Technical Note

Simple "Door-Locking" Technique Using One Single-Row Anchor for Repairing Large Bony Bankart Lesions

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Abstract: Large bony Bankart injuries are typically stabilized using screws or plates or multiple anchors. Here, the "door-locking" technique, using a single-row anchor, can provide effective fixation for massive bony Bankart injuries. This technique offers several advantages over open fixation surgery or other techniques that use more than 2 suture anchors, including simpler surgical procedures, lower medical costs, and satisfactory clinical outcomes.

A bony Bankart lesion involves a complex of the anterior inferior glenohumeral ligament and labrum combined with a small glenoid fracture.[1] The use of arthroscopic techniques with single-row or double-row suture anchors is a popular method for treating this condition, as they offer minimal trauma and quick recovery while restoring the stability of the shoulder joint.[2-4] However, when the fracture mass of the articular surface is greater than 25% of the scapular glenoid width (Kim grade type III), traditional open reduction and internal fixation with screws or plate is necessary to achieve satisfactory reduction and strong fixation.[5] Despite the success of these techniques, the opening procedures resulting in significant surgical trauma and can lead to post-operative complications such as bleeding, damage, and delayed recovery of shoulder joint function.[6,7]

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For a significant bony Bankart injury, it is uncommon to repair it using a single-row suture anchor. Here, the author used arthroscopic reduction and a single-row suture anchor to fix a large bony Bankart lesion (almost half of the glenoid) (Fig 1a-c), and the results of this technique demonstrated stable fixation and satisfactory restoration of shoulder function (Video 1). For this type of study, ethics approval was not required. Before the surgery, the patient was informed and provided writing consent in the clinic. This patient gave us permission to collect his clinical data and publish them, including general information, imaging, and video.

Surgical Technique (With Video Illustration)

The patient is positioned in the right lateral decubitus position, with the left upper arm suspended at an abduction angle of 45° and anterior flexion of 15° (Fig 2a). The arthroscope enters the glenohumeral joint cavity through the regular posterior observation channel and examines the glenoid labrum complex and the condition of the glenoid. The anterior approach serves as the operating channel. The fracture line is visualized, and the rotator cuff is assessed. The hematoma is cleaned up (Fig 2b), and the massive bony fracture is reduced by pulling. After careful observation, the attachment point and continuity of the inferior labrum are found to be normal at the inferior end of the fracture fragment (Fig 2c). The fracture fragment is effectively reduced using a gripper. For the superior end of the fragment, a single-row suture anchor (Bio-Push 4.5-mm; Arthrex, Naples, FL) is strategically inserted into the subchondral bone of the glenoid (Fig 2d). Two sutures are then passed through the capsule at the edge

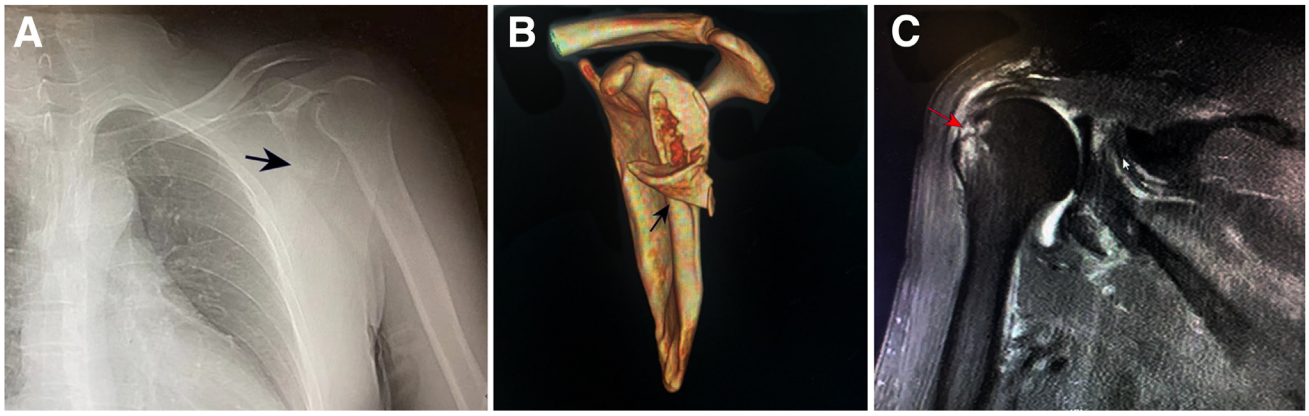

Fig 1. Results of imaging. 45-year old, male, Bony Bankart injury of left shoulder. (a) Anteroposterior radiograph shows a fracture of the glenoid (black arrow), with the humerus head located within the left shoulder joint. (b) Three-dimensional computed tomography (3D-CT) reveals significant displacement and rotation of a large fracture fragment (black arrow). (c) Magnetic resonance imaging (MRI) demonstrates edema and a fracture of the great tuberculum of the humerus, along with rotator cuff insertion injury (red arrow).

of the bony fragment, each keeping about 1 cm distance (Fig 2e). The fragment is secured to the glenoid with 2 knots, and the fixation strength and articular flatness are verified by probing (Fig 2f). The schematic diagrams of the "door-locking" technique indicate that the intact fragment is connected to a complete glenoid lip at its lower end, with its margin linked to the articular capsule. The anchor is inserted into the subchondral bone approximately up one-third of the fracture line (Fig 2g). The suture is threaded through the capsule, located 1 cm inferior to the anchor's level, and then tightly knotted to secure the fragment (Fig 2h).

After the surgical procedure, the patient's shoulder joint is maintained in a suspended position at a normal range of internal rotation (25°-30°) and elevation of 0° for a period of 6 weeks. Passive flexion and abduction are gradually initiated and limited to 90° 3 weeks' postsurgery, while external rotation is avoided. At the end of 6 weeks, the patient begins engaging in assisted exercises designed to strengthen the scapular stabilization muscles. These exercises include forward flexion, abduction, and cautious external rotation. By 12 weeks after surgery, the patient has fully recovered the range of motion and is encouraged to resume normal activities.

A follow-up radiograph and 3-dimensional computed tomography scan (Fig 3a and b) of the shoulder joint after surgery reveal that the glenoid fracture has properly healed in its anatomical position without displacement, resulting in a flat joint surface. The patient's joint stability is also normal, and they have regained functional activities close to their preinjury levels at 3 months' postoperation.

The equipment and anchor nail that used in the operation are listed in Table 1, including the brand name and manufacturer. Pearls and pitfalls of every step for this technique are listed in Table 2.

Discussion

Advances in arthroscopic techniques and instrumentation have bestowed substantial benefits to patients who undergo arthroscopic procedures for anterior glenoid rim fractures repair, particularly in terms of functionality and less iatrogenic damage, when compared with open surgeries.[8] Small- and medium-sized bony Bankart repairs using cannulated screws, as well as single-row or double-row suture anchors, have been widely studied.[8-11] In contrast, larger bony Bankart injuries (>25% of the glenoid) are typically fixed with reduction plates and screws,[12] or with arthroscopic procedures requiring more than 1 suture anchor.[13]

The minimally invasive "door-locking" technique requires only one suture anchor. Compared with open plate fixation, the "door-locking" technique causes less soft-tissue injury, bleeding, and lower medical costs. In addition, the patient experiences a benefit in earlier rehabilitation and function. Yoo and Song[14] reported a similar repair technique, which involved locking a "bucket-handle" type bony Bankart lesion by arthroscopic placement of knotless suture anchors. It was believed that attaching the labrum to this fragment facilitated reduction and fixation.[14] The "bucket-handle" type bony Bankart lesion refers to a fracture fragment with intact labrums at both ends. Overall, this case achieved satisfactory results up until the final follow-up. The advantages and disadvantages of this "door locking" technology are summarized in the Table 3.

Based on our understanding, the "door-locking" technique is not suitable for every type of bony Bankart injury and has specific indications. The bony Bankart injury is characterized by 3 main features: (1) at least one labrum of the displaced bony fragment must be intact at both end; (2) the bony fragment should be

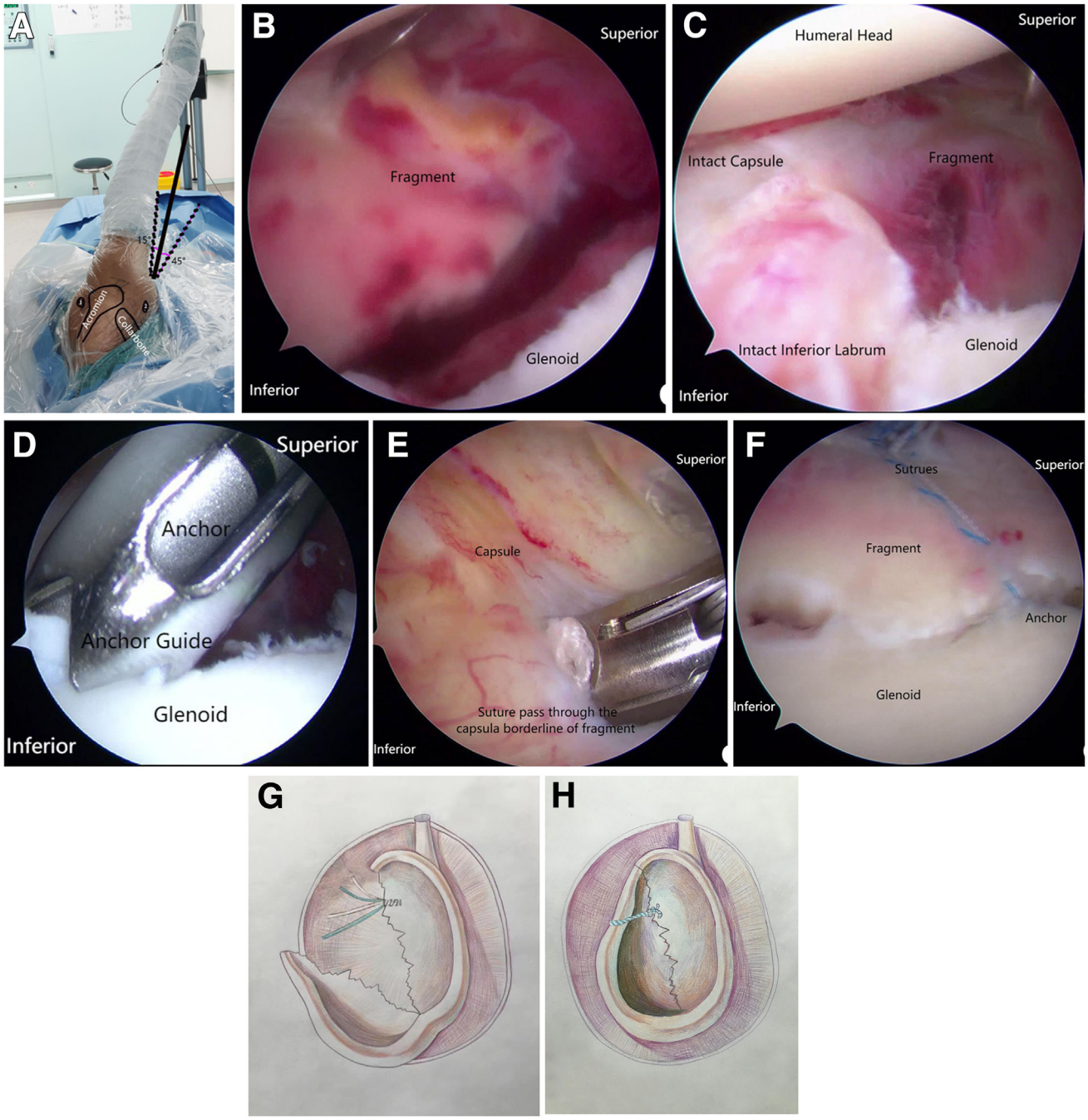

Fig 2. The key steps for surgical fixation of large bony Bankart injury. (a) The operation is performed in lateral decubitus position with upper arm suspend at an abduction angle of 45° and anterior flexion of 15°. Portal placements are labeled as follows: 1, standard posterior portal serves as the observation approach; 2, standard anterior portal serves as the operation approach. (b) After cleaning up the hematoma, the large bony fragment is attempted to be relocated using wire grabber pliers. (c) The integrity of the capsule and inferior labrum surrounding the borderline of the fragment is confirmed. (d) When using an anchor guide to place the anchor through the standard anterior portal, it is essential to take caution to ensure that the anchor is accurately positioned in the upper third of the glenoid fracture line. Moreover, the anchor should penetrate the subchondral bone to ensure robust fixation and stability. (e) Stitches passing through the borderline of the fragment's capsule are facilitated by sutures inserted through the assistance of a stitching apparatus. (f) As the sutures are tightened, the fragment is reduced and stabilized in place. (g) The schematic diagram indicates that the intact fragment is connected to a complete glenoid lip at its lower end, with its margin linked to the articular capsule. The anchor is inserted into the subchondral bone approximately up one-third of the fracture line. (h) The suture is threaded through the capsule, located 1 cm inferior to the anchor's level, and then tightly knotted to secure the fragment.

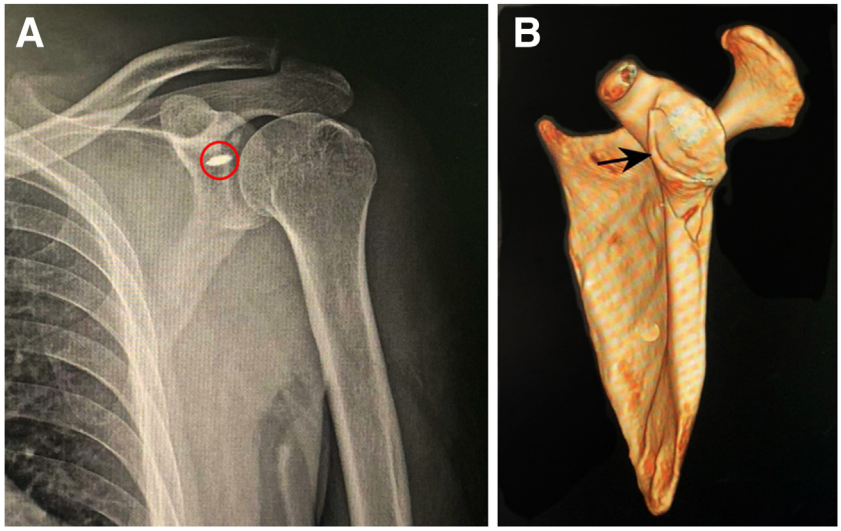

Fig 3. The imaging results postoperation. (a) Radiograph reveals the normal relationship between the humeral head and glenoid, with a red circle indicating the location of the anchor nail. (b) Three-dimensional computed tomography demonstrates that the gap between the bony fracture and glenoid is small, and the articular surface is smooth (black arrow).

entirely intact rather than shattered; and (3) the articular capsule surrounding the bony fragment must be intact. The glenoid labrum at the inferior end of the bony fragment provides a natural anchor point for the fixation of the bony fragment and restricts its movement. Moreover, the "door-locking" technique provides stability to the other end of the bony fragment. This technique operates on the principle of locking a door where both the articular capsule and the hard or serrated fracture surface served as the "door frame." Simultaneously, the labrum at the inferior end of the bony fragment served as a hinge, while the suture anchor at the superior end acted as a "lock" to restrict movement.

Moreover, it should be noted that even through the "door-locking" technique uses only one anchor, it provides comparable stability as the plate screw technique. This satisfactory outcome is attributed to the mechanical nature and glenohumeral contact patterns of the shoulder joints.[15] In comparison with the joints of lower lambs, the shoulder joint mainly carries centrifugal loads as opposed to centripetal loads when in a neutral position. Therefore, the load on the glenoid experiences less pressure and is unlikely to displace when the joint moves randomly, despite being fixed with a simple single-row anchor. The glenohumeral joint's anatomical structure characteristics play a critical role in determining the contact areas and patterns.[16] The contact areas were found to be the least at 0° elevation and 0° starting rotation in the scapular plane. At 0°, 60°-120°, and 180° of height in the scapular plane in starting rotation, the central glenoid contact regions were anterior, superior—anterior, and inferior—anterior, respectively. As the elevation increased from 0° to 60°, 120°, and 180° in the scapular plane, with 20° internal rotation, the central glenoid contact regions moved from the anterior—inferior to the anterior portion, and then to the inferior and posterior—inferior regions. Following the surgery, the shoulder joint was suspended at approximately 20° internal rotation and 0° elevation, resulting in minimal glenohumeral contact area and pressure from the humeral head, which had a negligible effect on the stability of the glenoid fragment during the early postoperative stage. During the early rehabilitation stage, as the range of motion in the shoulder joint increased, the loading locations on the glenoid primarily focused on superior or anterior—superior regions, which indicated a transition from the fracture area to the normal area. The single-row anchor technique employed in this study provided stable fixation of the massive glenoid fragments.

Nevertheless, the limitations and risks of this technique cannot be ignored (Table 4). First, the indication for this "door-looking" technique is limited to cases that do not involve bony Bankart injuries with more than 2

Table 1. The Brand Name and Manufacturer of Equipment Used in Operation

Equipment	Brand Name	Manufacturer
Arthroscopic system	Smith & Nephew	Smith & Nephew (Andover, MA)
DYNAMICS POWER 4.5-mm synovial planer	Smith & Nephew	Smith & Nephew (Andover, MA)
FASTIN RC	Depuy Mitek	DePuy Mitek (Raynham, MA)

Table 2. Pearls and Pitfalls of Every Step for this "Door-Locking" Technique

Steps	Pearls	Pitfalls
Preoperation examinations of CT-3D and MRI	The 3D CT of the separated humerus head and glenoid provides a clear visualization of the glenoid fracture condition The MRI scan reveals damage to the soft tissue, especially the rotator cuff	An inadequate and cursory assessment through imaging can lead to the missed diagnosis of microfractures or soft-tissue injuries, ultimately leading to the implementation of an incorrect treatment strategy
Patient lateral positioning	The abduction traction of the shoulder joint ensures sufficient operating space in the glenohumeral joint	Excessive traction can heighten the risk of soft-tissue injuries around the shoulder joint, including the brachial plexus and rotator cuff
Intraoperative exploration and clearance	Thorough debridement and detailed exploration will help to understand the damage to the fracture block and the surrounding glenolabial and joint capsule, which is important to determine whether a single anchoring fixation technique is appropriate	Incomplete debridement can lead to hazy surgical visualization, thereby increasing the complexity of the surgical procedure Failure to find the multiple fragments, tearing capsule and glenoid lip surrounded fragment, can elevate the risk of fixation instability when using a single anchor
The positions of the nail and the suture line	The nail was inserted into the subchondral bone and the upper third of the fracture line to provide strong pull-out resistance The suture line throughout the capsule surrounding the fragment at 1 cm below the level of the nail to pull up and retract the fragment	Placement into the cancellous bone can be easily pulled out The suture line and nail at the same level cannot pull the fragment up, and the fragment is prone to descending due to the pressure exerted by the humerus head
Rehabilitation plan postoperation	Limitation rang of should joint 6 months after operation is good for fracture healing and avoiding dislocation	Too much movement too early can lead to the dislocation of the fracture mass

3D-CT, 3-dimensional computed tomography; MRI, magnetic resonance imaging.

fractural fragments, as well as cases involving lacerated glenolabial complexes at both ends. Second, the single anchor offers soft fixation, which lacks the strong mechanical stability provided by steel plate or hollow screw (known as hard fixation). Consequently, there is a greater risk of loss of fracture fragment location. Third, the early postoperative range of motion of the shoulder joint is restricted to minimize stress on the fracture fragment. This is because the "door-locking" technique provides inferior strength, compared with hard fixation or multiple anchor-fixation techniques. Limited movement can easily increase the risk of capsular adhesions and muscular atrophy. Fourth, the "door-locking" technique is exceedingly challenging for young surgeons to accomplish proficiently, and exceptional surgical skill is needed to ensure the nail placement and line crossing.

In addition, this study only involved one case, which cannot represent the common phenomenon of glenoid fracture. Further investigations with a large number of cases are necessary to demonstrate the effectiveness of this "door-locking" technique. what's more, the follow-up period was not long enough, and continued observation is required to evaluate the displacement of the bony fragment and shoulder function. We also acknowledge that our fixation principle was based on theoretical inference and lacks a mechanical model to validate its rationale.

Table 3. Advantages and Disadvantages of "Door-Locking" Technology

Advantages	Disadvantages
Minimally invasive surgical treatment, less medical injury, and fast rehabilitation	The surgical indication for this technique is rigorous; it needs experimented surgeons to screen for appropriate cases
The lateral positioning and traction of the upper limb effectively maintains the femoral head away from the glenoid, thereby providing ample room for surgical maneuvering	The surgeon must possess highly skilled arthroscopy operation skills and experience The learning curve for this technique to repair bony Bankart injuries is rather extensive
Single-anchor fixation offers shorter operation time and reduced medical costs	Single-anchor fixation still poses a potential risk of dislocation of the fracture fragment

Table 4. Limitations and Risks of the "Door-Locking" Technique

Limitations	Risks
Strict indication, not for the comminuted fracture or with lacerated glenolabial complex at both ends of fracture fragment	Suitable only for patients with the special type of bony Bankart injury
Compared with plates or screws, the single anchor cannot offer as robust mechanical fixation	A potential risk of dislocation of the fracture fragment
The early postoperative range of motion of the shoulder joint is restricted	Increase the risk of capsular adhesions and muscular atrophy
Surgeons must possess exceptional surgical skill	It is exceedingly challenging for young surgeons to accomplish proficiently

The "door-locking" technique, using a single-row anchor, can provide effective fixation for a massive bony Bankart injury, if at least one end of the bony portion connected to the labrum remains intact, and the entire bony fragment maintain its integrity. Its benefits include simpler surgical procedures, lower medical costs, and satisfactory clinical outcomes compared with open fixation surgery or other techniques that use more than 2 suture anchors.

Disclosures

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References

1. Nolte PC, Elrick BP, Bernholt DL, Lacheta L, Millett PJ. The bony Bankart: Clinical and technical considerations. *Sports Med Arthrosc Rev* 2020;28:146-152.
2. DeFroda SF, Perry AK, Bodendorfer BM, Verma NN. Evolving concepts in the management of shoulder instability. *Indian J Orthop* 2021;55:285-298.
3. Greenstein AS, Chen RE, Knapp E, et al. A biomechanical, cadaveric evaluation of single-versus double-row repair techniques on stability of bony Bankart lesions. *Am J Sports Med* 2021;49:773-779.
4. Liles J, Fletcher A, Johnston T, Riboh J. Arthroscopic double-row bony Bankart bridge repair using a tensionable knotless system. *Arthrosc Tech* 2021;10:e957-e962.
5. Kim YK, Cho SH, Son WS, Moon SH. Arthroscopic repair of small and medium-sized bony Bankart lesions. *Am J Sports Med* 2014;42:86-94.
6. Bonnevialle N, Clavert P, Arboucalot M, et al. Contribution of arthroscopy in the treatment of anterior glenoid rim fractures: A comparison with open surgery. *J Shoulder Elbow Surg* 2019;28:42-47.
7. Beletsky A, Cancienne JM, Manderle BJ, Mehta N, Wilk KE, Verma NN. A comparison of physical therapy protocols between open Latarjet coracoid transfer and arthroscopic Bankart repair. *Sports Health* 2020;12:124-131.
8. Davis SM, Field LD. Arthroscopic techniques to stabilize glenoid bony Bankart fragments. *Arthrosc Tech* 2022;11:e1547-e1550.
9. Park I, Lee J-H, Hyun H-S, Oh M-J, Shin S-J. Effects of bone incorporation after arthroscopic stabilization surgery for bony Bankart lesion based on preoperative glenoid defect size. *Am J Sports Med* 2018;46:2177-2184.
10. Ganokroj P, Keyurapan E. Arthroscopic bony Bankart repair using a double-row double-pulley technique. *Arthrosc Tech* 2019;8:e31-e36.
11. Chen AZ, Greaves KM, deMeireles AJ, Fortney TA, Saltzman BM, Trofa DP. Clinical outcomes of arthroscopic bony Bankart repair for anterior instability of the shoulder: A systematic review. *Am J Sports Med* 2022;51:2758-2765.
12. Giordano V, Pires RE, Labronici PJ, et al. Open reduction and internal fixation of Ideberg type IA glenoid fractures: Tricks, pearls, and potential pitfalls based on a retrospective cohort of 33 patients focusing on the rehabilitation protocol. *Eur J Orthop Surg Traumatol* 2023;33:571-580.
13. Gaetke-Udager K, Yablon CM. Fractures around the shoulder: Radiologic update on surgical fixation techniques. *Semin Musculoskelet Radiol* 2019;23:99-108.
14. Yoo YS, Song HS. Locked bucket-handle type bony Bankart lesion resulting from manipulation. *Knee Surg Sports Traumatol Arthrosc* 2016;24:1896-1899.
15. LeVasseur MR, Mancini MR, Hawthorne BC, Romeo AA, Calvo E, Mazzocca AD. SLAP tears and return to sport and work: Current concepts. *J ISAKOS* 2021;6:204-211.
16. Soslowsky LJ, Flatow EL, Bigliani LU, Pawluk RJ, Ateshian GA, Mow VC. Quantitation of in situ contact areas at the glenohumeral joint: A biomechanical study. *J Orthop Res* 1992;10:524-534.