Technical Note

Surgical Technique of Arthroscopic Transosseous Implant-Less Rotator Cuff Repair Using "Arthrocuff" System

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Abstract: Rotator cuff tears remain one of the most common causes of shoulder pain and disability. Although many repair techniques like single-row, double-row, and transosseous equivalent repair have become popular, transosseous repair still remains the gold standard. Arthroscopic transosseous repair is a safe and affordable alternative to suture anchors. Considering this fact, a reusable instrumentation "ArthroCuff", was developed by SpowerN Medical Equipment (Chennai, India) in collaboration with the National Hub for Healthcare Device Development, India. Arthrocuff system not only aids a robust transosseous rotator cuff repair, but it is also cost-effective. We present the video technique of Arthrocuff for rotator cuff repair.

Introduction

Arthroscopic rotator cuff repair provides multiple advantages over open repair, like inspection of glenohumeral joint for pathologies, deltoid preservation, and early functional recovery.[1] The conventional open transosseous repair still remains the gold standard technique against which the present systems of anchor configurations are compared.[2]

Several techniques have been described in the literature for rotator cuff repair, and the most common configurations of anchors used are single row, double row, and the transosseous equivalent repairs.[3] More recently, transosseous arthroscopic systems have become available, combining the advantages of transosseous repair and arthroscopy.[4,5] Nevertheless, most of them are disposable one-time use systems and are not accessible in every country.[6,7]

Anchors and disposable systems place a significant financial burden to the patients in cost-conscious countries. Therefore, we developed a reusable system for arthroscopic transosseous cuff repair called "ArthroCuff" to overcome the cost issues. This system confers the mechanical and biological advantages of the open transosseous repair system while retaining the benefit of being an arthroscopic procedure.

We report the video technique of arthroscopic cuff repair using this system here (Video 1).

Surgical Technique

We prefer a lateral position with the affected arm suspended in traction. Next, we proceed with the diagnostic arthroscopy by doing a glenohumeral joint inspection through the posterolateral portal. At this stage, a biceps tenotomy, if indicated, is performed. Then, through a subacromial bursoscopy, rotator cuff tear pattern and mobility are assessed.

A low lateral working portal is made about 4 cm below the lateral end of the acromion. This portal is slightly lower than the routine lateral portal in order to aid the free passage of the transosseous jig under the acromion (Fig 1). Subsequently, a superior portal is made in line

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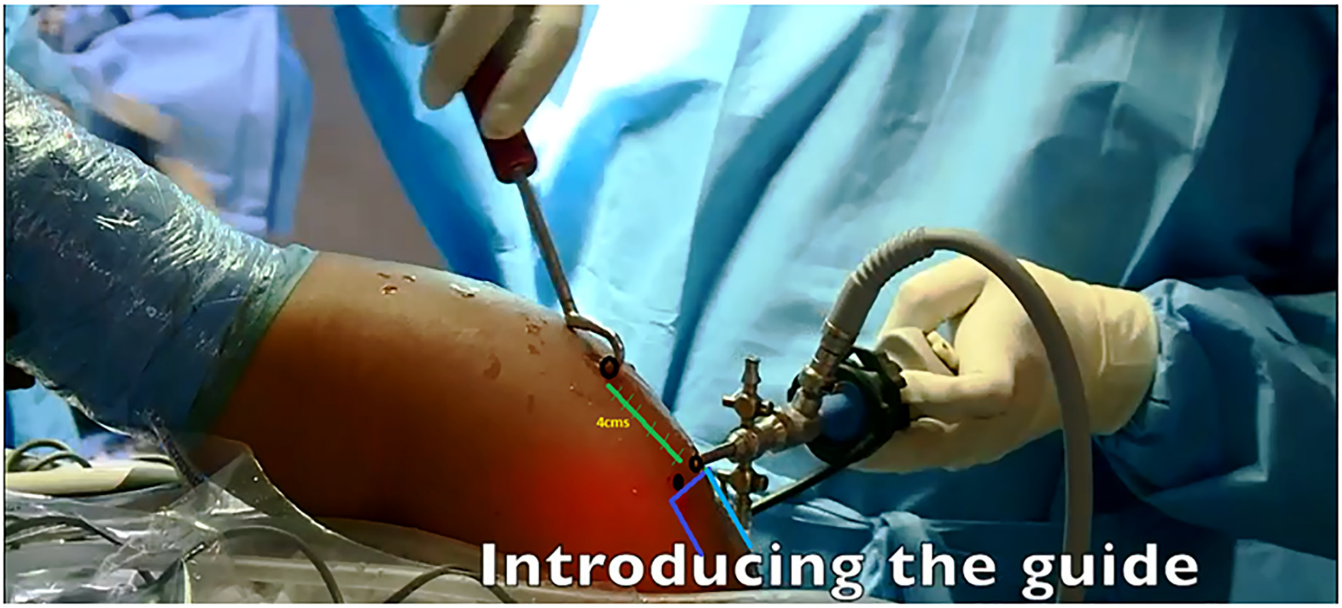

Fig 1. External image (right shoulder), of a patient in left lateral position, demonstrating the. low lateral portal (4 cm from the tip of the acromion) for introduction of the Arthrocuff transosseous guide.

with the medial footprint of the rotator cuff for creating the pilot hole, using the entry awl (Arthrocuff, SpowerN). The pilot hole serves as the vertical limb of the transosseous tunnel and is done using a 3.9-mm diameter straight awl tapped up to the laser mark (Fig 2). In addition to providing as an entry point for the jig, the pilot hole allows bone marrow to seep into the repair, enhancing biology and healing (Fig 3).

The ArthroCuff jig (SpowerN Medical Equipment) is then introduced through the lateral portal, and the tip of the jig is manipulated to engage in the pilot hole (Fig 4). The jig has a cannulated handle through which a 2.9-mm drill bit is used to create the transverse tunnel. This intersects the vertical limb formed by the pilot hole, forming an L-shaped transosseous tunnel, from the lateral cortex of the proximal humerus to the

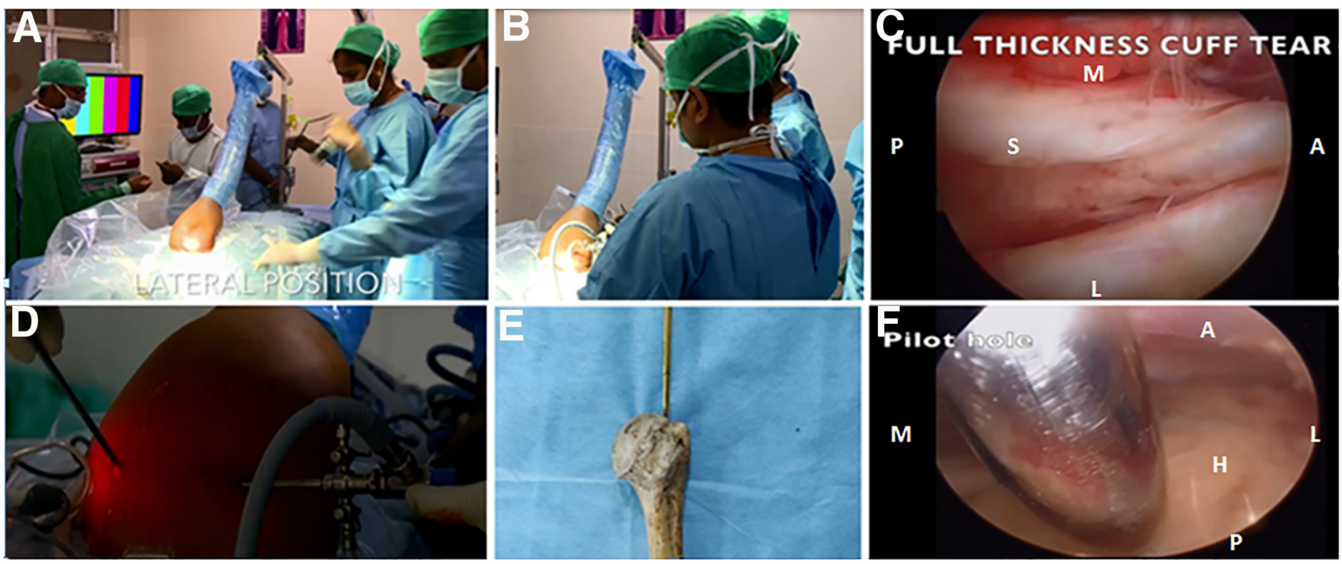

Fig 2. (A) External image (right shoulder), of a patient in left lateral position arm suspended in traction with a 4-kg weight. (B) Diagnostic arthroscopy performed through the posterolateral portal. (C) Arthroscopic view from posterior portal demonstrating full-thickness crescentic cuff tear. A, anterior; L, lateral; M, medial; P, posterior; S, supraspinatus tear. (D) External image (right shoulder), in left lateral position seen from posterior, demonstrating the lateral portal made for pilot awl. (E) Demonstration of the pilot hole in a cadaveric bone. (F) Arthroscopic view from posterior portal showing the entry awl in the medial rotator cuff foot print on the humeral head. A, anterior; H, humeral head foot print; L, lateral; M, medial; P, posterior.

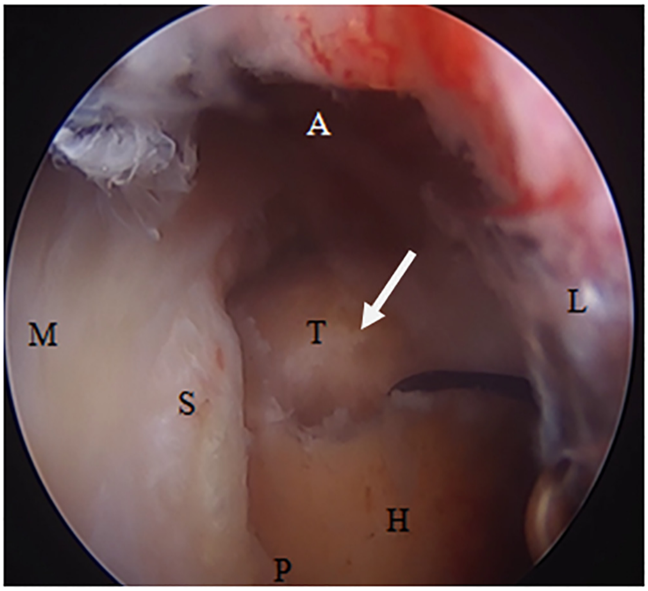

Fig 3. Arthroscopic view into the right shoulder, from posterior portal, showing the transosseous tunnel and shuttling sutures. The tunnel also acts like a crimson-duvet, bathing the repair surface with the much-needed biology. A, anterior; H, humeral head foot print; L, lateral; M, medial; P, posterior; S, supraspinatus tear; T, vertical limb of the tunnel with shuttle sutures.

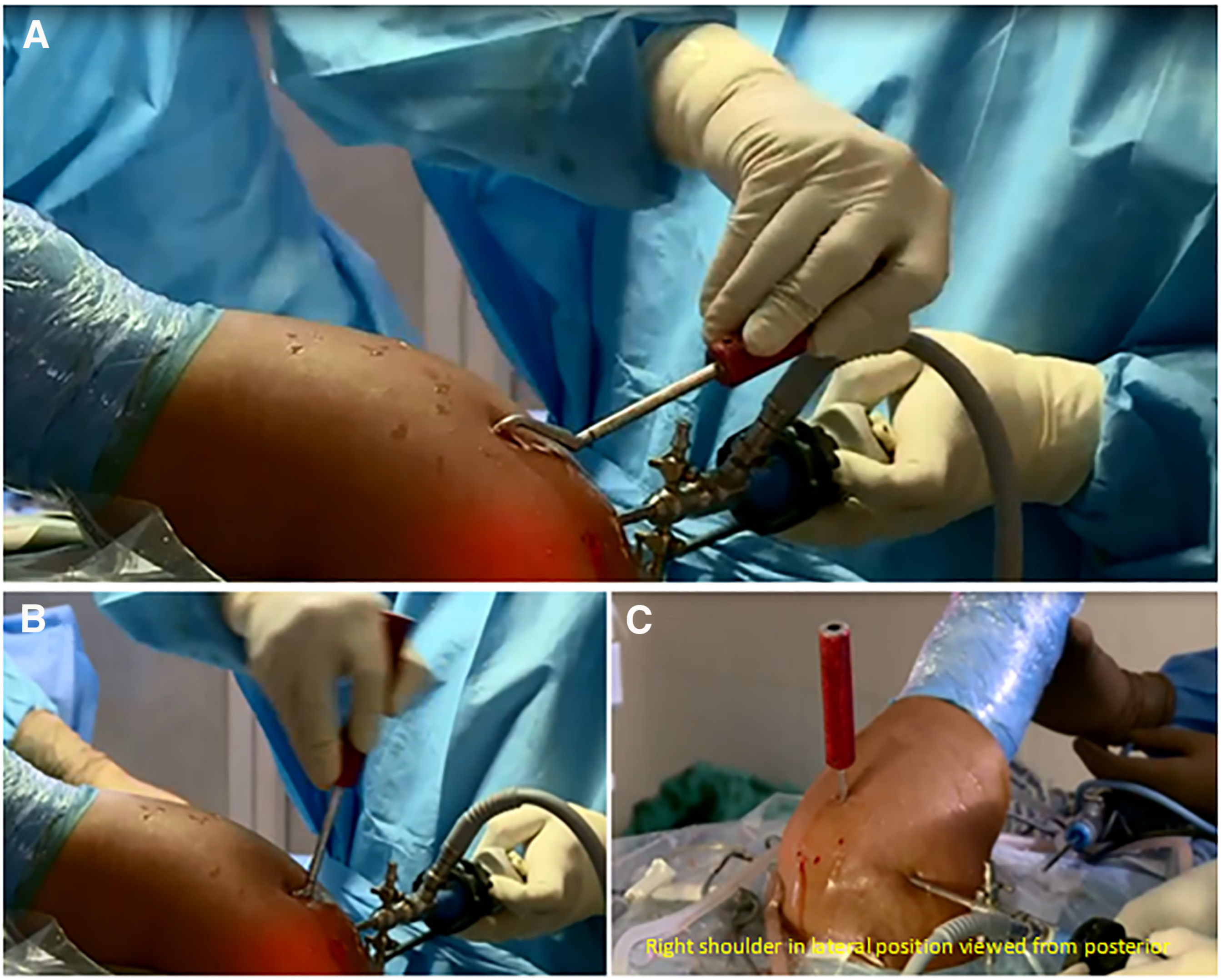

Fig 4. (A) External image of the right shoulder from the front, demonstrating the entry of Arthrocuff jig via the accesory lateral portal. Note: The tip of the jig is inserted first. (B) Once the tip is viewed subacromialy, the jig is maneuvered to engage the pilot hole. (C) The jig snugly fits once engaged in the pilot hole.

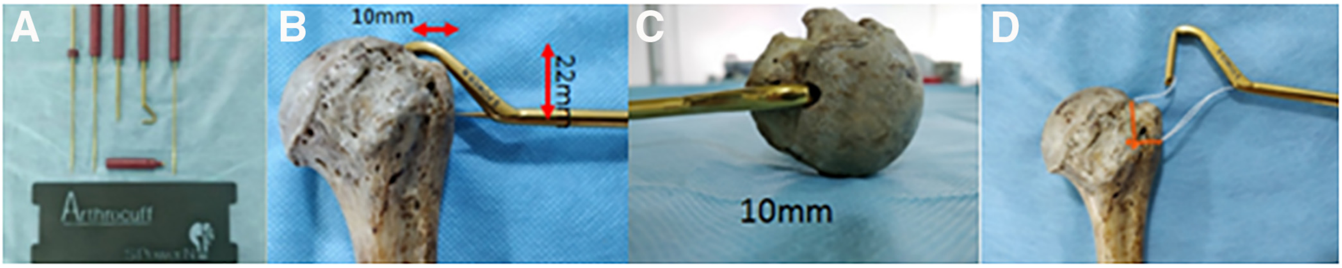

Fig 5. (A) Arthrocuff instrumentation. (B) Picture demonstrating the dimensions of the bone bridge. (C) The pilot hole is made close to the articular surface, and the jig has an inbuilt 10-mm horizontal offset and 22-mm vertical offset that helps in maintaining adequate bone bridge. (D) The pilot hole and the transverse drill meet to complete the tunnel.

footprint area on the head. The "ArthroCuff" jig is designed to create a bone bridge with the vertical tunnel of 22 mm and a transverse tunnel of 10 mm. This ensures maximal bone volume between the tunnels, which, in turn, minimizes suture cut-out and at the same time, it is not low enough to endanger the axillary nerve (Fig 5).

A shuttling loop loaded to the locking screw tip guide (SpowerN Medical Equipment) is introduced through the cannulated handle of the jig. Through the transverse tunnel, the guide with the shuttling mechanism encounters the Arthrocuff jig.(Fig 6) The screw locks to the tip of the jig and disengages from the guide. As the guide is removed, the screw and shuttle loop remains locked to the jig's tip (Fig 7). Subsequently, the jig is withdrawn from the pilot hole, and the shuttling process is completed. Two FiberWires are shuttled through the transosseous tunnel using the shuttle loop (Fig 8).

Using a retrograde suture passer, standard rotator cuff repair is completed using sliding knots. The above steps can be repeated in large tears to create another tunnel 1 cm apart in the footprint. Again, various suture configurations like simple, mattress, H-type or Xbox technique can be incorporated. In the ArthroCuff system, the knots fall over the lateral cortex and close to the entry point of the transverse tunnel (Fig 9), thus providing better footprint coverage, increased bone tendon surface

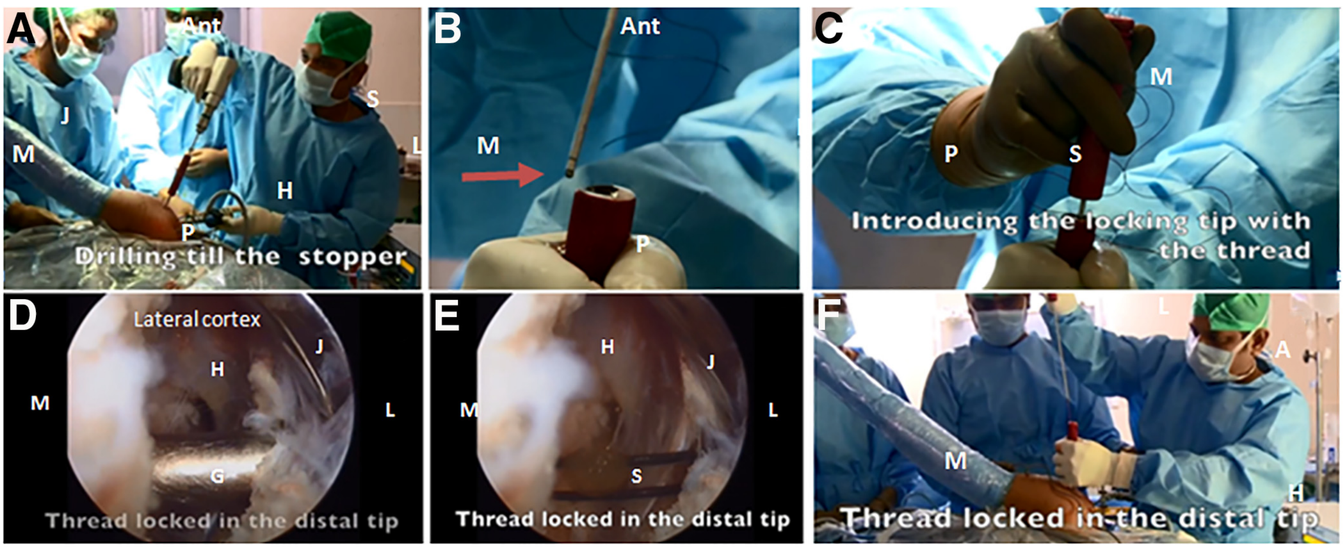

Fig 6. (A) External image of the right shoulder from front, demonstarting the Arthrocuff jig in the accesory lateral portal, and through the cannulated handle in the jig, a 2.9-mm drill with a stopper is used to create the transverse tunnel. (B) Locking screw tip guide: The arrow showing the locking screw docked in the tip of the guide. (C) The guide is introduced through the cannulated handle, and the screw locks onto the tip of the Arthrocuff jig. (D) Arthroscopic view of the right shoulder from posterior portal showing the lateral cortex of the proximal humerus, the Arthrocuff jig (J) and the guide, which is introduced through the cannulated handle and into the lateral cortex of humerus (G). M, medial, L, lateral, H, lateral cortex of humerus. (E) Arthroscopic view of the right shoulder from posterior portal showing the lateral cortex of the proximal humerus (H), the Arthrocuff jig (J) and the shuttle sutures (S) after the screw is locked on the jig and the guide is withdrawn. L, lateral; M, medial. (F) External image of the right shoulder from the front, demonstrating the Arthrocuff jig in the accesory lateral portal, and through the cannulated handle in the jig, the guide is withdrawn. The shuttle sutures can be seen disengaged from the guide and passing through the jig.

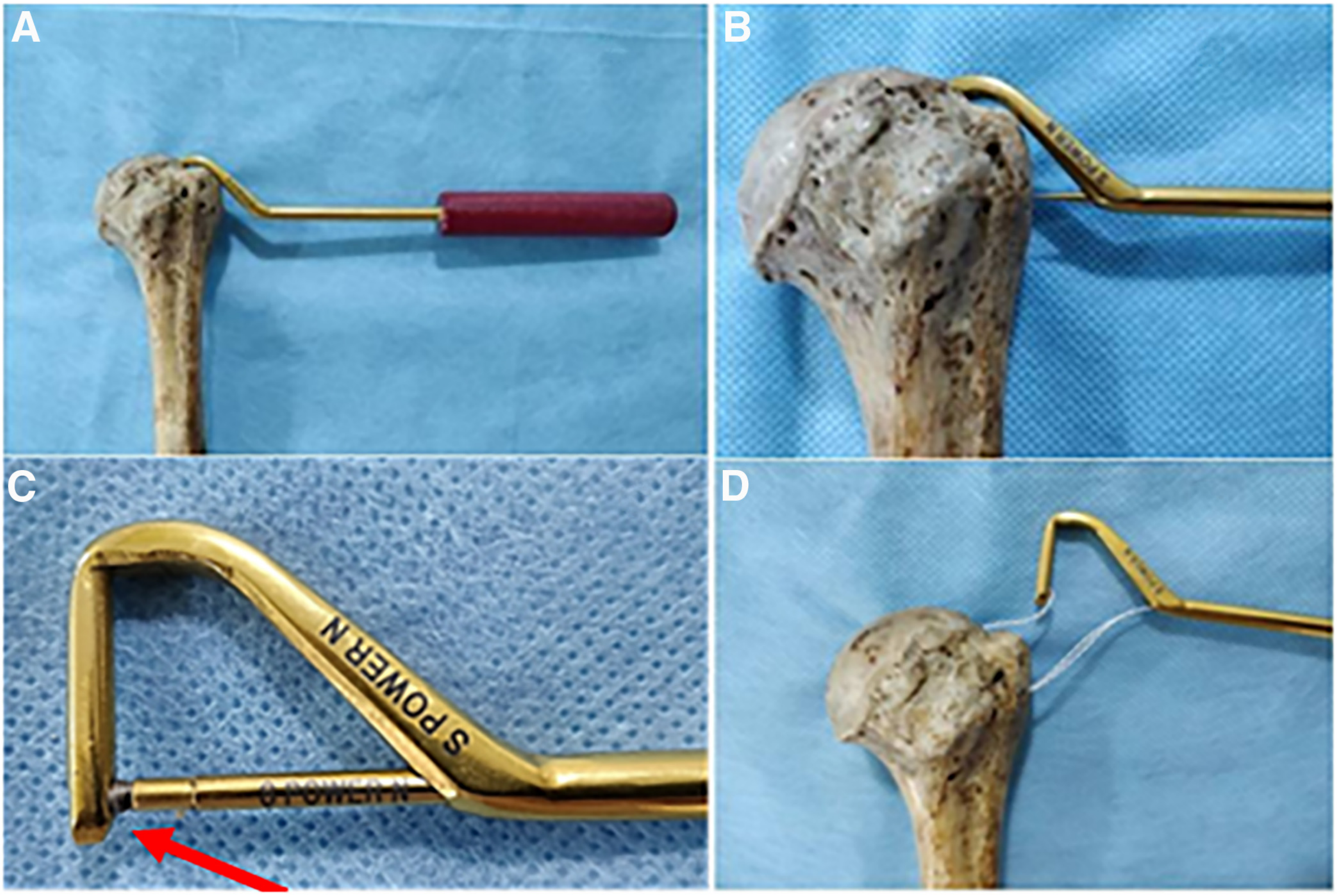

Fig 7. (A) Picture demonstrating the Arthrocuff jig in the pilot hole in a cadaveric bone (left humerus). (B) The lateral cortex of the humerus is drilled through the cannulated handle of the Arthrocuff jig. (C) Close in view demonstrating how the locking screw with shuttle sutures engages with the Arthrocuff jig. (D) The shuttling process can be seen completed in the image once the Arthrocuff jig is withdrawn from the pilot hole.

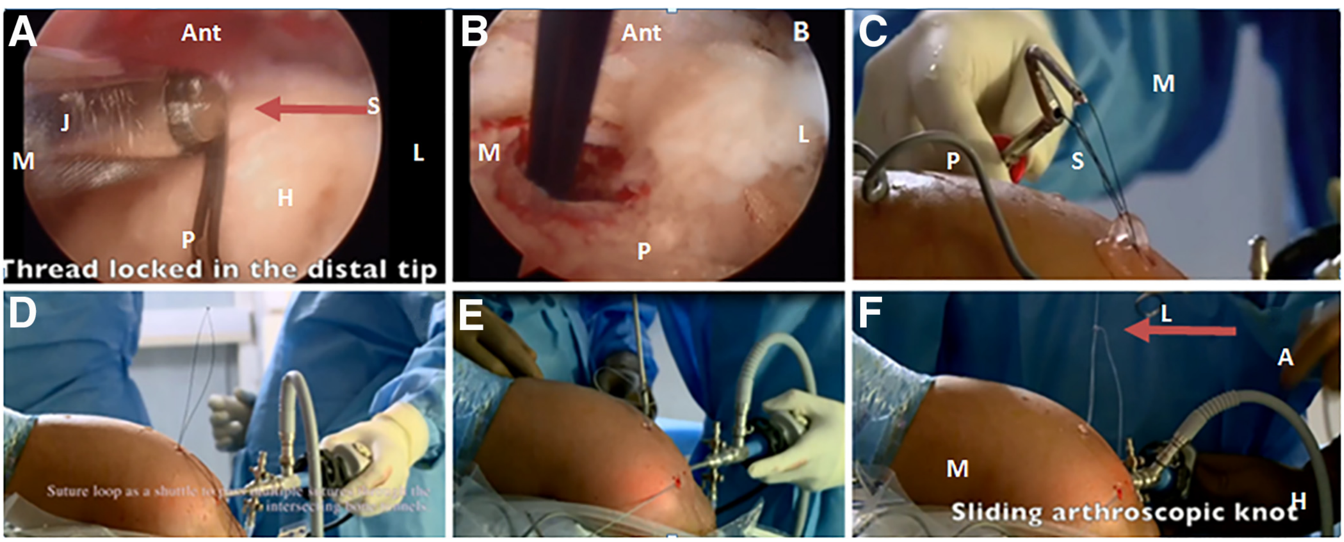

Fig 8. (A) Arthroscopic view of the right shoulder from posterior portal with arrow showing the tip of Arthrocuff jig (J) with the screw and shuttle sutures locked onto the tip (S), humeral head footprint (H). Ant, anterior; L, lateral; M, medial; P, posterior. (B) Arthroscopic view of the right shoulder from posterior portal showing the shuttle sutures. (D) The shuttle sutures are used to pass FiberWires across the tunnel. (E and F) Using a Multifire Scorpion (Arthrex) and sliding knots (arrow), cuff repair is completed.

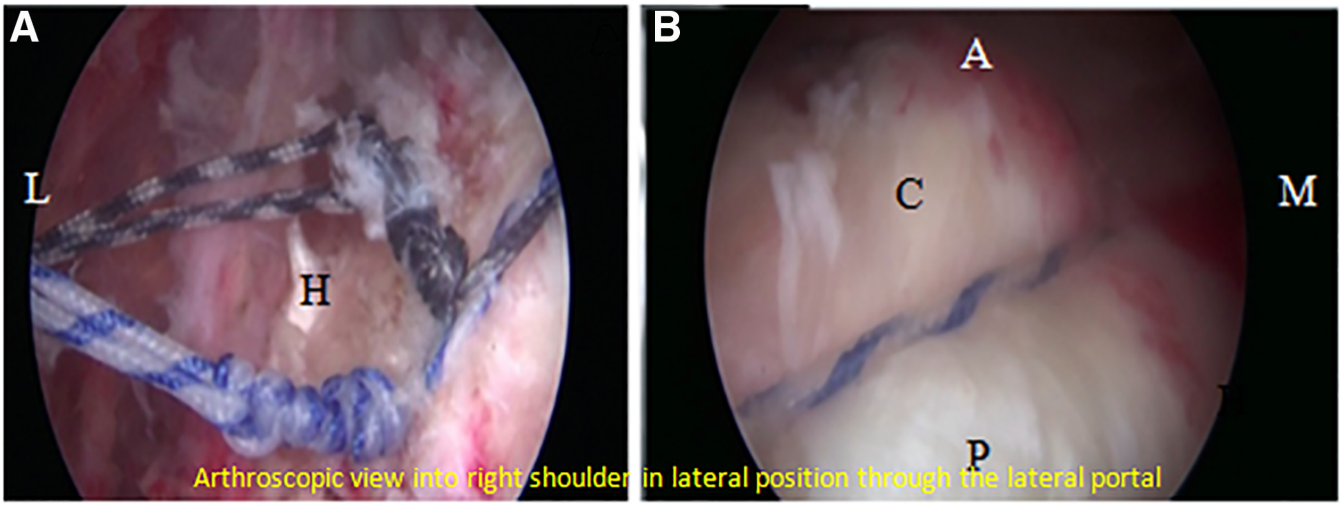

Fig 9. (A) Arthroscopic view of the right shoulder from posterior portal, after.supraspinatus repair using the Arthrocuff system, showing a wide area of compression compared to the point contact with suture anchors. A, anterior; C, cuff; H, lateral cortex of humerus; L, lateral; M, medial; P, posterior. (B) The knots are placed over the lateral cortex, rather than on the cuff tissue.

contact, and a tangential compression vector perpendicular to the rotator cuff (Table 1).

Discussion

The transosseous suture technique provides good footprint coverage, contact area, and linear compression equivalent to other suture anchor techniques like double row or transosseous equivalent repair.[8] The initial fixation strength is mainly due to the tangential compression force in a tunnel repair technique, leading to a superior tuberosity—tendon fixation and limited interface micromotions. This, in turn, provides better healing potential.[9]

The lateral portal in our technique for introducing the jig is 4 cm from the tip of the acromion along its anterior border. This is in consideration of the normal anatomical variations of the course of the axillary nerve, which is usually 6.1 ± 0.7 cm from the top anteriorly and 7 cm posteriorly[10] and the space needed to manipulate the jig in the subacromial space. We did not have any axillary nerve injury in our series of patients who had surgeries using this technique.

Cadaveric biomechanical studies by Behrens et al. have compared the initial fixation strength of the suture bridge rotator cuff repair construct to the traditional transosseous suture construct. They have showed similar results with both techniques with respect to load to failure, and cyclical testing.[11] In another study comparing transosseous Xbox configuration, Kummer et al. found similar pullout strength when compared to the suture bridge technique.[12] It has been shown by Caldwell et al. that the ultimate strength to failure can be significantly improved by placing the lateral tunnel more distal (>10 mm) or tying the sutures over a wider bone bridge.[13] The design of our transosseous jig (vertical 22 mm, transverse 10 mm) allows for maximal lateral cortical purchase to prevent suture cut-out and inherently enables a wider bone bridge.

The void created by the tunnel in the lateral cortex may be considered a stress riser, and some authors have used cortical augments to fill the void. However, studies have shown no benefit with cortical augments.[14] We did not use any cortical augmentation in our patients and did not experience intraoperative cut-outs. One reason could be the design of our jig system and the comparatively lower mean age group undergoing cuff repair in our institute.[15] Multiple advantages exist with this system: better footprint coverage, a better milieu for repaired tissue healing, and cost-effectiveness (Table 2).

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
1. Clearance of sub-deltoid bursa for visualization of lateral cortex 2. Lower lateral portal for insertion of jig	1. Suture may unload during the shuttling process.
3. Pilot hole to be made at the medial footprint 4. Jig tip should be introduced and visualized inside the subacromial space before maneuvering it into the pilot hole.	2. Care should be taken in suture management. If the sutures from vertical limb and horizontal limb of the tunnel are not differentiated, repair can become cumbersome.
5. Jig should be held in position firmly during the drilling of lateral cortex and introduction of shuttle mechanism. 6. Allow adequate spacing between tunnels to prevent convergence.	3. Lateral portal is lower than 5 cm from the acromion and can injure the axillary nerve.

Table 2. Advantages and Disadvantages

Advantages	Disadvantages
1. Better footprint coverage and better tendon footprint compression	1. Technically demanding and steep learning curve.
2. Cost effective compared to disposable/anchor systems	2. Possibility of tunnel confluence if placed too close to each other.
3. Good initial fixation strength	3. Medial tunnel placement may be challenging in patients with large lateral acromion overhang.
4. Multiple suture configurations are possible with two tunnels and supports both FiberWires and FiberTapes.	4. Potential of failure by bone cut out
5. The tunnels allow for bone marrow seepage, aiding biological repair.	5. Need further studies in osteoporotic bone to suggest need for cortical augments.
6. Revision in failed anchor repair is possible with this system, as it allows for usage of the jig through the anchor voids.	

Conclusion

Shoulder arthroscopy has become quite an expensive procedure with the need to use multiple suture anchors. Since ArthroCuff is an autoclavable and reusable implant-less system, it provides significant cost efficiency compared to Suture anchors, without compromising the results.

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