Shuttle Suture Technique for Passing Rotator Cuff Suture Through the Plate Eyelet Holes in Proximal Humerus Fixation

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Abstract: The proximal humerus fracture is common in both adult and elderly patients, with an incidence of approximately 5%, of whom about 1 in 4 is treated operatively. To achieve the healing of the fracture, the operative technique is combined with an internal fixation by a locking plate and tension band rotator cuff sutures by passing the sutures through each eyelet hole of the plate and tightening them. The tension band rotator cuff sutures provide good functional and radiographic outcomes in cases of proximal humerus fracture. The surgeons normally pass a rotator cuff suture through each eyelet hole using a curved needle which can pass only one suture in one eyelet hole. We propose a shuttle suture technique to easily pass the rotator cuff sutures through the eyelet holes of the locking plate.

Proximal humerus fracture is common in both adult and elderly patients, with an incidence of approximately 5%,1 of whom about 1 in 4 is treated operatively.2 To achieve the healing of the fracture, the operative technique is combined with an internal fixation by a locking plate and tension band rotator cuff sutures by passing the sutures through each eyelet hole of the plate and tightening them. Shukla et al.3 reported that augmenting the plate and screw fixation with tension band rotator cuff sutures provides good functional and radiographic outcomes in cases of proximal humerus fracture.

Augmentation with tension band rotator cuff sutures is an important surgical step following fracture fixation with a locking plate and locking screws. A biomechanical study found that the stability of the fracture fixation was increased by augmentation with tension band rotator cuff sutures, which reduced the tension force between the 2 parts of the fracture site.3 In addition, the tension band rotator cuff sutures transmit the forces of the fracture site to the locking plate and the humeral shaft. These sutures also can prevent displacement of the fracture during postoperative rehabilitation. The sutures augment the ability of the plate to stabilize the fracture by passing a rotator cuff suture through each eyelet hole using a curved needle, which normally can pass only one suture in one eyelet hole. In addition, it is difficult to pass through the eyelet hole if the eyelet hole is covered with soft tissue or a bony fragment. In this paper, we propose a shuttle suture technique to easily pass the rotator cuff sutures through the eyelet holes of the locking plate.

Surgical Technique (With Video Illustration)

The patient is set in a semisupine position on a radiolucent table and prepped and draped in a sterile fashion. Before starting the operation, shuttle sutures are inserted through the eyelet holes of a Proximal Humeral Internal Locking System (PHILOS) plate (Synthes, Zuchwil, Switzerland). To do this, a double length of ETHIBOND no. 2 (Ethicon, Somerville, NJ) is formed. The 2 tails of the ETHIBOND no. 2 are passed through an eyelet hole from the inferior to the superior part of the PHILOS plate (Fig 1A). The 2 tails of the
double loop are inserted through the loop end of the ETHIBOND no. 2 (Fig 1B) and pulled until the knot close to the eyelet hole (Fig 1C). A length of ETHIBOND no. 2 is inserted through each eyelet hole using the same procedure. The shuttle sutures on the same side of the PHILOS plate are gathered with a silk 2-0. Then, a stabilization pin of an aiming device is attached to the PHILOS plate (Fig 1D).

A deltopectoral approach is created with an incision through the skin and subcutaneous tissue. The cephalic vein is identified and retracted to the medial side. After the subdeltoid and subacromial spaces are reached, the fracture site is identified. Each ETHIBOND no. 5 is used to suture the subscapularis, supraspinatous, and infraspinatous tendons, respectively (Fig 2A and B). The fracture fragments are mobilized and reduced with standard rotator cuff sutures. Kirchner wires are inserted for temporary fixation and the reduction alignment is checked with a fluoroscope. The PHILOS plate is then applied 5 mm

**Fig 1.** The steps of passing the shuttle sutures through the eyelet holes of the PHILOS plate. (A) The 2 tails of the ETHIBOND no. 2 are passed through an eyelet hole from the inferior to the superior part of the PHILOS plate. (B) The 2 tails of the double loop are inserted through the loop end of the ETHIBOND no. 2 and (C) pulled until the knot is close to the eyelet hole. (D) Each ETHIBOND no. 2 is inserted through each eyelet hole following this step. (D) Shuttle sutures in the same side of the PHILOS plate is gathered with a silk 2-0, then, a stabilization pin of an aiming device is attached on the PHILOS plate.

**Fig 2.** Right shoulder in a semisupine position through deltopectoral approach. Each ETHIBOND no. 5 is used to suture the (A) subscapularis, (B) supraspinatus, and infraspinatous tendons, respectively.
distally to the top of the greater tuberosity and slightly posterior to the bicipital groove. After good alignment is achieved, the fracture is fixed with locking screws. The next step is to augment the rotator cuff sutures to the eyelet holes of the PHILOS plate as tension band rotator cuff sutures. We start with loosening the shuttle suture on the eyelet hole of the PHILOS plate (Fig 3A). A clamp is inserted through the loop of the shuttle suture then grasped and the rotator cuff suture passed through the suture loop, and then (C) passed through the eyelet hole of the PHILOS plate by the shuttle suture technique.

Fig 3. Right shoulder in a semisupine position through deltopectoral approach. (A) The shuttle suture on the eyelet hole of the PHILOS plate is identified and loosened for shuttle of the rotator cuff suture. (B) A clamp is inserted through the loop of the shuttle suture then grasped and the rotator cuff suture passed through the suture loop, and then (C) passed through the eyelet hole of the PHILOS plate by the shuttle suture technique.

Fig 4. Right shoulder in a semisupine position through deltopectoral approach. After completely passing the rotator cuff sutures, (A) the tension of each rotator cuff suture is adjusted and tightened over the eyelet hole of the PHILOS plate. (B) All rotator cuff sutures are completely tightened over the eyelet holes of the PHILOS plate.
After completely passing the rotator cuff sutures, the tension of the rotator cuff sutures is adjusted and tightened over the eyelet holes of the PHILOS plate (Fig 4 A and B). The alignment is then checked by fluoroscope. When the position is correct, a Redivac drain is inserted and the skin closed layer by layer. Postoperative radiographs (Fig 5 A and B) showed good reduction of the proximal humerus fracture compared with the preoperative radiographs (Fig 5 C and D). The entire surgical technique is shown in Video 1, with audio narration. Tables 1 and 2 present pearls, pitfalls, advantages, and disadvantages of using this technique.

**Discussion**

Locking plate fixation augmented with tension band rotator cuff sutures provides good clinical and radiographic outcomes in displaced proximal humerus fracture fixation. The tension band rotator cuff sutures increase the stability of fixation by transferring a

| Table 1. Pearls and Pitfalls |
|-----------------------------|
| **Pearls**                  |
| The shuttle sutures are tensioned and gathered with silk before applying the plate. |
| In the step of applying the plate on the bone, the surgeon must clear the shuttle sutures to avoid overlaying of the shuttle sutures by the plate. |
| The loop end of the ETHIBOND no. 2 is passed through the eyelet hole of the locking plate from the superior to the inferior part. |
| The size of each shuttle suture should be small and strong so they can be easily passed through each eyelet hole of the locking plate. |
| This technique can be used to pass more than one rotator cuff suture through the one eyelet hole of the locking plate. |
| **Pitfalls**                 |
| The surgeon should avoid using weak sutures as shuttle sutures. |
significant part of the forces acting on the fracture site to the plate and helping to prevent fixation displacement.

There are several methods that can be used to pass the rotator cuff sutures through the eyelet hole of the locking plate. In the first technique, the surgeon puts each rotator cuff suture in a curved needle which is then passed through the eyelet hole of the locking plate. The disadvantages of this technique are that it can be difficult to pass the rotator cuff suture if the eyelet hole is obstructed by soft tissue and/or a fracture fragment, and also it can be difficult to pass 2 rotator cuff sutures through the single eyelet hole of the locking plate. A second technique has been reported by Kim et al. and Cho et al., which involves first passing the rotator cuff sutures through a washer, which is then fixed with a cortical screw.4,5 The disadvantage of this technique is that it uses only one cortical screw to maintain the rotator cuff suture, giving it less stability when compared with securing each rotator cuff suture with each eyelet hole of the locking plate. The shuttle technique of passing the rotator cuff sutures through the eyelet holes of the locking plate is easy to do, can be used to pass more than one rotator cuff suture through the one eyelet hole of the locking plate, and increases the stability of fixation. In this technique, the shuttle suture should be strong and small. It may be unable and/or hard to pass the rotator cuff suture through the eyelet holes of the plate if the shuttle suture is big and/or weak. In addition, the rotator cuff sutures should be designed and mapped with the eyelet holes of the locking plate. The shuttle sutures should be strong and small. It may be unable and/or hard to pass the rotator cuff suture through the eyelet holes of the plate if the shuttle suture is big and/or weak. In addition, the rotator cuff sutures should be designed and mapped with the eyelet holes of the locking plate before shuttling. It is hard to re-shuttle the rotator cuff suture if the shuttle sutures have already been used. We describe a new shuttle suture technique for easily passing one or more rotator cuff sutures through the eyelet holes of a locking plate.

Table 2. Advantages and Disadvantages

| Advantages | Disadvantages |
|------------|--------------|
| It is easier to pass each rotator cuff sutures through each eyelet hole of the locking plate than with other techniques. | The operative field may be disturbed by the numerous shuttle sutures. |
| More than one rotator cuff suture can be passed through the one eyelet hole. | |
| The tension can be separately adjusted for each rotator cuff suture. | |

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