Technical Note

Arthroscopic Treatment of Snapping Scapula Syndrome With Scapulothoracic Bursectomy and Partial Scapulectomy

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Abstract: Snapping scapula syndrome (SSS) is a painful and debilitating condition that occurs as a result of disruption of normal scapulothoracic articulation and inflammation of numerous soft tissue and bursal structures that function to facilitate scapulothoracic motion. Historically, when nonoperative management of SSS failed, patients progressed to open surgical management. However, as arthroscopic techniques have evolved, the condition has been increasingly treated arthroscopically because of the minimally invasive nature, periscapular muscle-preserving approach with decreased risk to surrounding neurovascular structures, better intraoperative visualization, and quicker patient recovery and rehabilitation. The objective of this Technical Note is to describe our arthroscopic approach for the management of SSS using two portals to complete a scapulothoracic bursectomy and partial scapulectomy of the superomedial scapula. Level of Evidence: Level I: shoulder

Introduction

The concave anterior scapula and the convex thoracic wall constitute an anatomical mismatch.[1,2] Various soft tissue interpositions and bursae ensure sufficient scapulothoracic gliding motion.[1] However, anatomical deviations contributing to this interaction can lead to the rare entity of the snapping scapula syndrome (SSS).[3] This clinical condition can range from mildly symptomatic, intermittent bursitis to debilitating recalcitrant crepitus.[4] In many cases, the exact etiology remains unclear but potential causes are posttraumatic changes, Luschka tubercles, osteochondromas, subscapular elastofibromas, anterior angulation of the medial scapula, and an excessively concave scapula.[3-5]

In general, one can distinguish a symptomatic bursitis as a result of overuse in overhead athletes or persistent mechanical irritation due to anatomical abnormalities resulting in concomitant inflammation and ultimately SSS.[4] Initial nonoperative management with NSAIDs, corticosteroid injections, and physiotherapy to strengthen the periscapular muscle to correct posture and deficiencies regarding the subscapularis and serratus anterior is indicated.[1,6] If nonoperative treatment fails or provides merely transient relief after a corticosteroid injection, surgical intervention may be required.

Various open and arthroscopic approaches have been described in the literature aiming to remove inflamed portions of the extended scapulothoracic supraserratus and infraserratus bursae. Additionally, some cases involve a trapezoid bursae resection (located posterior

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to the scapula), as well as a partial scapulectomy. Open approaches are comparatively invasive and involve splitting the trapezoid muscle while preserving the spinal accessory and dorsal scapular nerves, allowing the rhomboid and levator scapulae to be elevated and bursal tissue removed.[1] Lastly, if needed, the superomedial angle of the scapula can be excised, and the detached muscle groups are reattached to the scapula.[1] This requires postoperative immobilization in a shoulder sling for at least 4 weeks to facilitate muscle healing. Active motion can be reached in 8 weeks.[1] With the aim of a less invasive approach, arthroscopic techniques have gained popularity, keeping periscapular muscles intact and leading to less strict postoperative management.[4,7]

Detailed knowledge about the arthroscopic anatomy is crucial, in particular, attention must be focused on the location of the spinal accessory nerve, dorsal scapular nerve, dorsal scapular artery, and suprascapular nerve.[4] Knowing their anatomical landmarks and preserving these neurovascular structures are fundamental for the arthroscopic approach, which provides a minimally invasive option to address the superomedial angle of the scapula and subserratus space, as well as to perform the bursectomy, adhesiolysis and scapuloplasty.[8] In this Technical Note, we describe our preferred arthroscopic approach for the management of SSS using two arthroscopic portals to complete a scapulothoracic bursectomy and partial scapulectomy of the superomedial scapula (Video 1). Pearls and pitfalls based on nearly two decades of SSS management are also discussed herein.

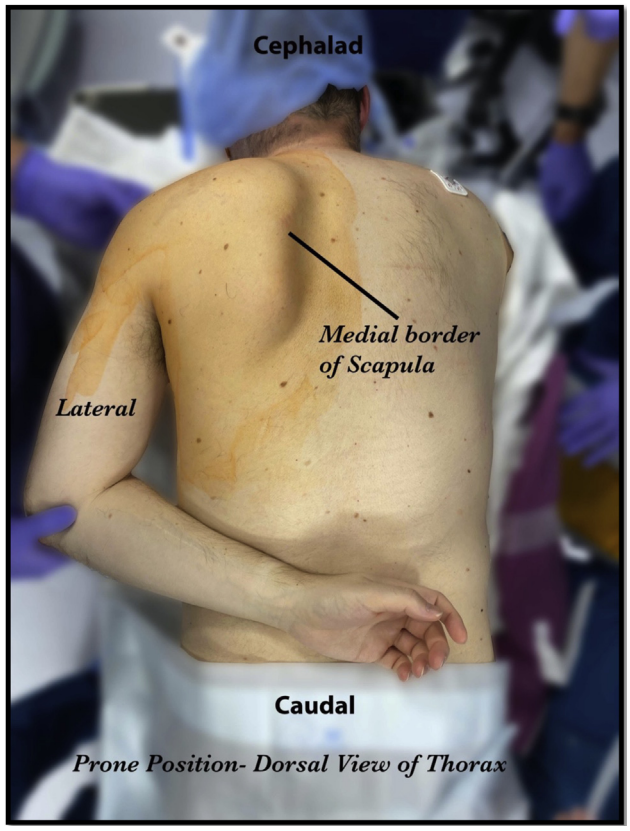

Fig 1. Arthroscopic access to the subscapular space is enhanced with specific patient positioning. While the patient is prone, the operative arm is positioned in a "chicken-wing" position, where the shoulder is abducted and extended, the elbow is flexed, and the dorsum of the hand is placed against the dorsal surface of the patient's torso. To increase visualization, the elbow may be further flexed to draw the hand further cephalad. This position preferentially elevates the medial scapula away from the thoracic wall.

Surgical Technique

Patient Positioning and Anesthesia

Following induction of anesthesia, the patient is placed in the prone position. Care is taken to ensure all bony prominences are well padded including the chest, anterior pelvic structures, knees, and shins. The operative (left) arm is abducted and internally rotated, and the elbow is flexed to bring the dorsal hand in contact with the dorsal surface of the torso. This is the "chicken-wing" position, which draws the medial scapula away from the thoracic wall and opens the subscapular space (Fig 1). A rolled towel is placed anterior to the left shoulder to elevate the shoulder away from the bed and improve the scapula winging position. The table is then placed in reverse Trendelenburg of ~15° and then rotated so the patient's nonoperative side is rotated toward the floor. We then surgically prep and drape the patient's operative side, making sure the arm is free and taking care to ensure all aspects of the anterior and axillary regions of the shoulder are properly prepped and draped.

Portal Placement, Diagnostic Arthroscopy, and Scapulothoracic Bursectomy

Following a team timeout and antibiotic administration, a preoperative examination under anesthesia is performed and used to identify location of crepitus and mark areas of resection. The patient's operative dorsal shoulder landmarks are marked with solid lines, notably the inferior aspect of the scapula, medial scapular border, superomedial scapular border, and scapular spine are all marked. The surgeon should ensure adequate space between portal placement and the medial scapular border to prevent damage to the dorsal scapular artery and nerve (Fig 2A). For the inferior viewing portal, the skin is incised 2.5 cm medial to the medial border of the scapula and at an appropriate distance distal from the superior margin of the scapula to allow the arthroscopic trocar to reach the area of resection when placed through the portal (Fig 2B). The arthroscopic pump should be maintained under 50 mm Hg to prevent excessive extravasation of

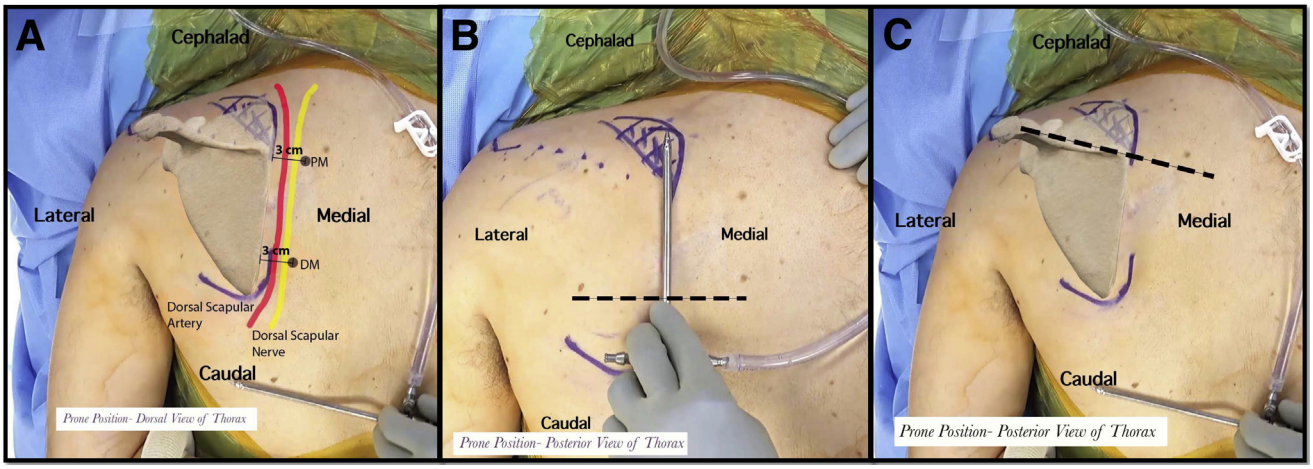

Fig 2. (A) Portal placement for arthroscopic partial scapulectomy relies on an understanding of the surrounding anatomy. Two portals are placed medial to the medial scapular border. (B) The inferior portal is placed so that the tip of the arthroscopic trochar can reach the superior scapular border with the trochar collar hubbed at the portal site. (C) The superior portal should be positioned at the same distance from the medial scapular border and placed in line with the scapular spine.

fluid. The arthroscope is introduced, followed by creation of the superomedial portal, which is established with a 5-mm cannula (Arthrex, Naples, FL) under direct visualization. This is localized ~2.5 to 3 cm medial to the medial border of the scapula and in line with or distal to the extension of the scapular spine (Fig 2C). Each portal is intentionally established at least 2.5 cm medial to the medial scapular border to endure not to violate the dorsal scapular nerve and artery. By staying distal to the spine of the scapula, one avoids the main branch of the dorsal scapular nerve. A 4.0-mm arthroscopic shaver is then introduced into the scapulothoracic space, and scapulothoracic bursectomy is performed. A combination of radiofrequency ablation and arthroscopic shaving removes the bursal tissue and associated fibrotic adhesions. Throughout the scapulothoracic decompression, care is taken to prevent violation of the thoracic wall to make sure instrumentation remains superficial to the intercostal musculature and ribs. The subscapular space prebursectomy and postbursectomy can be seen in Fig 3, A and B, respectively. Additionally, during the scapulothoracic

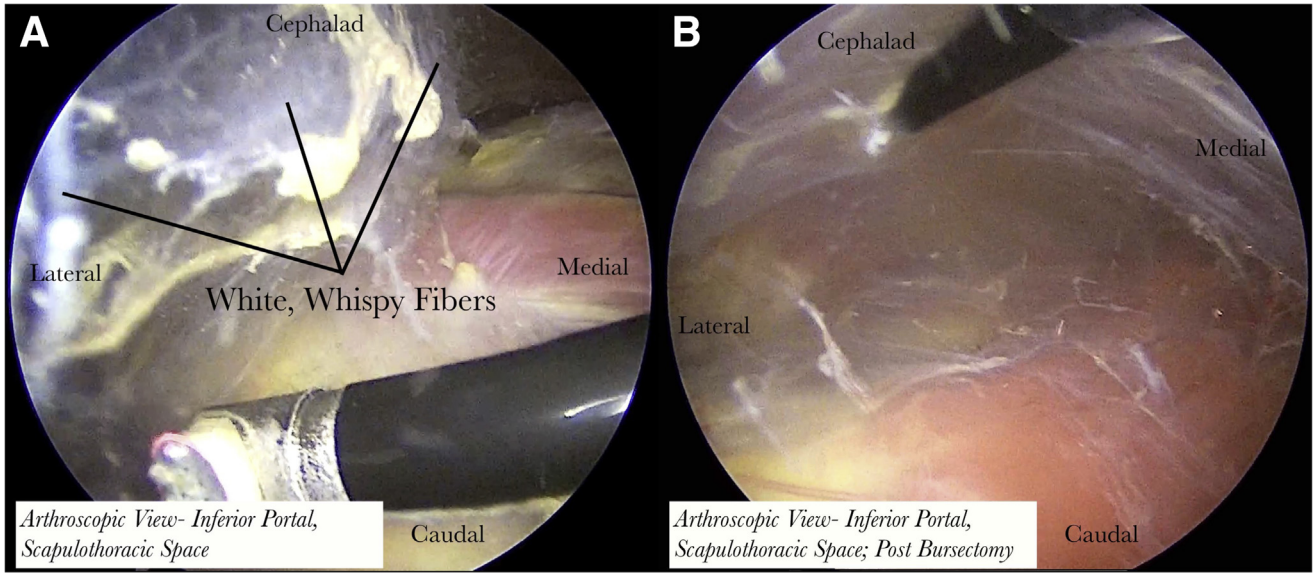

Fig 3. Once the arthroscopic camera is placed into the subscapular space, the surgeon should be able to visualize the subscapular bursa. (A) This area is traditionally described as having wispy, white fibers that have the appearance of spider webs. If the camera is intramuscular and red muscle fibers are visualized, the arthroscope should be removed and repositioned. (B) Once properly resected, the surgeon should be able to adequately visualize the dorsal thoracic wall and the deep surface of the subscapularis muscle.

bursectomy, the shaver and radiofrequency ablation device should not be used to resect beyond the medial border of the scapula to protect the dorsal scapula artery and nerve, as well as the rhomboid musculature.

Partial Superomedial Scapulectomy

Next, an 18-gauge spinal needle is inserted along the superior margin of the scapula and helps define the area of the intended resection. The scapulothoracic space is entered just cranial to the superior osseous margin of the scapula (Fig 4A). The needle is advanced into the space to mark the superior edge of the scapula, and then is pulled back, so as not to interfere with partial scapulectomy. Then, using a combination of the arthroscopic shaver, a burr (Arthrex, Naples, FL), and a powered arthroscopic rasp (PowerRasp, Arthrex), the surgeon performs the partial scapulectomy. In total, ~3 cm by 2 cm of bone is removed from the superomedial scapula, which is measured directly from the superomedial apex of the scapula. The resection is completed in an oblique fashion, resulting in a triangular shaped area of resection from the superomedial scapula. The scapula is quite thin, so the bone needs to be contoured carefully to eliminate any sharp edges. Once the resection is completed, the spinal needle can be advanced back into the subscapular space and used as a reference to directly visualize the amount of bony resection. Once complete, a dynamic exam is performed by ranging the operative extremity in varying positions of abduction to ensure resolution of any mechanical compression against the underlying thoracic rib cage.

If the patient has symptoms along the inferior pole of the scapula, the arthroscopic camera can be switched to the superomedial portal, and the arthroscopic shaver and ablation device can be used to complete an inferior bursectomy and partial scapulectomy in a similar fashion.

Following completion of the scapulectomy and bursectomy, flow pressure should be decreased to allow for identification and cauterization of any bleeding. The inflow is then disconnected, and suction is attached to the trocar outflow to help remove excess arthroscopy fluid. Given the tendency for fluid extravasation to the surrounding soft tissue, musculature, chest wall and breast, the surgeon should gently roll towels toward the arthroscopic portals to help remove excess fluid. Throughout the course of the procedure, the surgical anesthesia team and postoperative care team members are made aware of the potential for fluid extravasation, and blood pressure is monitored carefully with relative hypotension to decrease the need for higher arthroscopic pump pressures, as well as careful monitoring of the pericervical region to prevent excessive swelling.

Procedure Completion and Closure

Following completion of the scapulothoracic bursectomy and superomedial scapulectomy, the portal sites are closed with 3-0 nylon in standard fashion. Typically, long-acting local anesthetics are injected into the

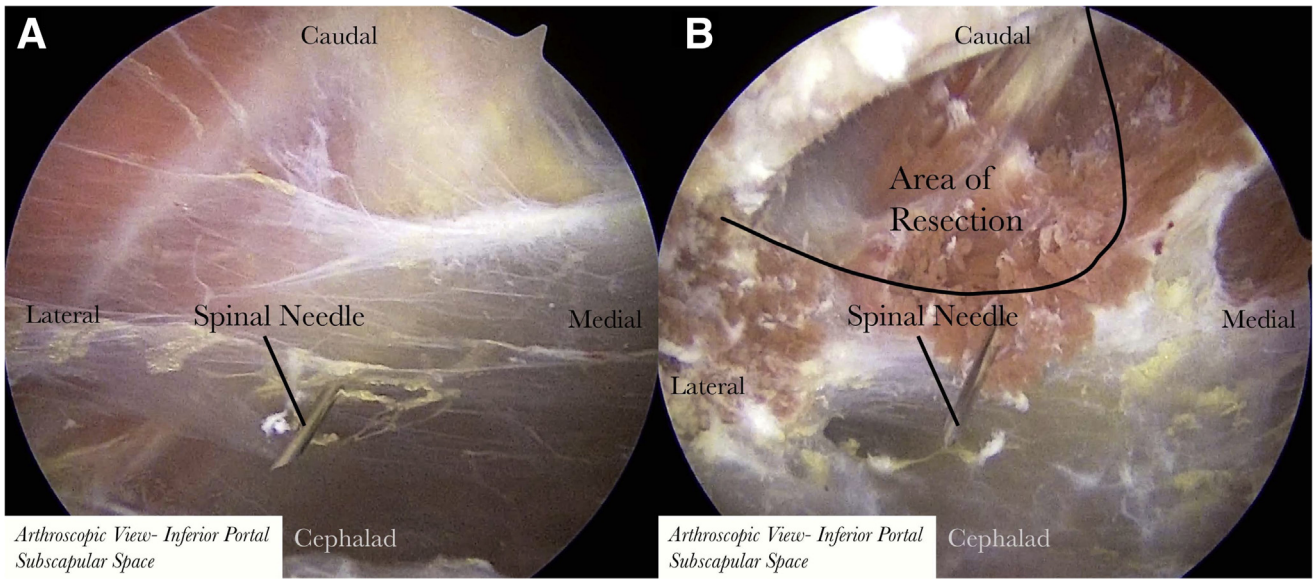

Fig 4. In order to properly evaluate the amount of boney resection during partial scapulectomy, an 18-gauge spinal needle can be used as a reference. (A) Prior to resection, the needle is advanced into the subscapular space just cephalad to the superior medial scapular border. (B) Once the bony margin is identified, the needle can then be pulled back, so that it keeps its position but will not interfere with the partial scapulectomy. Following completion of bony resection, the needle can be advanced back into the subscapular space and used as a reference to evaluate the amount of scapulectomy performed.

Table 1. Pearls and Pitfalls

Pearls	Pitfalls
Positioning the patient in the "chicken-wing" position allows for increased scapulothoracic space (Fig 1).	Inferomedial portal placement too inferior results in insufficient visualization during superomedial scapula dissection and scapulectomy.
Establishment of the inferomedial portal should allow the camera to reach the superomedial aspect of the scapula (Fig 2).	Portal placement if too close of proximity to the medial scapular border increases risk of damage to the dorsal scapular nerve.
Establish both the superomedial and inferomedial portal ~2.5-3 cm medial to medial scapular border to prevent neurovascular injury.	Violation of the intercostal musculature and thoracic wall during bursectomy and scapular resection may result in the development of a pneumothorax.
Spinal needle placement at the superomedial angle of the scapula allows for effective marking of the initial osseous border of the scapula and subsequent quantification of scapular resection (Fig 4).	Injury to surrounding vasculature can be challenging to manage arthroscopically and may necessitate the need for open management.

surgical site using the same spinal needle that was used to mark the scapular resection.

Postoperative Rehabilitation

Postoperatively, a sling is used for patient comfort as needed. The patient should begin working with a therapist immediately to prevent periscapular adhesions and improve scapular mobility. The patient may progress to full active range of motion and full weight bearing.

Discussion

Recalcitrant SSS caused by scapular and soft tissue anomalies, resulting in impingement and subsequent inflammation of surrounding structures can lead to significant disability and pain.[1,3,9] The surgical technique presented herein allows the operating surgeon to perform an entirely arthroscopic scapulothoracic bursectomy and partial scapulectomy. The goal of this procedure is to remove anomalous anatomic structures such as fibrous bands, Luschka tubercles, or other bony and/or soft tissue growths in an effort to allow for smooth and painless scapulothoracic articulation.[6,10] The technique aims to minimize risk to surrounding neurovascular structures by using two portal sites that are positioned in anatomic safe zones.[11] Despite the ever-present risk to surrounding neurovascular structures, namely, the superficial branch of the transverse cervical nerve, spinal accessory nerve, suprascapular nerve, and dorsal scapular neurovascular structures, we believe that with attention to neurovascular anatomy when placing portals, this technique can be performed safely and effectively. Furthermore, in the setting of proper patient selection,[12,13] this procedure has been shown to yield favorable and reproducible results as reported by Menge et al.[5]

Other approaches to arthroscopic scapulothoracic decompression and partial scapulectomy have been described.[14,15] Saper et al. described an arthroscopic two-portal technique; however, their technique uses two superior based portals—one proximal (Bell's portal) and one medial to the superior angle of the scapula.[14] Additionally, Andreoli et al. describe using a superomedial portal (Ejnisman's portal), in addition to a second portal in line with the scapular spine.[15] Although these approaches provide adequate access to the superomedial aspect of the scapula, allowing for decompression and partial scapulectomy,[14,15] the presented technique carries these same advantages among others. When using one portal located inferomedially to the scapula and a second medial to the scapular spine, as described in our technique, there is a lower risk of injury to the suprascapular nerve due to the avoidance of the suprascapular region, as well as increased access to the more inferior aspects of the scapulothoracic space.[9] This is advantageous in cases in which crepitus is noted at the inferomedial aspect of the scapula requiring an inferomedial scapulectomy in addition to the routinely performed infraserratus bursectomy. In addition, when performed by an experienced surgeon, initial placement of the inferomedial portal may carry a lower risk of intrathoracic penetration secondary to an improved angle of insertion with the patient positioned in the "chicken-wing" position. Qualitative anatomical studies are outstanding and needed to verify this clinical observation.

Although the benefits of our technique are significant, the following should be taken into consideration (Table 1). First, care must be taken to place the inferomedial portal in a position that will allow the tip of the trocar to reach the superomedial aspect of the scapula. If the portal is established too inferiorly, arthroscopic dissection and partial scapulectomy become increasingly challenging and may result in insufficient scapular resection. Additionally, if either the superomedial or inferomedial portals are established without adequate distance between the portal and the medial scapular border, there is increased risk of damage to the dorsal scapular nerve and artery. Additionally, the patient should be counseled preoperatively and reassured

postoperatively that the fluid induced swelling to the neck and anterior chest is anticipated and will resolve in 1-2 days.

SSS is an underdiagnosed and painful condition that often impacts young, active patients and creates lasting symptoms and disability.[3,9] In this Technical Note, we present a technique for arthroscopic management of SSS that includes scapulothoracic bursectomy and superomedial partial scapulectomy, which has been refined over nearly two decades of experience. Furthermore, the presented approach is effective, proven, and reproducible while minimizing the risks associated with this challenging procedure.

References

1. Gaskill T, Millett PJ. Snapping scapula syndrome: diagnosis and management. *J Am Acad Orthop Surg* 2013;21:214-224.
2. Spiegl UJ, Petri M, Smith SW, Ho CP, Millett PJ. Association between scapula bony morphology and snapping scapula syndrome. *J Shoulder Elbow Surg* 2015;24:1289-1295.
3. Warth RJ, Spiegl UJ, Millett PJ. Scapulothoracic bursitis and snapping scapula syndrome: A critical review of current evidence. *Am J Sports Med* 2015;43:236-245.
4. Millett PJ, Gaskill TR, Horan MP, van der Meijden OA. Technique and outcomes of arthroscopic scapulothoracic bursectomy and partial scapulectomy. *Arthroscopy* 2012;28:1776-1783.
5. Menge TJ, Horan MP, Tahal DS, Mitchell JJ, Katthagen JC, Millett PJ. Arthroscopic treatment of snapping scapula syndrome: Outcomes at minimum of 2 years. *Arthroscopy* 2017;33:726-732.
6. Manske RC, Reiman MP, Stovak ML. Nonoperative and operative management of snapping scapula. *Am J Sports Med* 2004;32:1554-1565.
7. Nicholson GP, Duckworth MA. Scapulothoracic bursectomy for snapping scapula syndrome. *J Shoulder Elbow Surg J* 2002;11:80-85.
8. Bhatia DN. Scapulothoracic endoscopy for the painful snapping scapula: Endoscopic anatomy and scapuloplasty technique. *Arthrosc Tech* 2015;4:e551-e558.
9. Kuhne M, Boniquit N, Ghodadra N, Romeo AA, Provencher MT. The snapping scapula: diagnosis and treatment. *Arthroscopy Nov* 2009;25:1298-1311.
10. Aggarwal A, Wahee P, Harjeet Aggarwal AK, Sahni D. Variable osseous anatomy of costal surface of scapula and its implications in relation to snapping scapula syndrome. *Surg Radiol Anat* 2011;33:135-140.
11. Ruland LJ 3rd, Ruland CM, Matthews LS. Scapulothoracic anatomy for the arthroscopist. *Arthroscopy* 1995;11:52-56.
12. Ernat JJ, Millett PJ. Editorial commentary: Snapping scapula syndrome: Predictors of outcomes after arthroscopic treatment. *Arthroscopy* 2020;36:2973-2974.
13. Tytherleigh-Strong G, Gill J, Griffiths E, Al-Hadithy N. Prognosis after arthroscopic superior medial scapuloplasty for snapping scapula syndrome improves after a transient beneficial response with an ultrasound-guided subscapular cortisone injection. *Arthroscopy* 2020;36:2965-2972.
14. Saper M, Kasik C, Dietzel D. Arthroscopic scapulothoracic decompression for snapping scapula syndrome. *Arthrosc Tech* 2015;4:e631-e636.
15. Vicente Andreoli C, de Castro Pochini A, Diniz Carvalho C, et al. Superomedial portal (Ejnisman's portal) and modified "chicken-wing" patient position for scapulothoracic arthroscopy. *Arthrosc Tech* 2020;9:e51-e55.