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(54) **SURGICAL SYSTEM AND METHOD INCLUDING CERCLAGE WITH LOOP**

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A61B 17/56 (2006.01)

(52) **U.S. Cl.**

CPC **A61B 17/82** (2013.01); **A61B 17/06166** (2013.01); **A61B 2017/564** (2013.01); **A61B 2017/567** (2013.01)

(58) **Field of Classification Search**

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See application file for complete search history.

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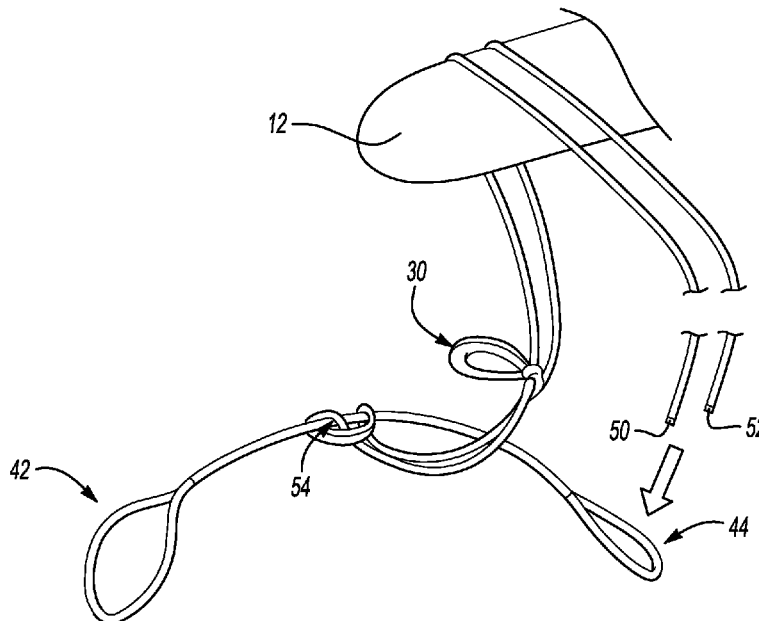
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(57) **ABSTRACT**

This disclosure details a surgical system and method, which is useful for treating an acromioclavicular (AC) joint. In an example, the disclosed system includes a cerclage which is provided relative to a coracoid process and which includes a loop. In that example, a clavicle is held relative to the coracoid process using a clavicle fixation assembly, which includes suture passed through the loop of the cerclage.

5 Claims, 6 Drawing Sheets



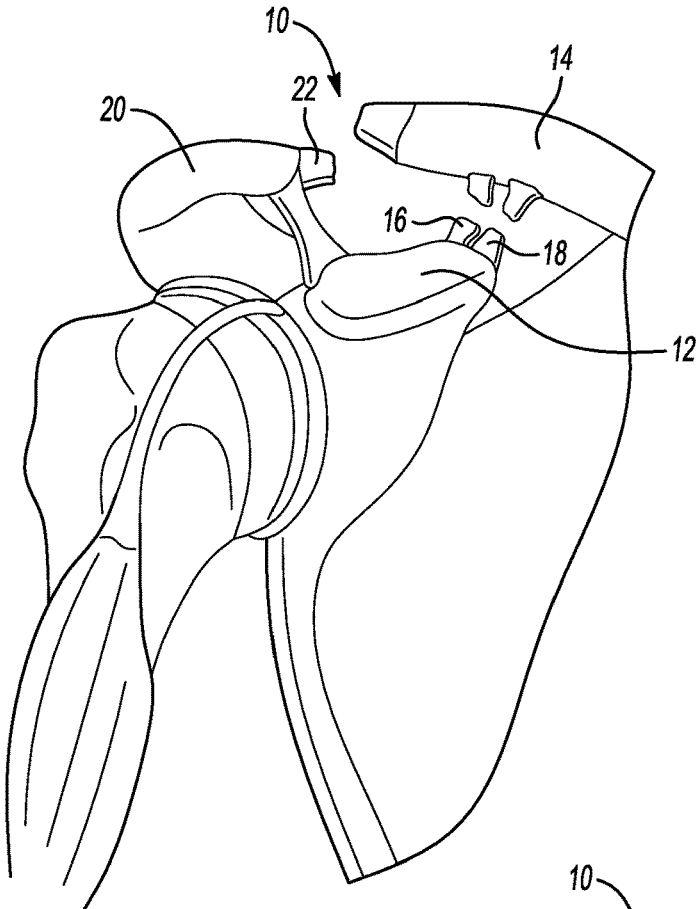


Fig-1

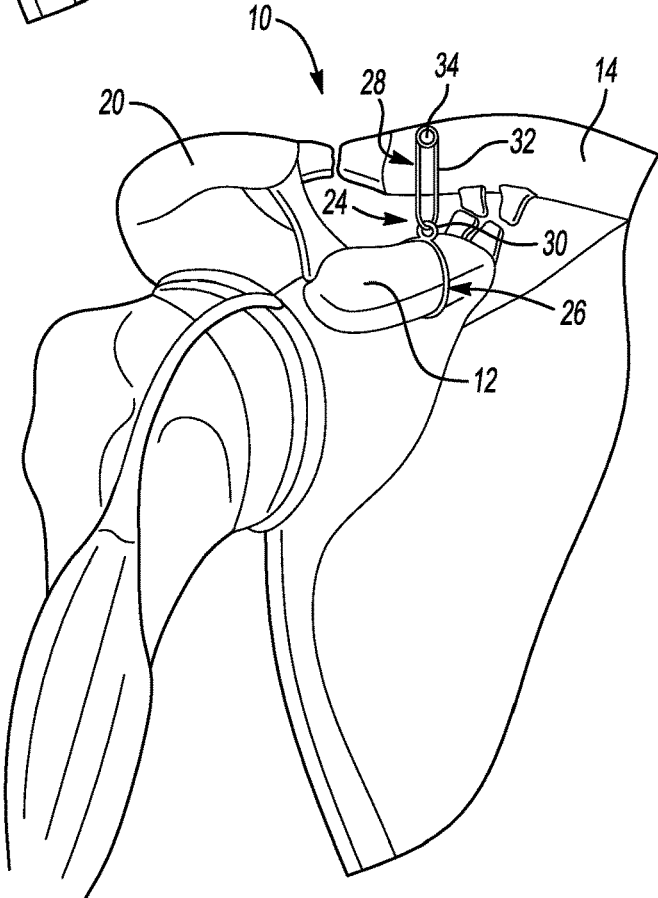


Fig-2

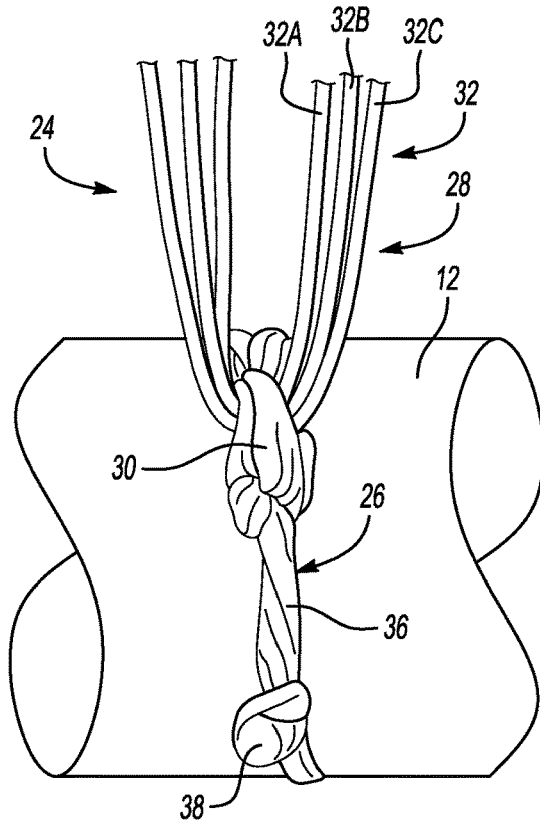


Fig-3

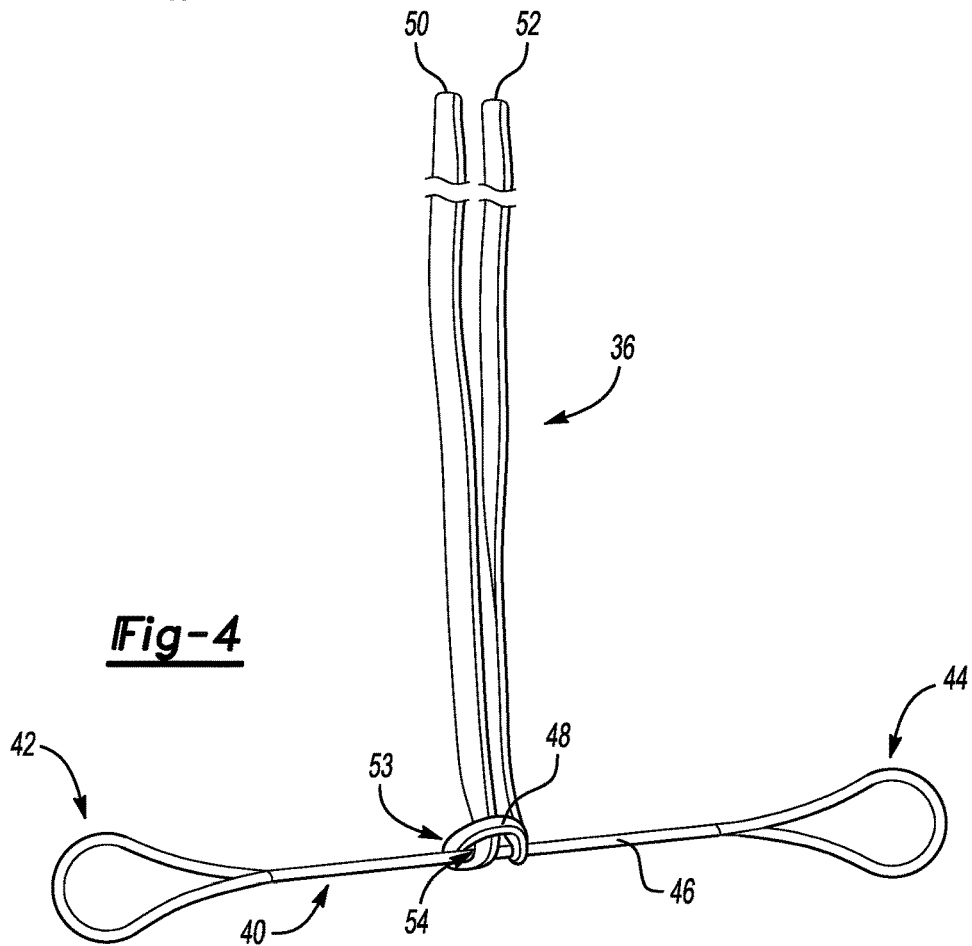


Fig-4

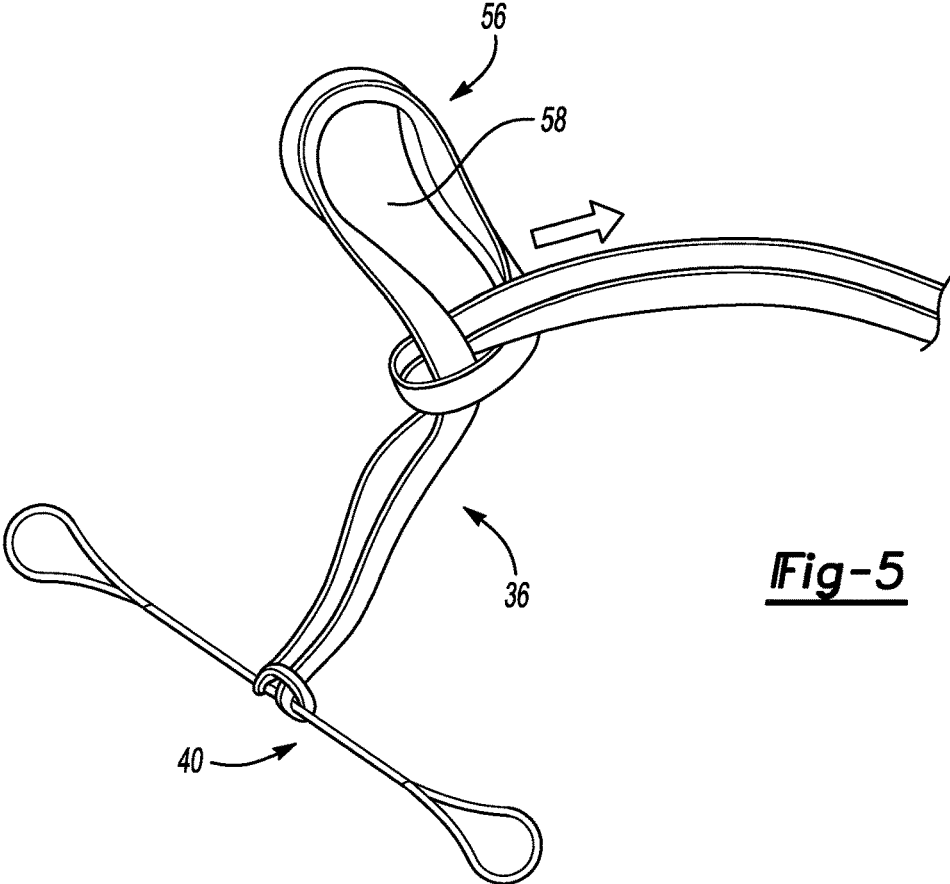


Fig-5

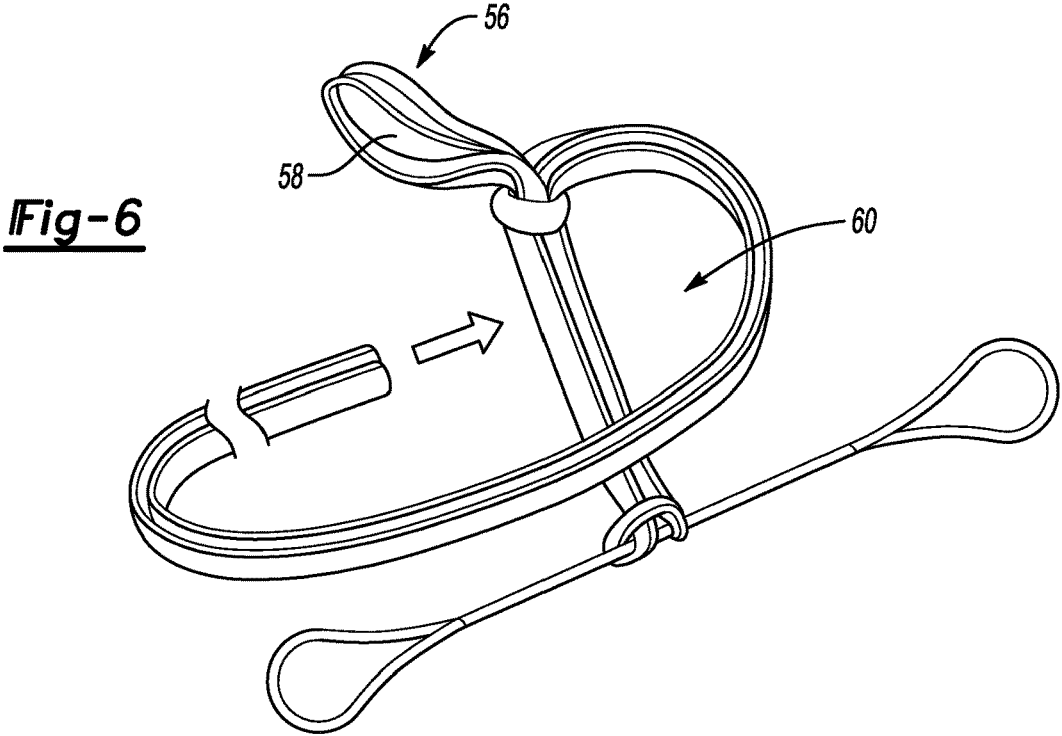
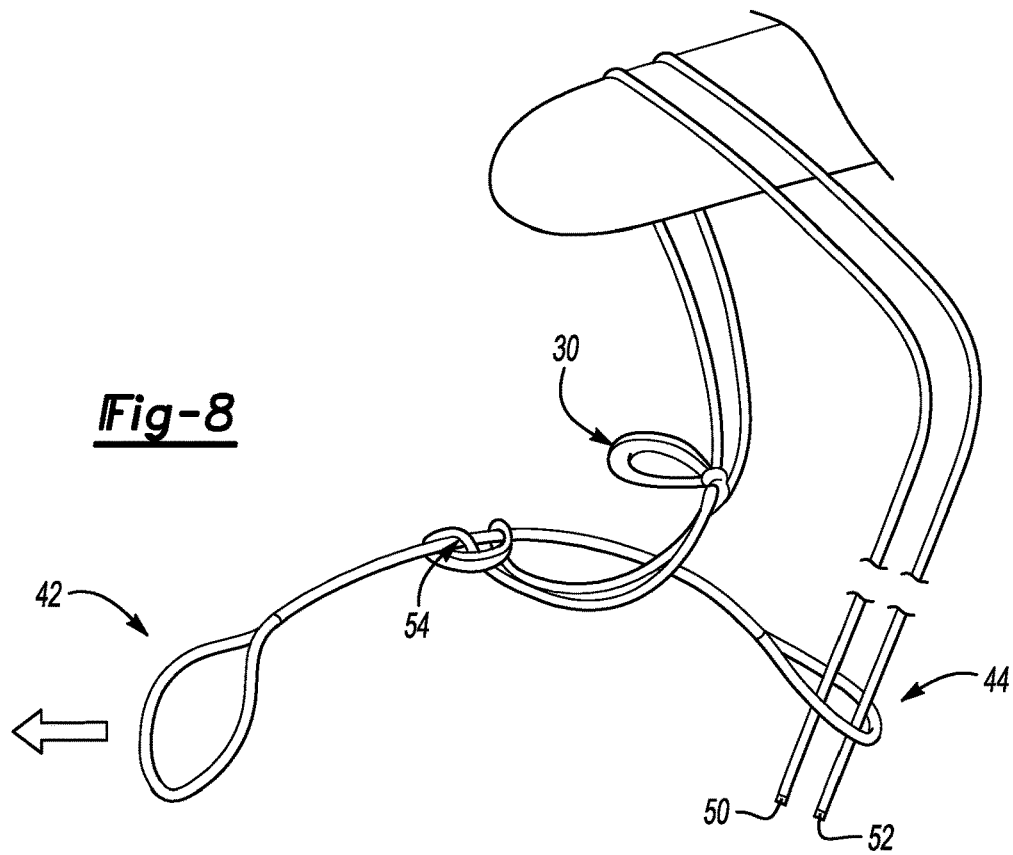
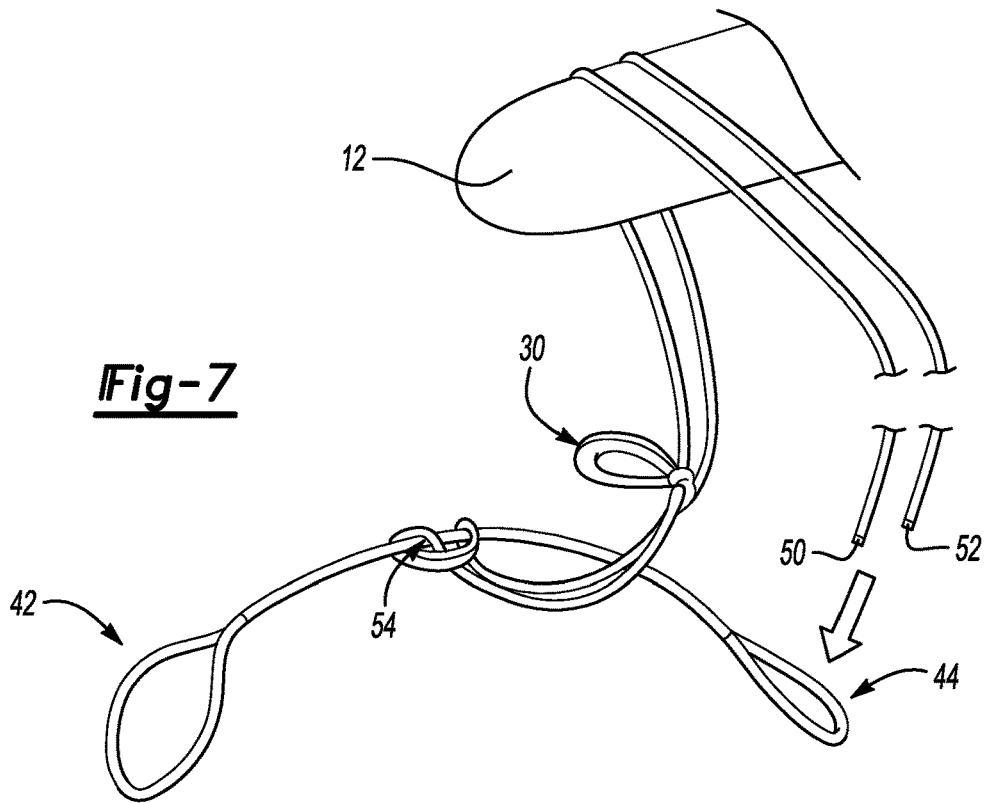


Fig-6



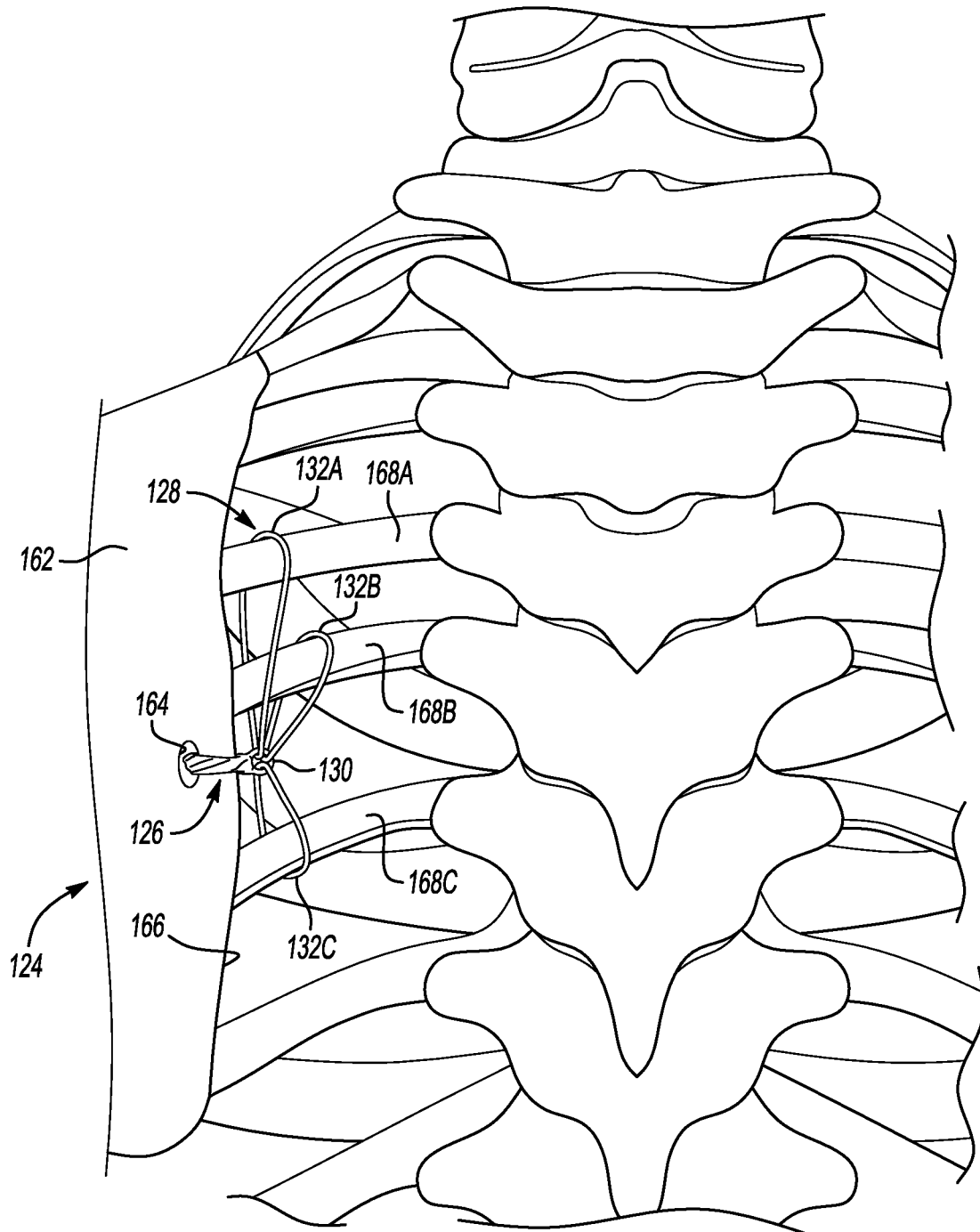


Fig-9

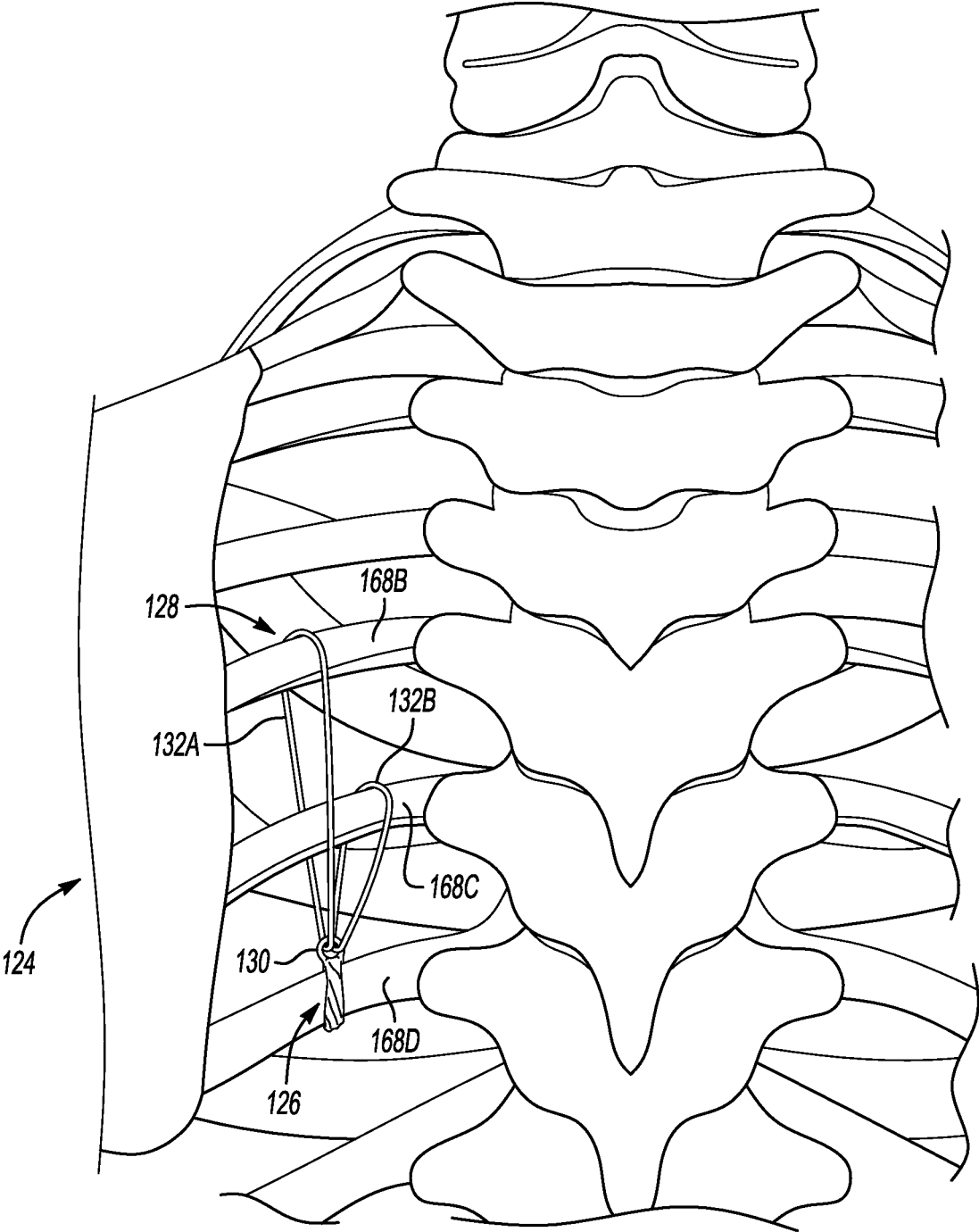


Fig-10

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SURGICAL SYSTEM AND METHOD INCLUDING CERCLAGE WITH LOOP

BACKGROUND

Cerclages are sometimes used to maintain the relative position of fractured bone fragments to promote healing. Known cerclages include materials such as cable (i.e., wire) or fabric, and are provided by wrapping the cable or fabric around a fractured bone. After wrapping, the cable or fabric is then locked into place relative to the bone, such as with a plug or clip.

SUMMARY

This disclosure details a surgical system and method including a cerclage with a loop. The system and method is useful in treating various displaced, dislocated, cut, and/or fractured bones. The system and method is useful in treating an acromioclavicular (AC) joint. In an example, the disclosed system includes a cerclage which is provided relative to a coracoid process and which includes a loop. In that example, a clavicle is held relative to the coracoid process using a clavicle fixation assembly, which includes suture passed through the loop of the cerclage.

The cerclage is a separate, dedicated assembly provided about a bone, such as the coracoid process, and is connectable to other assemblies, such as a clavicle fixation assembly, via the loop. As such, assemblies connected to the cerclage via the loop can be adjusted independent of the cerclage. Further, in an example, the cerclage can be installed around the coracoid process before the clavicle is positioned using the clavicle fixation assembly. In this way, the clavicle can be positioned by passing or sliding suture through the loop of the cerclage without requiring a surgeon to balance simultaneous installation of the cerclage and the clavicle fixation assembly.

A system configured for treatment of an acromioclavicular (AC) joint according to an exemplary aspect of the present disclosure includes, among other things, a cerclage configured to be arranged about a coracoid process. The cerclage includes a loop.

A method for treatment of an acromioclavicular (AC) joint according to an exemplary aspect of the present disclosure includes, among other things, providing a cerclage about a coracoid process such that the cerclage includes a loop, and passing a portion of a clavicle fixation assembly through the loop.

Another method according to an exemplary aspect of the present disclosure includes, among other things, providing a cerclage about a first bone such that the cerclage includes a loop, passing a strand of suture through the loop, tensioning the strand of suture, and fixing the strand of suture relative to a second bone to hold a relative position of the first and second bones.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a partial view of a shoulder, and in particular an acromioclavicular (AC) joint, with torn ligaments.

FIG. 2 illustrates a similar view of a shoulder to FIG. 1, but in FIG. 2 an example system for treating the AC joint has been installed.

FIG. 3 is a partial, close-up view of the system for treating the AC joint of FIG. 2.

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FIG. 4 illustrates a step of an example method, and in particular illustrates a suture tied relative to a pull-through suture using a hitch knot.

FIG. 5 illustrates a step of the example method, and in particular illustrates the suture being tied into a first overhand knot.

FIG. 6 illustrates a step of the example method, and in particular illustrates the suture being tied into a second overhand knot.

FIG. 7 illustrates a step of the example method, and in particular illustrates free ends of the suture being inserted into a loop of the pull-through suture.

FIG. 8 illustrates a step of the example method, and in particular illustrates a force being applied to another loop of the pull-through suture such that the free ends are pulled through the hitch knot.

FIG. 9 illustrates a portion of a body including the thoracic spine from a posterior perspective, and in particular illustrates a system for providing a scapular fusion.

FIG. 10 illustrates the same portion of the body as FIG. 9, and in particular illustrates another system for treating a slipped or fractured rib.

DETAILED DESCRIPTION

This disclosure details a system and method, which is useful in treating an acromioclavicular (AC) joint. FIG. 1 is a view of an exemplary view of a shoulder, and in particular illustrates an AC joint **10** including a coracoid process **12** and a clavicle **14** superior to the coracoid process **12**. In a healthy AC joint, coracoclavicular ligaments **16**, **18** connect the coracoid process **12** to the clavicle **14**. The AC joint **10** further includes an acromion **20** lateral to the clavicle **14** and, in a healthy AC joint **10**, the acromion **20** is connected to the clavicle **14** by an acromioclavicular ligament **22**. In FIG. 1, each of the ligaments **16**, **18**, **22** is fully torn and, as such, the clavicle **14** is out of position relative to a healthy AC joint in which those ligaments are not torn. While three fully torn ligaments are shown in FIG. 1, this disclosure is useful in treating AC joints with other defects, such as AC joints with one or more ligaments that are worn, partially torn, or fully torn. Further, this disclosure can be used outside the context of the AC joint, and in particular can be used for sternal closures, for scapular fusions (FIG. 9), or for treating fractured or dislocated ribs (FIG. 10).

FIG. 2 illustrates a system **24** configured to treat an AC joint **10**. In FIG. 2, the system **24** is installed relative to the AC joint **10** and holds the clavicle **14** in a position substantially similar to that of a healthy AC joint in which the ligaments **16**, **18**, **22** are not torn.

The system **24** includes a cerclage **26** arranged about the coracoid process **12** and a clavicle fixation assembly **28** configured to hold the clavicle **14** in place relative to the coracoid process **12**. Further, the cerclage **26** includes a loop **30**, and a portion of the clavicle fixation assembly **28** is configured to pass through the loop **30**. The clavicle fixation assembly **28**, in this example, includes at least one strand of suture **32** passed through the loop **30** and a fixation device **34**, such as an anchor like those of the PushLock® or SwiveLock® offered commercially by Arthrex, Inc., insertable into the clavicle **14** and configured to hold the suture **32** and, in turn, to hold the clavicle **14** in place. The suture **32** may be fixed relative to the clavicle **14** using a fixation device **34** other than an anchor or using another technique altogether. The suture **32** may include multiple strands of suture. The suture **32** may also include one or more strands of suture which are attached to the acromion **20**. In this

regard, the term clavicle fixation assembly **28** is inclusive of sutures connected to other bones, such as the acromion.

FIG. **3** is a partial, close-up view of the system **24** arranged relative to the coracoid process **12**. As shown, the cerclage **26** is arranged about the coracoid process **12**. The cerclage **26** is tightened firmly against, and directly contacts, an outer surface of the coracoid process **12**. The cerclage **26** extends about the entirety of the coracoid process **12**. The cerclage **26**, in this example, is made of a strand of suture **36**.

In an example, the suture **36** forming the cerclage **26** is a high strength braided suture, such as Arthrex, Inc.'s Fiber-Tape®. The suture **36** may include a multifilament cover formed of a plurality of braided fibers of ultrahigh molecular weight polyethylene (UHMWPE) and fibers of polyester. The cover may surround a core formed of twisted fibers of ultrahigh molecular weight polyethylene (UHMWPE). Other types of suture come within the scope of this disclosure, however.

In FIG. **3**, the suture **32** of the clavicle fixation assembly **28** includes three strands of suture **32A-32C**, each passing through the loop **30**. The strands of suture **32A-32C** may be made of the same type of suture as the cerclage **26** or another type of suture. Each of the three strands of suture **32A-32C** is tensioned and fixed to either the cerclage **14** or the acromion **20** using a fixation device such as the fixation device **34**.

In the example of FIG. **3**, the loop **30**, which is a shape produced by a curve that bends around an crosses itself, is formed by tying the suture **36** in at least one knot. In this way, the cerclage **26** and loop **30** are both formed of the suture **36**, and the loop **30** is integrally formed with the cerclage **26**. The loop **30** could be provided by a separate structure, however, which may be attached to the cerclage **26** by being sewn into the cerclage or by using some other attachment technique. In an example, a rigid eyelet made of a high strength, rigid polymer is sewn into the suture **36** to provide the cerclage **26** with the loop **30**. In another example, a through-hole may be formed in the suture **36**, such as by punching, and the through-hole may provide the loop **30**. An eyelet or stitching may provide a boundary of the through-hole.

After arranging the cerclage **26** about the coracoid process **12**, the cerclage **26** is tightened, the loop **30** is arranged near a superior portion of the coracoid process **12**, and a knot **38** is tied to hold the cerclage **26** in place. The knot **38** may include one or more known types of knots, including surgical knots. The strands of suture **32A-32C** can pass freely through the loop **30** to position the clavicle **14** and/or acromion **20**.

While the term cerclage is often used to refer to rings or loops of material that bind together fractured bones, the cerclage **26** is arranged relative to a healthy coracoid process **12**, in this example. The cerclage **26** itself is a ring or loop arranged about the coracoid process **12**, which includes an additional loop **30**, which in turn is used to maintain a position of the clavicle **14** and/or the acromion **20** to treat and/or stabilize the same. Use of the term cerclage in this disclosure does not denote that the bone being cerclaged is fractured.

An example method of providing the cerclage **26** relative to the coracoid process **12**, including forming the loop **30**, will now be described. A surgeon may perform the method either partially or entirely. One or more steps of the method may be performed by a manufacturer or surgical assistant. The method may be performed either partially or entirely during an arthroscopic surgical procedure.

With reference to FIG. **4**, the suture **36** used for the cerclage **26** is provided and is arranged relative to a pull-through suture **40**. The pull-through suture **40** includes a first end loop **42** and a second end loop **44** opposite the first end loop. A main section **46** connects the first and second end loops **42, 44**. The pull-through suture **40** may be provided by a strand of suture, such as a monofilament suture, and in one example is a thinner suture than the suture **36**. The first and second end loops **42, 44** may be provided by splicing and/or stitching relative to the main section **46**. The use of the pull-through **40** suture will be described below. The pull-through suture **40** does not form part of the as-installed cerclage **26** and instead is only used during the process of installing the cerclage **26**.

In FIG. **4**, the suture **36** is folded such that it exhibits a folded end **48** and first and second free ends **50, 52**. The suture **36** is tied into a cow hitch knot **53** about the main section **46** of the pull-through suture **40**, in this example. While a cow hitch knot is mentioned, other types of knots, such as other types of hitch knots, may be used, however. The cow hitch knot **53** is arranged such that the suture **36** exhibits a pull-through loop **54** adjacent the main section **46**. Tying the cow hitch knot **53** relative to the pull-through suture **40** may be referred to as preloading the pull-through suture **40** into the pull-through loop **54**, since this step may be done pre-operatively or before wrapping the suture **36** around the coracoid process **12**.

Next, the suture **36** is tied to provide the loop **30**. As shown, the suture **36** exhibits two lengths between the folded end **48** and the first and second free ends **50, 52**. As represented in FIG. **5**, the lengths are held together and simultaneously tied, as one, into a first overhand knot **56**. Another type of knot may be used. The first overhand knot **56** is held loose such that it exhibits an opening **58** provided by two lengths of the suture **36**, which will ultimately form the opening of the loop **30**. The loop **30**, in this regard, is provided by two looped lengths of suture **36**, which provides a robust connection point for the clavicle fixation assembly **28**.

Next, as represented in FIG. **6**, another knot is tied adjacent the first overhand knot **56**. In FIG. **6**, a second overhand knot **60** is tied. The second overhand knot **60** is fully tightened adjacent the first overhand knot **56** to hold the opening **58** in place, such that the opening **58**, and in turn the loop **30**, is prevented from closing. Thus, additional suture, such as that of the clavicle fixation assembly **28**, can pass through the loop **30**.

As mentioned, one or more steps of the method may be performed before a surgical procedure. In a particular example, the steps represented by FIGS. **4-6** may be performed pre-operatively by a surgical assistant or a manufacturer.

Once the construct of FIGS. **4-6** is formed, the first and second free ends **50, 52** are passed around the coracoid process **12** during a surgical procedure, as generally shown in FIG. **7**. The first and second free ends **50, 52** are then inserted into one of the first or second end loops **42, 44**. In FIG. **7**, first and second free ends **50, 52** are both inserted into the second end loop **44**. Then, as represented in FIG. **8**, the surgeon applies a force to the first end loop **42** to pull the second end loop **44**, and in turn the first and second free ends **50, 52**, through the pull-through loop **54**. The first and second free ends **50, 52** are then further pulled in the same direction to tighten the cerclage **26** about the coracoid process **12**. The knot **38** is then tied and trimmed, if necessary.

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With the cerclage 26 in place, the clavicle fixation assembly 28 may then be installed, such as by passing the suture 32 through the loop 30, tensioning the suture 32 to provide a desired position of the clavicle 14 and/or acromion, and fixing the at least one suture 32 in place relative to the clavicle 14 and/or acromion 20. While an example method has been described, this disclosure extends to variations of the above-described method.

As mentioned above, this disclosure can be used outside the context of the AC joint. FIGS. 9 and 10 illustrate two such examples. FIGS. 9 and 10 illustrate a system 124 similar to the system 24 with like parts preappended with a "1." The system 124 is used relative to bones adjacent the thoracic spine.

With reference to FIG. 9, a cerclage 126 is provided relative to a scapula 162. The cerclage 126 is provided through a hole 164, which may be drilled, in the scapula 162 and is wrapped about a medial edge 166 of the scapula 162. The cerclage 126 is arranged such that the loop 130 projects medially of the medial edge 166. The cerclage 126 is formed and placed using a technique similar to that described above and shown relative to FIGS. 4-8. A fixation assembly 128 including a plurality of strands of suture 132A, 132B, 132C is used to apply tension to the scapula 162 and to hold the scapula 162 relative to ribs 168A, 168B, 168C, thereby providing a scapula fusion.

In another example, the system 124 may be used to treat a slipped or fractured rib. With reference to FIG. 10, the system 124 includes a cerclage 126 provided about a rib 168D which is either slipped or fractured. The cerclage 126 is formed and placed using a technique similar to that described above and shown relative to FIGS. 4-8, and the cerclage 126 is arranged about the rib 168D such that the loop 130 projects from the rib 168D in a direction, here a superior direction, toward other, healthy ribs 168B, 168C to which the fixation assembly 128 will attach. In this example, the fixation assembly 128 includes two stands of suture 132A, 132B passed through the loop 130 and attached to a respective one of the ribs 168B, 168C. Before being attached to the ribs 168B, 168C, the strands of suture 132A, 132B are tensioned to position the rib 168D in a desired position to promote healing.

It should be understood that directional terms such as superior, medial, and lateral are used herein consistent with their art-accepted meaning. These terms should not otherwise be considered limiting.

Although the different examples have the specific components shown in the illustrations, embodiments of this disclosure are not limited to those particular combinations. It is possible to use some of the components or features from one of the examples in combination with features or com-

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ponents from another one of the examples. In addition, the various FIGS. accompanying this disclosure are not necessarily to scale, and some features may be exaggerated or minimized to show certain details of a particular component or arrangement.

One of ordinary skill in this art would understand that the above-described embodiments are exemplary and non-limiting. That is, modifications of this disclosure would come within the scope of the claims. Accordingly, the following claims should be studied to determine their true scope and content.

The invention claimed is:

1. A method for treatment of an acromioclavicular (AC) joint, comprising:
 - providing a cerclage about a coracoid process such that the cerclage includes a loop, wherein the cerclage is provided by folding a first strand of suture to provide the first strand of suture with a folded end and first and second free ends, and wherein the loop is provided by tying the first strand of suture adjacent the folded end; and
 - passing a portion of a clavicle fixation assembly through the loop.
2. The method as recited in claim 1, further comprising:
 - tying the first strand of suture to provide a pull-through loop adjacent the folded end; and
 - pulling the first and second free ends through the pull-through loop to tighten the cerclage against an outer surface of the coracoid process.
3. The method as recited in claim 1, further comprising:
 - attaching a portion of the clavicle fixation assembly to a clavicle.
4. The method as recited in claim 3, wherein the portion of the clavicle fixation assembly includes a second strand of suture, and further comprising a step of positioning the clavicle relative to the coracoid process by applying force to the second strand of suture.
5. A method, comprising:
 - providing a cerclage about a first bone such that the cerclage includes a loop, wherein the cerclage is provided by folding a first strand of suture to provide the first strand of suture with a folded end and first and second free ends, and wherein the loop is provided by tying the first strand of suture adjacent the folded end; after the cerclage is formed, passing a second strand of suture through the loop;
 - tensioning the second strand of suture; and
 - fixing the second strand of suture relative to a second bone to hold a relative position of the first and second bones.

* * * * *