a first horizontal section **32** configured to be positioned adjacent a back side of the patient and a second angled section **34** configured to be positioned adjacent a front side of the patient. The first horizontal section **32** and the second angled section **34** can meet adjacent the first and second sides **28, 30**, and can be separate pieces coupled together or can form an integral strap. Furthermore, in some embodiments, as shown in FIGS. **1** and **2**, the first horizontal section **24** and the first horizontal section **32** of the straps **12, 14** can be configured to be positioned vertically equidistant from the greater trochanters **36** of the patient. As such, the pelvic binder **10** is generally centered over the greater trochanters **36** to stabilize the pelvis.

(16) As described above, the pelvic binder **10** can comprise the first supporting member **18** and the second supporting member **20**. The first supporting member **18** can be coupled between the first strap **12** and the second strap **14** and can be configured to be positioned adjacent a first side **28** of the patient (e.g., a right side of the patient adjacent the ASIS **22**) in a substantially vertical orientation. The second supporting member **20** can be coupled between the first strap **12** and the second strap **14** and can be configured to be positioned adjacent a second, opposite side **30** of the patient (e.g., a left side of the patient adjacent the ASIS **22**) in a substantially vertical orientation. While the first and second sides **28, 30** are described and illustrated as being right and left sides of the patient, respectively, in some embodiments, the first and second sides may instead be left and right, respectively. In some embodiments, the back panel of the pelvic binder **10** can extend from the first supporting member **18** to the second supporting member **20**. Additionally, in some embodiments, the respective first horizontal sections **24, 32** and second angled sections **26, 34** of the first strap **12** and the second strap **14** can meet at the first supporting member **18** along the first side **28** and the second supporting member **20** along the second side **30**, respectively. Furthermore, the first supporting member **18** and the second supporting member **20** can be sufficiently rigid to maintain a vertical distance between the first strap **12** and the second strap **14** for proper positioning of the pelvic binder **10** on the patient.

(17) Furthermore, the pelvic binder **10** can be tightened or loosened around a patient by adjusting the third strap **16**. For example, in some embodiments, the second angled section **26, 34** of each strap **12, 14** can each be coupled to the third strap **16** to provide adjustable structural stability to a fractured pelvis. More specifically, in some embodiments, the third strap **16** can be removably (or permanently) coupled to at least one of the first strap **12** and the second strap **14** to join the straps **12, 14** together and act as a fastening mechanism of the pelvic binder **10**. The third strap **16** can also be adjustable and configured to pull the first strap **12** and the second strap **14** towards each other to form the second angled section **26, 34**. For example, the third strap **16** can be a single tension strap that cinches together the first strap **12** and the second strap **14**. This adjustment can tighten the pelvic binder **10** around the pelvis, thus providing structural stability. Furthermore, the adjustability allows for stabilizing pelvic bones of different shapes and sizes according to the size and age of the patient. Additionally, the third strap **16** can generally be configured to be positioned adjacent to and extend below the pubic tubercles **38** of the patient to permit access to the abdomen for medical procedures, as further described below. In some embodiments, the third strap **16** can generally be vertical in orientation and centered over the pubic symphysis. In some embodiments, other adjustable fasteners may be contemplated as part of the third strap **16** (e.g., belt buckles, buckle clips with adjustable straps, pulley systems, clicking belt locks, or other fastening mechanisms).

(18) As shown in FIG. **1**, the third strap **16** generally separates two portions of the second angled sections **26, 34** of the first strap **12** and the second strap **14**. More specifically, with respect to the first strap **12**, the second angled section **26** can include a first portion **40** that extends diagonally from the first supporting member **18** to the third strap **16** and a second portion **42** that extends

diagonally from the second supporting member **20** to the third strap **16**. The first portion **40** and the second portion **42** are each configured to be angled downward from a respective supporting member **18**, **20** to the third strap **16**, thus generally forming a “v” shape.

(19) With respect to the second strap **14**, the second angled section **34** can include a first portion **44** that extends diagonally from the first supporting member **18** to the third strap **16** and a second portion **46** that extends diagonally from the second supporting member **20** to the third strap **16**. The first portion **44** and the second portion **46** are each configured to be angled upward from a respective supporting member **18**, **20** to the third strap **16**, thus generally forming an inverted “v” shape. In some embodiments, however, the second angled section of the second strap **14** may be substantially horizontal, so that only the first strap **12** (e.g., the top strap) includes angled portions. In such embodiments, the third strap **16** only cinches down the first strap **12** toward the second strap **14** (e.g., rather than cinching both the first strap **12** and the second strap **14** toward each other).

(20) Generally, the straps **12**, **14**, **16**, and the supporting members **18**, **20** can enable the pelvic binder **10** to distribute loads across, for example, its superior and inferior borders (e.g., the first strap **12** and the second strap **14**) to provide sufficient pelvic compression while still leaving areas of pelvic region accessible for medical procedures. For example, as shown in FIGS. **1** and **2**, the pelvic binder **10** can include an open region **48** partially defined between the first portion **40** and the second portion **42** of the first strap **12** (e.g., inside the “v” shape). This open region **48** can permit access to the abdomen adjacent the pubic symphysis **50** of the patient for, e.g., a midline laparotomy procedure or preperitoneal packing. For example, the general access area needed for such procedures includes a superior border adjacent the umbilicus, an inferior border adjacent the pubic symphysis **50**, and lateral borders adjacent the ASIS **22**. The open region **48** provides access for such procedures within these borders while maintaining stability of the pelvis, that is, without requiring modification of the pelvic binder **10**, such as loosening, moving, or removing any straps. Accordingly, the pelvic binder **10** generally does not extend above or over the pubic symphysis **50** to allow access to the open region **48**. Furthermore, access to the urethra for Foley catheter insertion can be available beneath the pelvic binder **10**.

(21) Additionally, in some embodiments, the pelvic binder **10** can include a first opening **52** defined between the first strap **12**, the second strap **14**, the third strap **16**, and the first supporting member **18**. The pelvic binder **10** can also include a second opening **54** defined between the first strap **12**, the second strap **14**, the third strap **16**, and the second supporting member **20**. The openings **52**, **54** can each permit access to the common femoral artery (CFA) or the common femoral vein (CFV) along the first side **28** or the second side **30** of the patient, respectively. For example, the general access area needed for reliable CFA/CFV access includes a superior border adjacent the inguinal ligaments **56**, medial borders adjacent the pubic tubercles **38**, and lateral borders adjacent the ASIS **22**. The openings **52**, **54** provide access for such procedures within these borders while maintaining stability of the pelvis, that is, without requiring modification of the pelvic binder **10**, such as loosening, moving, or removing any straps or material. For example, FIG. **1** illustrates accessible locations **58**, **60** of the femoral artery and femoral vein, respectively, within the second opening **54**. Furthermore, such vascular access can be obtained by a medical professional or an autonomous device (as further described below).

(22) Vascular access during pelvic stabilization can be beneficial to permit, for example, central venous line insertion or REBOA (Resuscitative Endovascular Balloon Occlusion of the Aorta) procedures. For example, REBOA procedures can help manage abdominal, pelvic, or lower extremity bleeding and require rapidly placing a catheter into the femoral artery. The pelvic binder **10** of some embodiments, by providing the openings **52**, **54**, is thus REBOA-compatible. Some conventional binders, while thin enough to provide pelvic stabilization as well as access to the some portions of the abdomen, extend across the greater trochanters for such stabilization and, thus, are not REBOA-compatible because they obscure access to the femoral vessels. Additionally,

in some embodiments, to better accommodate interventional radiology procedures (such as REBOA, angiography, or endovascular embolization), the pelvic binder **10** can be made of radiolucent material.

(23) In some embodiments, one or more of the first strap **12**, the second strap **14**, the first supporting member **18**, and the second supporting member **20** can include one or more attachment mechanisms **62** configured to couple an attachment to the pelvic binder **10**. For example, these attachment mechanisms **62** can act as docking sites for different attachments (such as adjuncts for resuscitation). As such, the pelvic binder **10** can serve as a supporting base for certain attachments.

(24) As one example, one or more attachment mechanisms **62** can be coupled to or integral with the first strap **12** and/or the second strap **14** and can be configured to be coupled to a vascular access device (not shown). An example vascular access device is described in U.S. Provisional Patent Application No. 62/816,549, the entire contents of which is incorporated herein by reference. The vascular access device can be coupled to the pelvic binder **10** via one or more attachment mechanisms **62** to extend over one of the openings **52**, **54** in order to automatically or semi-automatically access the femoral artery **58** or the femoral vein **60** of the patient. By permitting use of an autonomous vascular access device fixed to the pelvic binder **10**, venous or arterial access can be automated (or at least semi-automated) while healthcare providers work on other aspects of the patient's resuscitation. Additionally, vascular devices manually placed by health care workers can be secured to the pelvic binder **10** via the attachment mechanism **62**. Securing these devices to the pelvic binder **10** can reduce the risk of inadvertent removal or dislodgement during patient transport or repositioning.

(25) As another example, one or more attachment mechanisms **62** can be coupled to one of the first supporting member **18** and/or the second supporting member **20** and can be configured to be coupled to a femoral traction splint (not shown). A femoral traction splint can thus be anchored to the pelvic binder **10** via the attachment mechanisms **62** and can naturally stabilize a bone of the patient (e.g., broken bones in the patient's lower extremities). A splint may also provide stability for the patient's leg during a surgical procedure.

(26) In yet another example, one or more attachment mechanisms **62** can be coupled to any of the above elements of the pelvic binder **10** and can be configured to be coupled to one or more restraints. For example, restraints can be coupled to the attachment mechanisms **62** and further coupled to a hospital bed or other structure to help restrain the patient.

(27) The attachment mechanisms **62** can also be configured to be coupled to other attachments not specifically described herein. In some embodiments, the attachment mechanisms **62** can be clips, buttons, snaps, buckles, hooks, or other fasteners. Furthermore, in some embodiments, the attachment mechanisms **62** may act as universal attachment mechanisms (e.g., be uniform in type, size, and/or shape) so that any potential attachment (e.g., vascular access device, splint, restraints, etc.) only need an equivalent mating attachment mechanism to be compatible with the pelvic binder **10**. In other embodiments, different attachment mechanisms **62** may be coupled to different portions of the pelvic binder **10**.

(28) In some embodiments, the pelvic binder **10** can further comprise one or more loops **64** coupled to and extending below the second strap **14** (e.g., the horizontal section **32** of the second strap **14**). For example, two loops **64** can be coupled to the second strap **14** and configured to wrap around the buttocks of the patient (e.g., similar to a jock strap). In some embodiments, each loop **64** can be permanently or removably coupled to the horizontal section **32** of the second strap **14** (e.g., a posterior end of the second strap **14**) and permanently or removably coupled to an anterior portion of the second strap **14**. As a result, the loops **64** can provide additional stabilization and, in some embodiments, can also prevent migration of a traction splint attachment. For example, in a trauma setting, a splint on the leg should provide traction (e.g., pulling the foot down away from the pelvis). This force would generally cause a pelvic binder to ride up higher on the patient, rather than allow the binder in a desired position for pelvic stability. In some embodiments, the loops **64**

can prevent the pelvic binder **10** from riding up higher on the patient by anchoring the pelvic binder **10** to the buttocks.

(29) Accordingly, the pelvic binder **10** of FIGS. **1** and **2** can provide compression for pelvic fractures and is configured to distribute loads across its superior and inferior borders in order to leave body regions free for CFV or CFA access or abdominal access for midline laparotomies or preperitoneal packing. The pelvic binder **10** can further serve as a base for a traction splint (e.g., for femur fractures), an autonomous vascular access device (to assist vascular access), restraints, and/or other attachments.

(30) Referring now to FIG. **3**, a pelvic binder **100** according to another embodiment of the present disclosure is shown. For example, the pelvic binder **100** can be fastened around the pelvis **200**, as shown in FIG. **4**. Similar to the pelvic binder **10** of FIGS. **1** and **2**, the pelvic binder **100** can be adjusted to allow for variable pelvic region sizes and can provide stabilization for a variety of pelvic fractures while permitting access to various regions for medical procedures. For example, the pelvic binder **100** can be fastened around the patient to allow access to a plurality of locations on the patient including the femoral vessels, anterior abdomen, and/or lower extremities.

(31) In some embodiments, the pelvic binder **100** can comprise a first strap **102**, a second strap **104**, a fastening mechanism **106**, a first supporting member **108**, and a second supporting member **110**. Generally, the first strap **102** and the second strap **104** can be configured to substantially surround the patient at a first location **112** and a second location **114**, respectively, adjacent the pelvis **200**. Also, the first strap **102** and the second strap **104** can be fastened around the pelvis **200** by the fastening mechanism **106**. More specifically, the fastening mechanism **106** can pull each respective strap **102**, **104** toward itself to tighten the pelvic binder **100** around the pelvis.

(32) In some embodiments, the first strap **102** can extend around the pelvis in a substantially horizontal orientation and can be configured to extend around the patient adjacent the ASIS **22**. The first strap **102** can include a single, integral strap, or can include two or more straps coupled together (e.g., at the first supporting member **108**, the second supporting member **110**, and/or other locations). Similarly, the second strap **104** can extend around the pelvis in a substantially horizontal orientation and can be located below the first strap **102**. The second strap **104** can include a single, integral strap, or can include two or more straps coupled together (e.g., at the first supporting member **108**, the second supporting member **110**, and/or other locations). In some embodiments, the first strap **102** and the second strap **104** can be configured to be positioned vertically equidistant from the greater trochanters **36** of the patient. As such, the pelvic binder **100** is generally centered over the greater trochanters **36** to stabilize the pelvis.

(33) As described above, the pelvic binder **100** can include the first supporting member **108** and the second supporting member **110**. More specifically, the first supporting member **108** can be coupled between the first strap **102** and the second strap **104** and can be configured to be positioned adjacent the first side **28** of the patient (e.g., a right or left side of the patient adjacent the ASIS **22**). The second supporting member **110** can be coupled between the first strap **102** and the second strap **104** and can be configured to be positioned adjacent the second, opposite side **30** of the patient (e.g., the opposite left or right side of the position adjacent the ASIS **22**). Accordingly, as shown in FIGS. **3** and **4**, the first supporting member **108** and the second supporting member **110** can be substantially vertical in orientation. In some embodiments, the first supporting member **108** and the second supporting member **110** can each be coupled to or integral with a back panel of the pelvic binder **10** (that is, along the posterior of the pelvic binder **10**) and the first strap **102** and the second strap **104** can extend from the first supporting member **108** to the second supporting member **110** along the anterior of the pelvic binder **10**.

(34) Furthermore, the fastening mechanism **106** can fasten together the first and second straps **102**, **104**. In some embodiments, the fastening mechanism **106** can include a first member **116**, a second member **118**, and one or more adjustable fasteners **120**. The first member **116** can be coupled between the first strap **102** and the second strap **104** on the first side **28** of the patient (e.g., to the

right of the patient's midline). The second member **118** can be coupled between the first strap **102** and the second strap **104** on the second side **30** of the patient (e.g., to the left of the patient's midline). For example, the first strap **102** can be configured to wrap around the patient and terminate at the first and second members **124**, **126**. Similarly, the second strap **104** can be configured to wrap around the patient and terminate at the first and second members **124**, **126**.

(35) The adjustable fastener **120** can be coupled to the first member **116** and the second member **118** and configured to pull the first member **116** towards the second member **118** to tighten and secure the pelvic binder **100** around the pelvis **200**. The adjustable fastener **120** can therefore adjust the pelvic binder **100** so that it can be configured for a variety of sizes of pelvic bones and pelvic fractures. In some embodiments, the adjustable fastener **120** may be a belt-like structure (e.g., with two straps each coupled to a respective member **116**, **118** and a buckle configured to tighten and secure the straps together). However, other adjustable fasteners may be contemplated in some embodiments (e.g., buckle clips with adjustable straps, pulley systems, clicking belt locks, or other fastening mechanisms). Furthermore, while three adjustable fasteners **120** are shown in FIGS. **3** and **4**, some embodiments may include a single fastener **120**, two fasteners **120**, or more than three fasteners **120**.

(36) Generally, the straps **102**, **104**, the supporting members **108**, **110**, and the fastening mechanism **106** can enable the pelvic binder **100** to distribute loads across, for example, its superior and inferior borders (e.g., the first strap **102** and the second strap **104**) to provide sufficient pelvic compression while still leaving areas of the pelvic region accessible for medical procedures. For example, the pelvic binder **100** can include a first opening **122** defined between the first strap **102**, the second strap **104**, the first supporting member **108**, and the fastening mechanism **106**. Access to one of the femoral artery **58** and the femoral vein **60** along the first side **28** of the patient can be permitted via the first opening **122**. The pelvic binder **100** can further comprise a second opening **124** defined between the first strap **102**, the second strap **104**, the second supporting member **110**, and the fastening mechanism **106**. The second opening **124** can permit access to one of the femoral artery **58** and the femoral vein **60** along the second side **30** of the patient.

(37) The openings **122**, **124** can be sized to encompass the general access area needed for reliable CFA/CFV access (as described above), while still permitting the pelvic binder **100** to maintain stability of the pelvis without requiring modification of the pelvic binder **100**. Furthermore, such vascular access can be obtained by a medical professional or an autonomous vascular device configured to be attached to the pelvic binder **100** or the patient directly. Accordingly, the pelvic binder **100** can permit vascular access for, for example, central venous line insertion or REBOA procedures, as described above. Additionally, to better accommodate interventional radiology procedures (such as REBOA), the pelvic binder **10** can be made of radiolucent material in some embodiments.

(38) The pelvic binder **100** can also provide abdominal access for midline laparotomies or preperitoneal packing while maintaining stability of the pelvis. For example, one of the plurality of fasteners **120** can be unfastened for such access without compromising the structural stability of the pelvis, as the other fasteners **120** can remain fastened to provide sufficient pressure for such stability. In one example, access to perform a laparotomy or pelvic packing can be provided by unfastening the top-most fastener **120** while keeping the middle and lower fasteners **120** secured. In another example, access to place a Foley catheter can be provided by unfastening the bottom-most fastener **120** while keeping the middle and upper fasteners **120** secured.

(39) Additionally, one or more of the first strap **102**, the second strap **104**, the first supporting member **108**, and the second supporting member **110** can include one or more attachment mechanisms (not shown) configured to couple an attachment to the pelvic binder **100**, similar to that described above with respect to the attachment mechanisms **62** of pelvic binder **10** of FIGS. **1** and **2**. As such, the pelvic binder **100** can be attached to, for example, a traction splint, an autonomous vascular access device, restraints, and/or other attachments.

(40) Accordingly, the pelvic binder **100** of FIGS. **3** and **4** can provide compression for pelvic fractures and is configured to distribute loads across its superior and inferior borders in order to leave body regions free for CFV or CFA access or abdominal access for midline laparotomies or preperitoneal packing. The pelvic binder **100** can further serve as a base for a traction splint (e.g., for femur fractures), an autonomous vascular access device (to assist vascular access), restraints, and/or other attachments.

(41) Referring now to FIGS. **5-7**, a pelvic binder **10a**, according to some embodiments, is illustrated. FIG. **6** illustrates the pelvic binder **10a** around a pelvis **200** of a patient (e.g., showing a portion of the patient's skeleton to illustrate a location of the pelvic binder **10a** during use). Generally, in some embodiments, the pelvic binder **10a** may comprise a first strap **12**, a second strap **14**, a fastening member **70**, a first supporting member **18**, and a second supporting member **20**. The first strap **12** can be configured to substantially surround the patient at a first location **13** adjacent to the pelvis **200**. For example, as shown in FIGS. **5** and **6**, the first strap **12** can be configured to extend around the patient at or near the anterior superior iliac spine (ASIS) **22**. Furthermore, the second strap **14** can be configured to surround the patient at a second location **15** adjacent to the pelvis (e.g., below the first strap **12**), as shown in FIGS. **5-7**, similar to the second strap **12** of the pelvic binder **10** of FIGS. **1** and **2**. Additionally, in some embodiments, the straps **12**, **14** can be routed through a back panel.

(42) In some embodiments, the first strap **12** can include a first horizontal section **24** and a second angled section **26**. The first horizontal section **24** can be configured to be positioned adjacent a back side of the patient, and the second angled section **26** can be configured to be positioned adjacent a front side of the patient. As such, the first horizontal section **24** and the second angled section **26** can meet at points adjacent to a first and second side **28**, **30** of the patient. Additionally, in some embodiments, the first horizontal section **24** and the second angled section **26** can form a single integral strap, or can be composed of two or more separate straps coupled together at the patient's sides **28**, **30** (and/or other locations). Similarly, the second strap **14** can include a first horizontal section **32** configured to be positioned adjacent a back side of the patient and a second angled section **34** configured to be positioned adjacent a front side of the patient. The first horizontal section **32** and the second angled section **34** can meet adjacent the first and second sides **28**, **30**, and can be separate pieces coupled together or can form an integral strap. Furthermore, in some embodiments, as shown in FIG. **6**, the first horizontal section **24** and the first horizontal section **32** of the straps **12**, **14** can be configured to be positioned vertically equidistant from the greater trochanters **36** of the patient. As such, the pelvic binder **10a** is generally centered over the greater trochanters **36** to stabilize the pelvis.

(43) Referring still to FIGS. **5-7**, similar to the supporting members **18**, **20** of the pelvic binder **10** of FIGS. **1** and **2**, the first supporting member **18** can be coupled between the first strap **12** and the second strap **14** and can be configured to be positioned adjacent a first side **28** of the patient (e.g., a right side of the patient adjacent the ASIS **22**) in a substantially vertical orientation. The second supporting member **20** can be coupled between the first strap **12** and the second strap **14** and can be configured to be positioned adjacent a second, opposite side **30** of the patient (e.g., a left side of the patient adjacent the ASIS **22**) in a substantially vertical orientation. Additionally, in some embodiments, the respective first horizontal sections **24**, **32** and second angled sections **26**, **34** of the first strap **12** and the second strap **14** can meet at the first supporting member **18** along the first side **28** and the second supporting member **20** along the second side **30**, respectively. Furthermore, the first supporting member **18** and the second supporting member **20** can be sufficiently rigid to maintain a vertical distance between the first strap **12** and the second strap **14** for proper positioning of the pelvic binder **10** on the patient.

(44) Furthermore, the fastening member **70** can act as a fastening mechanism of the pelvic binder **10a** to fasten together the first and second straps **12**, **14**. More specifically, the pelvic binder **10a** can be tightened or loosed around a patient by adjusting the fastening member **70**, and the second

angled sections **26**, **34** of the straps **12**, **14** can each be coupled to the fastening member **70** to provide adjustable structural stability to a fractured pelvis. For example, in some embodiments, the fastening member **70** can include a first member **72**, a second member **74**, and one or more adjustable fasteners **120**. The first member **72** can be coupled between the first strap **12** and the second strap **14** on the first side **28** of the patient (e.g., to the right of the patient's midline). The second member **74** can be coupled between the first strap **12** and the second strap **14** on the second side **28** of the patient (e.g., to the left of the patient's midline). The adjustable fastener **120** can be similar to the adjustable fastener **120** as described above with respect to FIGS. **3** and **4** and can be configured to pull the members **72**, **74** toward each other when tightened. This adjustment can tighten the pelvic binder **10a** around the pelvis, thus providing structural stability. Furthermore, the adjustability allows for stabilizing pelvic bones of different shapes and sizes according to the size and age of the patient. Additionally, the fastening member **70** can generally be configured to be positioned adjacent to and extend below the pubic tubercles **38** (or pubic symphysis **50**) of the patient to permit access to the abdomen for medical procedures, as further described below.

(45) As shown in FIGS. **5-7**, the fastening member **70** generally separates two portions of the second angled sections **26**, **34** of the first strap **12** and the second strap **14**. More specifically, with respect to the first strap **12**, the second angled section **26** can include a first portion **40** that extends diagonally from the first supporting member **18** to the first member **72** of the fastening member **70** and a second portion **42** that extends diagonally from the second supporting member **20** to the second member **74** of the fastening member **70**. The first portion **40** and the second portion **42** are each configured to be angled downward from a respective supporting member **18**, **20** to the fastening member **70**, thus generally forming a “v” shape. With respect to the second strap **14**, the second angled section **34** can include a first portion **44** that extends diagonally from the first supporting member **18** to the first member **72** of the fastening member **70** and a second portion **46** that extends diagonally from the second supporting member **20** to the second member **74** of the fastening member **70**. The first portion **44** and the second portion **46** are each configured to be angled upward from a respective supporting member **18**, **20** to the fastening member **70**, thus generally forming an inverted “v” shape. In some embodiments, however, the second angled section of the second strap **14** may be substantially horizontal, so that only the first strap **12** (e.g., the top strap) includes angled portions.

(46) The pelvic binder **10a** can further include one or more adjustable straps **84** configured to extend around the back of the patient and act as a secondary fastening mechanism. As shown in FIGS. **5-7**, the straps **84** can extend through the supporting members **18**, **20** along the sides of the pelvic binder **10a** as well as the back panel. When the pelvic binder **10a** is placed around a patient, a medical professional can pull tail portions **82** of the straps **84** to remove extra slack in the straps **84** around the patient's back for tightening the pelvic binder **10a**. While three adjustable straps **84** are shown in FIGS. **5-7**, some embodiments can include one, two, or more than three adjustable straps **84**.

(47) The straps **84** can contribute to tightening of the pelvic binder **10a** in addition to the above-described fastening member **70**. As a result, the pelvic binder **10a** can include both posterior tightening (via the posterior straps **84**) and anterior tightening (via the anterior fastening member **70**) to achieve proper compression for pelvic stabilization. In one example, the straps **84** can be tightened first to remove slack in the back, and then the fastening member **70** can be tightened in the front. In addition, as the pelvic binder **10a** is tightened from the posterior and anterior, the angled sections **26**, **34** of the first and second straps **12**, **14** can be pulled together rather than cinched inward (as they are in the pelvic binder **10** of FIGS. **1-2**). As a result, in some embodiments, the angled sections **26**, **34** can be substantially rigid (e.g., more rigid than those of the pelvic binder **10** of FIGS. **1-2**). In another example, the straps **84** can be used as a secondary tightening mechanism when the fastening member **70** is tightened as much as possible and the overall circumference of the pelvic binder **10a** is still too large (that is, the pelvic binder **10a** is still

not tight enough around the patient's pelvis for proper compression and stabilization). In some embodiments, the straps **84** can include locking mechanisms (not shown) to maintain the straps **84** in position when tightened. For example, the straps **84** can include ratcheting mechanisms, buckles, or other suitable locking mechanisms to keep the straps **84** in a tightened position when pulled.

(48) Generally, the straps **12**, **14**, the supporting members **18**, **20**, and the fastening mechanisms can enable the pelvic binder **10** to distribute loads across, for example, its superior and inferior borders (e.g., the first strap **12** and the second strap **14**) to provide sufficient pelvic compression while still leaving areas of pelvic region accessible for medical procedures. For example, as shown in FIGS. 5-7, similar to the pelvic binder **10** of FIGS. 1-2, the pelvic binder **10a** can include an open region **48** partially defined between the first portion **40** and the second portion **42** of the first strap **12** (e.g., inside the "v" shape). This open region **48** can permit access to the abdomen adjacent the pubic symphysis **50** of the patient for, e.g., a midline laparotomy procedure or preperitoneal packing. The open region **48** provides access for such procedures while maintaining stability of the pelvis, that is, without requiring modification of the pelvic binder **10a**, such as loosening, moving, or removing any straps. Accordingly, the pelvic binder **10a** generally does not extend above or over the pubic symphysis **50** to allow access to the open region **48**. Furthermore, access to the urethra for Foley catheter insertion can be available beneath the pelvic binder **10**.

(49) Additionally, in some embodiments, the pelvic binder **10a** can include a first opening **52** defined between the first strap **12**, the second strap **14**, the fastening member **70**, and the first supporting member **18**. The pelvic binder **10a** can also include a second opening **54** defined between the first strap **12**, the second strap **14**, the fastening member **70**, and the second supporting member **20**. The openings **52**, **54** can each permit access to one of the common femoral artery and the common femoral vein along the first side **28** or the second side **30** of the patient, respectively. The openings **52**, **54** provide access for such procedures while maintaining stability of the pelvis, that is, without requiring modification of the pelvic binder **10a**, such as loosening, moving, or removing any straps or material. For example, FIG. 6 illustrates accessible locations **58**, **60** of the femoral artery and femoral vein, respectively, within the second opening **54**. Furthermore, such vascular access can be obtained by a medical professional or an autonomous device (as described above with respect to the pelvic binder **10** of FIGS. 1 and 2).

(50) As described above, vascular access during pelvic stabilization can be beneficial to permit, for example, central venous line insertion or REBOA procedures. The pelvic binder **10a** of some embodiments, by providing the openings **52**, **54**, is thus REBOA-compatible. Additionally, in some embodiments, to better accommodate interventional radiology procedures (such as REBOA, angiography, or endovascular embolization), the pelvic binder **10a** can be made of radiolucent material.

(51) In some embodiments, as shown in FIG. 7, the pelvic binder **10a** can further comprise one or more loops **64** coupled to and extending below the second strap **14** (e.g., at least the horizontal section **32** of the second strap **14**). For example, similar to the loops **64** described above with respect to the pelvic binder **10** of FIG. 1, two loops **64** can be coupled to the second strap **14** and configured to wrap around the buttocks of the patient (e.g., similar to a jock strap). Each of the loops **64** can run from a posterior lateral part of the pelvic binder **10a** to the anterior, medial part of the pelvic binder **10a**. As a result, the loops **64** can provide additional stabilization and, in some embodiments, can also prevent migration of a traction splint attachment.

(52) In some embodiments, one or more of the first strap **12**, the second strap **14**, the first supporting member **18**, and the second supporting member **20** can include one or more attachment mechanisms **62** configured to couple an attachment to the pelvic binder **10a**. These attachment mechanisms **62** can be similar to those described above with respect to FIG. 1 and can act as docking sites for different attachments (such as adjuncts for resuscitation). As such, any of the above-described attachments (e.g., vascular access device, femoral traction splint, restraints, etc.), can be coupled to the attachment mechanisms **62** of the pelvic binder **10a**.

(53) Accordingly, similar to the pelvic binder **10** of FIGS. **1-2**, the pelvic binder **10a** of FIGS. **5-7** can provide compression for pelvic fractures and is configured to distribute loads across its superior and inferior borders in order to leave body regions free for CFV or CFA access or abdominal access for midline laparotomies or preperitoneal packing. The pelvic binder **10a** can further serve as a base for a traction splint (e.g., for femur fractures), an autonomous vascular access device (to assist vascular access), restraints, and/or other attachments.

(54) It will be appreciated by those skilled in the art that while the invention has been described above in connection with particular embodiments and examples, the invention is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein. Various features and advantages of the invention are set forth in the following claims.

Claims

1. A device used for stabilizing the pelvis of a patient, the device comprising: a first strap configured to substantially surround the patient at a first location adjacent the pelvis, the first strap including: a first horizontal section configured to be positioned adjacent a back side of the patient, and a second angled section configured to be positioned adjacent a front side of the patient; a second strap configured to substantially surround the patient at a second location adjacent the pelvis and below the first strap, the second strap including: a first horizontal section configured to be positioned adjacent the back side of the patient, and a second angled section configured to be positioned adjacent the front side of the patient, wherein the first horizontal section of the first strap and the first horizontal section of the second strap are configured to be positioned vertically equidistant from greater trochanters of the patient; and a third strap positioned between the first strap and the second strap and coupled to the second angled sections of the first strap and the second strap.
2. The device of claim 1 and further comprising a first supporting member coupled between the first strap and the second strap and configured to be positioned adjacent a first side of the patient adjacent the anterior superior iliac spine.
3. The device of claim 2 and further comprising a second supporting member coupled between the first strap and the second strap and configured to be positioned adjacent a second, opposite side of the patient adjacent the anterior superior iliac spine.
4. The device of claim 3, wherein the first horizontal section and the second angled section of the first strap are configured to meet at the first supporting member along the first side of the patient and the second supporting member along the second side of the patient.
5. The device of claim 3, wherein at least one of the first strap, the second strap, the first supporting member, and the second supporting member includes an attachment mechanism.
6. The device of claim 5, wherein the attachment mechanism is coupled to one of the first strap and the second strap and is configured to be coupled to a vascular access device configured to access one of the femoral artery and the femoral vein of the patient when the device is positioned around the pelvis.
7. The device of claim 5, wherein the attachment mechanism is coupled to one of the first supporting member and the second supporting member and is configured to be coupled to a femoral traction splint.
8. The device of claim 3, wherein the second angled section of the first strap includes a first portion that extends diagonally from the first supporting member to the third strap and a second portion that extends diagonally from the second supporting member to the third strap.
9. The device of claim 8 and further comprising an open region partially defined between the first

portion and the second portion configured for permitting access to the pubic symphysis of the patient for a midline laparotomy procedure when the device is positioned around the pelvis.

10. The device of claim 3 and further comprising a first opening defined between the first strap, the second strap, the third strap, and the first supporting member, the first opening configured for permitting access to one of the femoral artery and the femoral vein along the first side of the patient.

11. The device of claim 3 and further comprising a second opening defined between the first strap, the second strap, the third strap, and the second supporting member, the second opening configured for permitting access to one of the femoral artery and the femoral vein along the second side of the patient when the device is positioned around the pelvis.

12. The device of claim 1, wherein the third strap is adjustable and configured to pull the first strap and the second strap toward each other to form the second angled sections of the first strap and the second strap and to tighten the device around the pelvis.

13. The device of claim 1, wherein the third strap is removably coupled to at least one of the first strap and the second strap.

14. The device of claim 1, wherein the third strap is configured to be positioned adjacent to and extend below the pubic tubercles of the patient.

15. The device of claim 1, wherein the first horizontal section of the first strap and the first horizontal section of the second strap are configured to be positioned vertically equidistant from the greater trochanter of the patient when the device is positioned around the pelvis.

16. The device of claim 1 and further comprising a loop coupled to and extending below the second strap at an anterior location and a posterior location thereof, the loop configured to wrap around the buttocks of the patient when the device is positioned around the pelvis.

17. A device configured to be worn by a patient for stabilizing the pelvis of the patient, the device comprising: a first strap configured to substantially surround the patient at a first location adjacent the pelvis; a second strap configured to substantially surround the patient at a second location adjacent the pelvis below the first strap; a fastening mechanism configured to fasten the first strap and the second strap around the pelvis; a first supporting member coupled between the first strap and the second strap and configured to be positioned adjacent a first side of the patient adjacent the anterior superior iliac spine; a second supporting member coupled between the first strap and the second strap and configured to be positioned adjacent a second, opposite side of the patient adjacent the anterior superior iliac spine, wherein the second strap is configured to substantially surround the patient by extending directly from the first supporting member directly to the second supporting member; and a first opening defined between the first strap, the second strap, the first supporting member, and the fastening mechanism, first opening configured for permitting access to one of the femoral artery and the femoral vein along the first side of the patient.

18. The device of claim 17 and further comprising a second opening defined between the first strap, the second strap, the second supporting member, and the fastening mechanism, the second opening configured for permitting access to one of the femoral artery and the femoral vein along the second side of the patient.

19. The device of claim 17, wherein the fastening mechanism includes: a first member coupled between the first strap and the second strap along the first side of the patient, a second member coupled between the first strap and the second strap along the second side of the patient, and an adjustable fastener coupled to the first member and the second member and configured to pull the first member toward the second member to tighten the device around the pelvis.

20. The device of claim 17, wherein the fastening mechanism includes a third strap coupled to the first strap and the second strap, the third strap being adjustable and configured to pull the first strap and the second strap toward each other to tighten the device around the pelvis.

21. A device used for stabilizing the pelvis of a patient, the device comprising: a first strap configured to substantially surround the patient at a first location adjacent the pelvis, the first strap

including: a first horizontal section configured to be positioned around an entire back side of the patient, and a second angled section configured to be positioned adjacent a front side of the patient; a second strap configured to substantially surround the patient at a second location adjacent the pelvis and below the first strap, the second strap including: a first horizontal section configured to be positioned around the entire back side of the patient, and a second angled section configured to be positioned adjacent the front side of the patient; and a third strap positioned between the first strap and the second strap and coupled to the second angled sections of the first strap and the second strap.
