Technical Note

Arthroscopic Shoulder Fusion for Obstetric Brachial Plexus Palsy

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Abstract: Shoulder fusion for sequelae of obstetrical brachial plexus injury is reported as a valuable surgical solution with very good results and functional range of motion. It is traditionally performed in open fashion. Few reports describe the technique of arthroscopic shoulder fusion, but nearly all of them were done in cases with traumatic brachial plexus injury that have normal joint anatomy. This report describes and discusses the arthroscopic shoulder fusion technique in cases with disorganized glenohumeral joint secondary to obstetric brachial plexus injury. An illustrative case example is presented.

Introduction (With Video Illustration)

Obstetric brachial plexus injuries (OBPIs) are common birth injuries, with about 25% of the patients left with permanent disability, in which the shoulder joint is the most commonly affected. Usually these shoulders are different than the normal ones as a result of the muscle imbalance and glenohumeral dysplasia.[1]

Narakas[2] classified the severity of OBPI into 4 groups. Group 1, which is the most common pattern, involves only the C5/6 roots resulting in shoulder abduction and elbow flexion weakness. In group 2, the C7 nerve root is also involved with associated wrist drop. These groups have a greater rate of spontaneous recovery. In contrast, group 3 is associated with complete paralysis, and group 4 has an additional Horner's syndrome; both have a worse prognosis.

Patients with Narakas group 1 and 2 usually have internal rotation contracture due to unopposed action of the subscapularis (supplied by the upper and lower subscapular nerves) in the presence of weak external rotators as a result of the involvement of the upper roots. Shoulder abduction and deltoid function are also abnormal in these patients.[3,4]

The muscle imbalance leads to progressive flattening and retroversion of the humeral head. The glenoid, which is lined by hyaline cartilage, becomes bi-concave with a false posteroinferior facet. With time, the humerus dislocates posteriorly, creating a pseudoglenoid in which the humeral head articulates with the joint capsule overlying cortical bone. Secondary adaptive changes occur with overgrowth of the acromion and lateral clavicle. The coracohumeral and coracoacromial ligaments become elongated and tight, restricting more the external rotation.[3,5]

Shoulder arthrodesis is a salvage procedure that is occasionally indicated in skeletally mature patients. It is usually used in total plexus injury in which there is a painful and flail shoulder, with best outcomes seen when the rest of the shoulder girdle muscles are functioning (trapezius, levator scapulae, serratus anterior, and rhomboids). The objectives of shoulder arthrodesis in these cases are to provide a stable, painless shoulder and to allow active elevation and abduction of the shoulder via the scapulothoracic motion.[6]

To decrease non-union and soft-tissue problems of shoulder arthrodesis, arthroscopic shoulder fusion was proposed by some authors to reduce the morbidity of open shoulder fusion. However, most of these studies reported arthroscopic shoulder fusion in traumatic BPI with normal shoulder anatomy.[6-9]

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Arthroscopic arthrodesis of the shoulder in OBPI is not commonly reported. The distorted glenohumeral joint geometry in neglected late presentation cases might be the obstacle for arthroscopic procedure. The aim of this report is to present the technique of arthroscopic shoulder fusion in patients with shoulder dysplasia secondary to OBPI and to report difficulties faced during this procedure. This Technical Note describes our arthroscopic shoulder fusion for OBPIs (Video 1, Table 1).

Technique

The procedure is performed with the patient under general anesthesia with an interscalene nerve block. The patient is positioned in a modified beach chair position (semi-setting). The position of the patient on the table should be optimized to allow free circumferential axis to the shoulder. The patient's head is secured in a special headrest and padded with surgical towels all around to protect the patient's eyes and ears. Care should be taken to maintain the head and neck of the patient in neutral position. The patient is shifted laterally so that the medial border of the scapula should be just at the edge of the operating table (Fig 1).

Examination under anesthesia of the operated shoulder is performed first to assess the passive range of motion and the stability of the shoulder. The patient's skin is disinfected with povidone iodine, and sterile drapes are applied. With the patient under general anesthesia, an arthroscopic pump is used starting with pressures around 40 mm Hg.

Arthroscopy is performed via standard posterior portal as the main viewing portal. In those cases with glenoid dysplasia and posterior humeral subluxation, it is better to make the posterior portal higher than the standard posteromedial portal (1 cm inferior and medial to posterolateral edge of the acromion). A blunt trocar is used to avoid humeral head perforation during searching for the joint and the lateral traction by the assistant helps in getting access to the joint. Once inside, usually there is a lot of fibrous tissues and adhesions.

The anterior and lateral portals are then established with an outside-in technique using a spinal needle as a guide. A motorized shaver (4 mm, Tomcat HC Shaver Blade; Stryker Endoscopy, Santa Clara, CA) is introduced from anterior portal for complete debridement and removal of all intra-articular fibrous tissue. All soft tissues over the glenoid and humeral head are removed with switching between anterior, posterior, and lateral portals. An electrocautery probe (VAPR Coolpulse Premiere 90 Electrode; DePuy Mitek, Raynham, MA) is mandatory to remove all intra-articular adhesions between the glenoid and subscapularis and between the glenoid and infraspinatus (Fig 2).

A motorized 4 mm burr (Standard 12-Flute Barrel Burr; Stryker Endoscopy) is then used to denude the articular surfaces of the humeral head, acromion, and glenoid until reaching the subchondral bone. Care is taken to avoid excessive bone removal especially from the glenoid due to preexisting dysplasia (Fig 3). After completing the cartilage removal, the arm is repositioned in 30° flexion, 30° abduction, and 30° internal rotation (functional position).

Table 1. Pearls and Limitations of Arthroscopic Shoulder Fusion in OBPI

Pitfalls and Limitations	Pearls
These shoulders have irregular joint surfaces with poor bone stock. It is difficult to reach a sound surface coaptation in these cases.	The patient optimized in a modified beach chair position (semi-setting) allows free circumferential axis to the shoulder.
Joint entry is usually challenging due to collapsed head, loss of normal contour, and joint retroversion. It is not uncommon to perforate the head with the trocar.	The use of C guide eliminates the need for navigation during screw insertion and allows precise and accurate screw positioning.
The insertion of the screws with good trajectory is strenuous, especially when the shoulder is swollen after the initial debridement. The use of C guide is mandatory to ensure the desired screw direction.	An acromiohumeral screw is important to increase the stability of the construct and decrease the load on glenohumeral screws.
The joint space is tight in OBPI compared with shoulder in normal conditions. Thus, care should be taken to avoid damage to the arthroscopy lens by the shaver or the radiofrequency device.	The posterior portal entry point in a disorganized shoulder should be higher than the standard portal to avoid head penetration by trocar and to facilitate the work above the humeral head.
The use of bone graft is troublesome with arthroscopy in comparison with open surgery. Thus, the acquisition of a more or less coapted surface is necessary to decrease the need for graft insertion.	Before the insertion of the glenohumeral screws, 2 preliminary guidewires are inserted and checked by fluoroscopy to ensure the optimal position before screw advancement.
These cases have already poor bone stock. Therefore, care should be taken to avoid excessive bone removal, which may lead to fractures and increase the risk of complications.	No bone graft is needed as long as the surface coaptation is maintained.

OBPI, obstetric brachial plexus injury.

Under arthroscopic and fluoroscopic guidance, 2 serrated guidewires (1 cm apart) are introduced percutaneously using an anterior cruciate ligament C guide across the lateral aspect of the proximal humerus and into the glenoid cavity (Fig 4). Wires are measured and reamed first by 4 mm cannulated drill bit. Two cannulated half-threaded 6.5-mm screws are then inserted over the guidewires to compress the bleeding bone surfaces together with the arm held in the functional position. Another guidewire is then inserted from the acromion to the humeral head and another 6.5 mm cannulated screw is inserted over it.

The screws are sequentially tightened to achieve adequate compression of the glenohumeral surfaces. The position of each screw is then verified with fluoroscopy (Fig 5).

Postoperatively, the patient is immobilized in a humeral abduction brace for 8 weeks. Active hand and elbow motion are allowed immediately. After sound union at 8 weeks, the sling is removed and scapulothoracic motion is allowed. Strengthening is permitted at the twelfth week, and full activity is regained when radiographic healing is observed.

Figs 6-10 describe an illustrative case.

Fig 1. Modified beach chair position of the patient, showing her right shoulder. The arrows indicate the old scars of the previous soft tissue and bony procedures for obstetric brachial plexus injury.

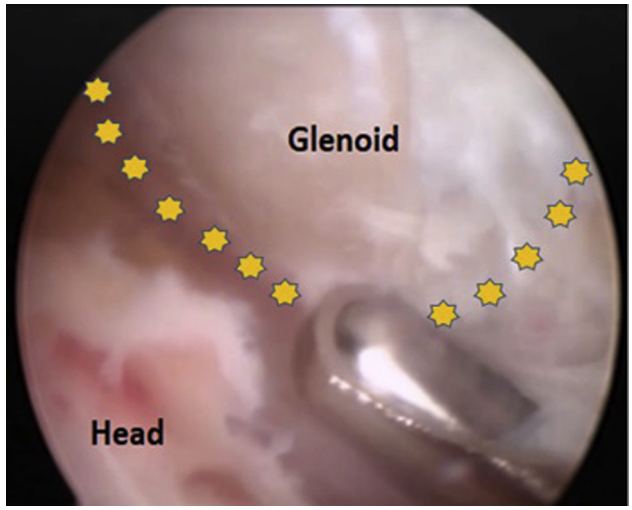

Fig 2. Arthroscopic view from the lateral portal in a right shoulder in the modified beach chair position. Debridement of the glenohumeral joint is done using a motorized shaver through the anterior portal until complete visualization of the glenoid surface and the head is achieved.

Discussion

Arthrodesis of the shoulder is a surgical procedure that is indicated in cases of infection, obstetrical brachial plexus palsy, post-traumatic brachial plexus palsy, massive irreparable rotator cuff tears, combined paralysis and insufficiency of the rotator cuff and deltoid muscle, or stabilization after resection of a neoplastic lesion.[10]

An arthroscopic technique is better than the open one because it is a less-invasive procedure. With 2 arthroscopic portals and percutaneous cancellous screws, similar results can be achieved without problems like hardware irritation due to protrusion at the side of the acromion, risk of infection, and risk of fractures of the humerus after surgery with plates. Arthroscopy allows complete visualization of the joint surface so that accurate acromiohumeral and glenohumeral

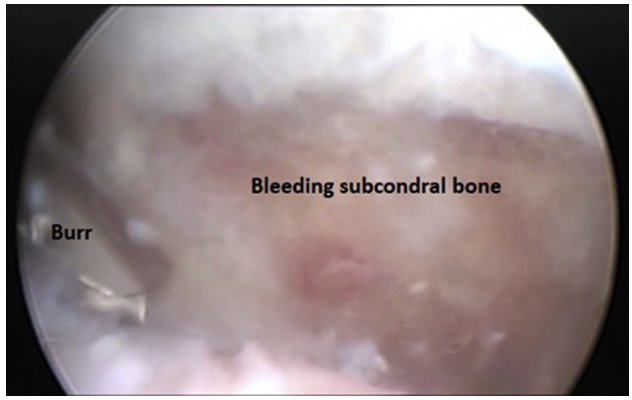

Fig 3. Arthroscopic view from the lateral portal in a right shoulder in the modified beach chair position. A motorized burr is used to denude the cartilage until reaching the bleeding subchondral bone.

decortication can be performed with a minimum degree of surgical aggressiveness.[6]

The arthroscopic shoulder fusion may have some limitations (Table 1). The joint entry is usually challenging due to collapsed head, loss of normal contour, and joint retroversion. Moreover, the tight joint space may predispose to arthroscopic lens damage, head perforation with the trocar, and make the insertion of any bone graft difficult. Thus, it is necessary to obtain a sound surface coaptation for fusion, which is an obstacle in cases of OBPI due to poor bone stock and excessive glenoid retroversion.

To obtain an optimum functional result in arthrodesis, trapezius, levator scapulae, serratus anterior, and rhomboid muscles must be able to function properly.[11] Atlan et al.[12] evaluated the results of the shoulder fusion in BPI and found that the shoulder fusion provided active abduction greater than 45° in more than 75% of the cases and active rotation more than 45° in almost 65% of the cases with very low rate of pseudoarthrosis.

Chammas et al.[13,14] reported that glenohumeral arthrodesis is a reliable method for restoring shoulder function in case of brachial plexus sequalae lesion, giving more strength but less external rotation than shoulder nerve repair. Rtaimate et al.[15] found that shoulder fusion for BPI results in excellent function; hand–mouth and hand–pocket movements were possible by all the patients with little pain. Active motion was: 48° abduction, 46° antepulsion, 40° internal rotation, 46°external rotation, and 23° retropulsion.

It was Morgan and Casscells[16] who first described an arthroscopic technique for shoulder arthrodesis. Porcellini et al.[8] found that arthroscopically assisted glenohumeral arthrodesis provided results that are at least equal to those of open arthrodesis, however, with a much less-invasive approach. Success and complication rates are the same as for those of the completely open procedure. In their series there were 2 cases with traumatic BPI.

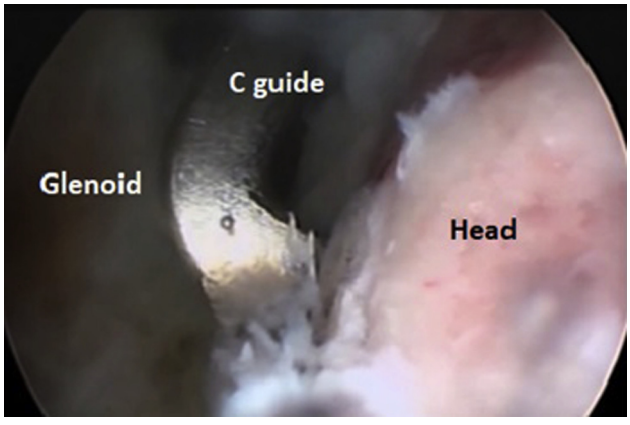

Fig 4. Arthroscopic view from the posterior portal in a right shoulder in the modified beach chair position. A C guide is introduced through the modified anterior portal to insert 2 percutaneous 6.5-mm cannulated screws.

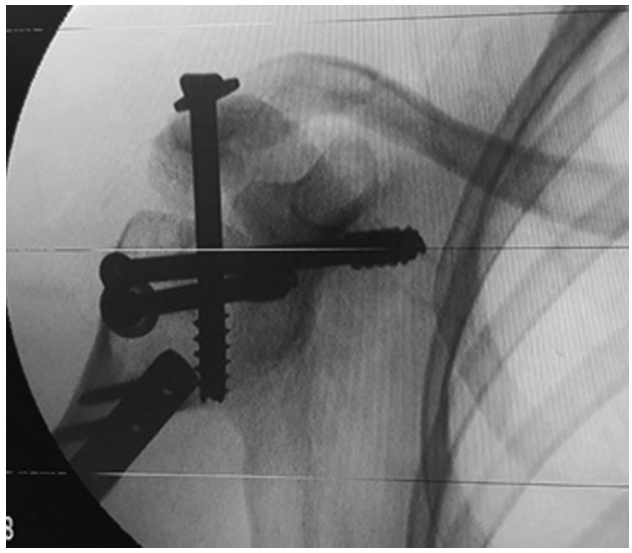

Fig 5. Intraoperative check fluoroscopy (anteroposterior view of the right shoulder) shows adequate acriomo- and glenohumeral screws placement.

Jiménez-Martín and Pérez-Hidalgo[10] reported 14 year-follow up of 17-year- old male patient with traumatic BPI that was treated with arthroscopic shoulder fusion using 3 cannulated screws. His forward flexion was 90°; his maximum abduction was 40°.

Lenoir et al.[6] performed arthroscopic glenohumeral fusion in 8 patients with traumatic BPI. The mean time to fusion was 3 months; the mean American Shoulder

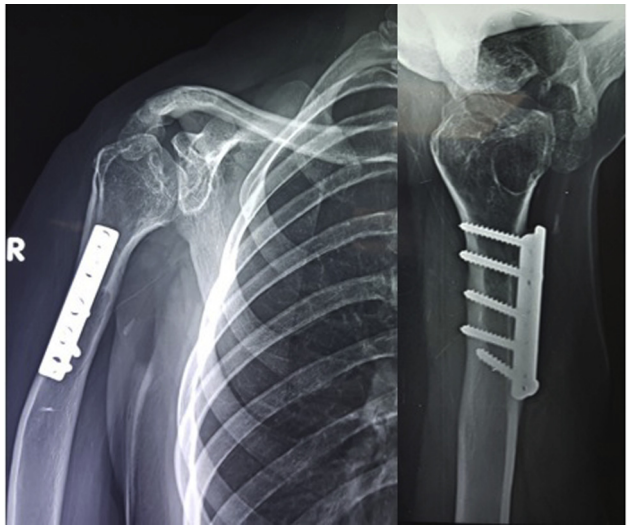

Fig 6. Anteroposterior and lateral radiographs of a patient's right shoulder with right-sided obstetric brachial plexus injury Narakas pattern 1 (Erb's palsy C 5,6). Radiographs show a fixed healed humeral derotation osteotomy 13 years ago, severe glenohumeral dysplasia with lost humeral head contour, hooked acromion, and irregular glenoid surface.

Fig 7. Coronal computed tomography films of the right shoulder show humeral head destruction and glenoid hypoplasia.

and Elbow Surgeons score was 69; the mean Disabilities of the Arm, Shoulder and Hand score was 36; and the mean Simple Shoulder Test score was 4. The mean active flexion and abduction were 80° (range, 60°-90°) and 59° (range, 40°-80°), respectively. They reported very few complications.

Syal and MacDonald[9] performed arthroscopic shoulder fusion on two patients with traumatic BPI using cannulated screws. They found that the technique is a reasonable and safe option for achieving symptomatic relief of refractory shoulder instability.

Fig 8. Axial computed tomography films of the right shoulder show flattening of the humeral head with glenoid hypoplasia and retroversion.

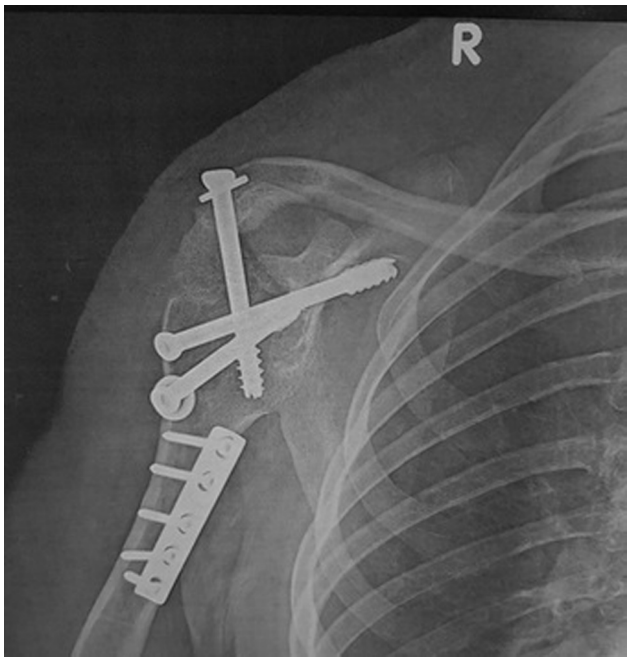

Fig 9. Follow-up radiograph (anteroposterior view) of the right shoulder shows complete sound fusion of the glenohumeral joint following arthroscopic shoulder arthrodesis.

Lädermann and Denard[7] described an arthroscopic-assisted shoulder arthrodesis using O arm—based navigation. They found that this technique allowed minimal surgical aggression and presented a suitable surgical solution for a 52-year- old woman with sequalae of obstetric BPI. The presented case was that of a younger patient (26 years old) and was submitted to multiple previous operations before shoulder fusion. Moreover, instead of an O arm, a conventional C arm fluoroscopy was used helped by the anterior cruciate ligament C guide for accurate screws' placement without any navigation.

Kamineni et al.[17] performed a systematic review on shoulder fusion in different shoulder pathologies and found that the arthroscopic-guided glenohumeral arthrodesis has better patient rehabilitation and satisfaction due to sparing of the deltoid muscle. They also confirmed the necessity of an anterior cruciate ligament zig or the help of the O-arm navigation for better screw insertion.

However, whereas in some studies that described the arthroscopic-assisted fusion only intra-articular fixation was performed, in the present arthroscopic technique, extra-articular fusion was also done after adequate preparation of the undersurface of the acromion.

Thangarajah and Lambert[18] emphasized that the main priority of glenohumeral arthrodesis in patients with BPI is to restore the shoulder girdle function as a platform for the remainder of the upper extremity, particularly if there is a powerful and functionally useful hand and forearm. This can be achieved by providing stability and reducing the pain from recurrent or persistent inferior glenohumeral subluxations. Arthrodesis remains a useful option in cases in which the rotator cuff function is absent and the deltoid function is less than grade 3, particularly if there is instability or articular surface damage at the glenohumeral joint. The main aim of management is to provide a stable shoulder that allows the hand to be positioned in space such that the patient can carry out basic functions of daily living activities.[19,20]

This report discusses the pearls and tricks of arthroscopic shoulder fusion technique in disorganized shoulders secondary to OBPI (Table 1).

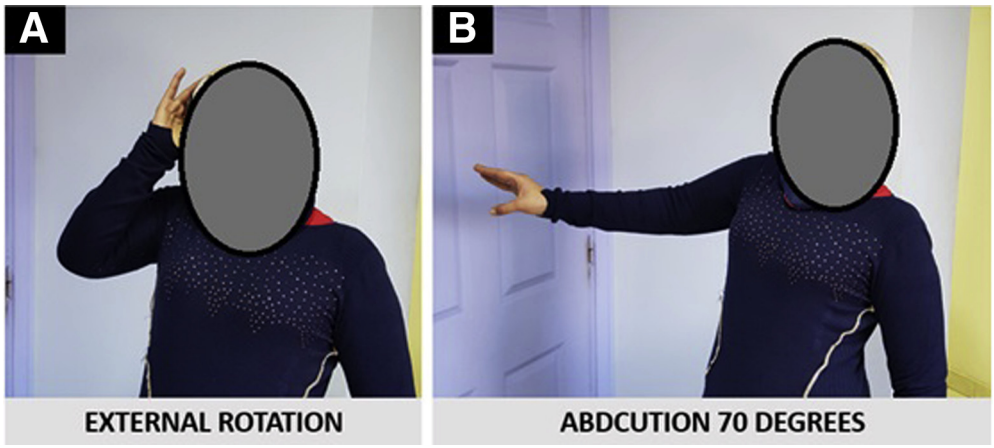

Fig 10. Active range of motion was achieved at the end of the follow up (9 months). (A) External rotation; (B) abduction up to 70°. Pain score improved from 7 to 1 after 6 months. The patient was satisfied with the surgery, as she was able to resume her daily activities with her right hand moving up to her mouth and hair.

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