Technical Note

Anatomical Description and Technical Considerations of the Portal of Willingboro for All-Arthroscopic Biceps Tenodesis

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Abstract: The portal of Willingboro is a unique portal designed as a means of all arthroscopic biceps tenodesis for biceps tendinopathy. The portal allows for tenodesis to be efficiently and effectively performed in the subgroove space with low technical demand. This Technical Note provides detailed descriptions of the anatomical structures and standard shoulder arthroscopy portals relevant to the location of the portal of Willingboro. The structures discussed include the standard anterior, posterior, and lateral shoulder arthroscopy portals along with the axillary and musculocutaneous nerves, subscapularis and pectoralis major tendons, axillary artery, and major bony anatomic landmarks of the shoulder region. These descriptions may be used as a guideline or reference for safe creation of the portal of Willingboro.

Biceps tendinopathy can be a significant pain generator in affected patients. When conservative measures fail, surgical intervention for biceps tenotomy/tenodesis has been shown to provide excellent outcomes.[1] In the setting of biceps tenodesis, numerous areas have been described for the site of tenodesis with good success.[2] Among these locations are intra-articular, within the groove, suprapectoral, below the groove, and subpectoral.[2,3]

Recently, a technique was described for an all-arthroscopic below-the-groove/suprapectoral tenodesis using unicortical button fixation.[4] To facilitate this procedure, a unique portal, known as the portal of Willingboro (POW), was used. This approach to tenodesis is performed entirely arthroscopically, using a modified lateral portal for viewing, along with the POW as the working portal for tenodesis of the long head of the biceps superior to the pectoralis major tendon insertion on the humerus.[4] Although the technique has been well described and demonstrated in video media, localization and use of the portal have only been touched on briefly. The aim of this Technical Note is to further characterize the POW in terms of anatomical landmarks for proper portal placement as well as relevant neurovascular and musculotendinous anatomy to avoid iatrogenic injury.

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Surgical Technique

Positioning and Anatomic Marking

Patients may be positioned in the beach-chair or lateral decubitus position. The lead author's position of choice is the lateral decubitus position. There are several reasons for this preference, including the ability to stand at the head of the bed for ease of working and the ability to open up the subdeltoid space by having the patient's arm abducted and forward flexed away from the body. The arm is abducted approximately 45° and forward flexed 10 to 15° with 10 pounds of lateral arm distraction. An Ioban (3M, St. Paul, MN) is placed in the axilla region to aid in sterility.

The superior aspect of the shoulder is marked before the start of the case. Standard structures are identified, including the acromion, acromioclavicular joint, coracoid, confluence of the clavicle and acromion, and the long head of the biceps tendon (LHBT). Direct palpation of the anterolateral edge of the acromion, coracoid process, and LHBT can usually be performed and marked accordingly (Fig 1).

Portal Placement

Video 1 demonstrates the placement of the POW and the use of this portal for biceps tenodesis. The technique requires 2 additional portals from the standard posterior and anterior portals for shoulder arthroscopy. The viewing portal for this technique requires a modified lateral portal to enter the subdeltoid space (Fig 2). This modified lateral portal is created at the anterior one-third of the lateral border of the acromion and approximately 2 cm inferior from its edge, as seen in figure. The scope trochar is then introduced through the modified lateral portal onto the humeral head and then directed on a 45° trajectory anterior and inferior into the subdeltoid space. The subdeltoid space is a theoretical space deep to the deltoid muscle, superficial to the rotator cuff and glenohumeral joint capsule, which provides viewing access to the LHBT as it exits the rotator interval and transverse humeral ligament.[5] Care must be taken not to place this portal too inferior, as the axillary nerve can course 3.1 cm inferior to the lateral edge of the acromion.[6]

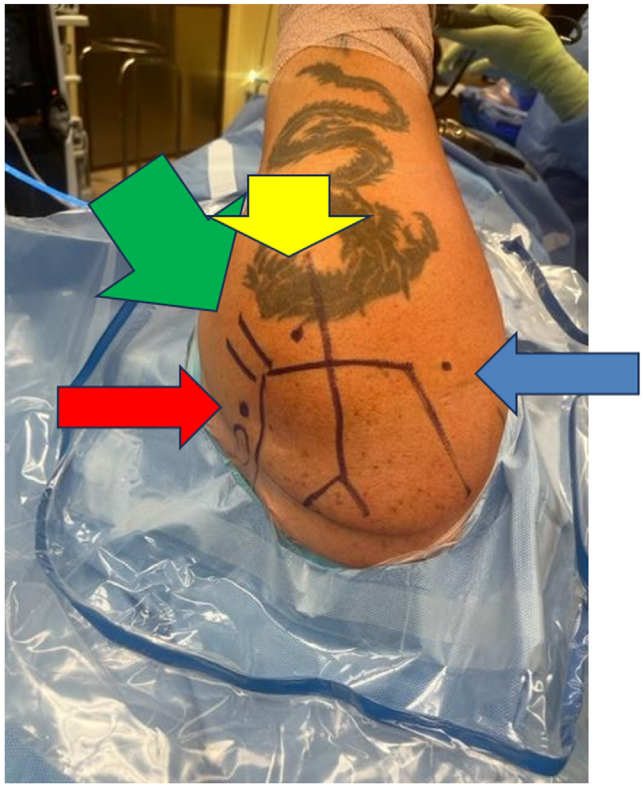

Fig 1. Pictured is a right shoulder in the lateral decubitus position with the anatomical landmarks (acromion, clavicle, coracoid process) and starting portals marked. Standard anterior (red arrow) and posterior (blue arrow) portals are used. The lateral portal (yellow arrow) is placed at the anterior one-third of the lateral acromion edge. The biceps tendon has been palpated in the bicipital groove and marked (green arrow).

Fig 2. Visualization of the subdeltoid space in this right shoulder is needed for suprapectoral tenodesis. It is obtained via placement of the arthroscope through the modified lateral portal. This modified lateral portal is created at the anterior one-third of the acromion 2 cm interior to the lateral edge. The arthroscope is directed anteriorly and inferiorly down the humeral neck toward the bicipital groove.

The POW is placed using the standard anterior portal as a reference. The standard anterior portal is placed 1 to 2 cm inferomedial to the anterolateral edge of the acromion within the rotator interval (Fig 3A). This can be done under direct visualization from the posterior portal or through palpation of the acromion and coracoid process.[7] In relation to the anterior portal, the POW is approximately 4 cm, or 3 fingerbreadths away, from the anterior portal at a 45° angle in the inferolateral direction down the humerus (Fig 3B).[4] A spinal needle is used to localize this portal, and care should be taken to ensure that the portal allows for a perpendicular access plane to the subgroove region of the humerus. Once confirmed, the portal is placed directly over the LHBT subgroove and above the pectoralis major tendon (Fig 4). Typically, this portal is 2 cm above the upper border of the pectoralis major tendon. This has been found to be satisfactory for onlay procedures requiring button or small-diameter suture-based anchors in the lead author's hands and can be centered over the anterior aspect of the humerus for optimal fixation (Fig 5).

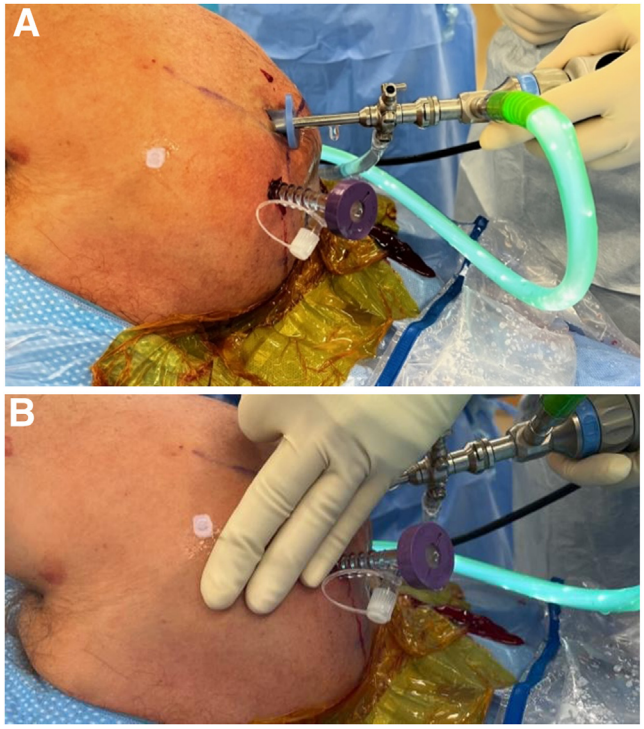

Fig 3. (A) This is the right shoulder of a patient positioned in right lateral recumbent. The modified anterolateral portal, used for viewership in this technique, is represented by the blue cannula with the arthroscopic camera inserted. The purple cannula represents the standard anterior portal. The spinal needle demonstrates the approximate location of the portal of Willingboro. (B) The same right shoulder pictured in the right lateral decubitus position demonstrates the portal of Willingboro (marked by a spinal needle) is approximately 4 cm, or 3 fingerbreadths away from the anterior portal at a 45° angle in the inferolateral direction down the humerus.

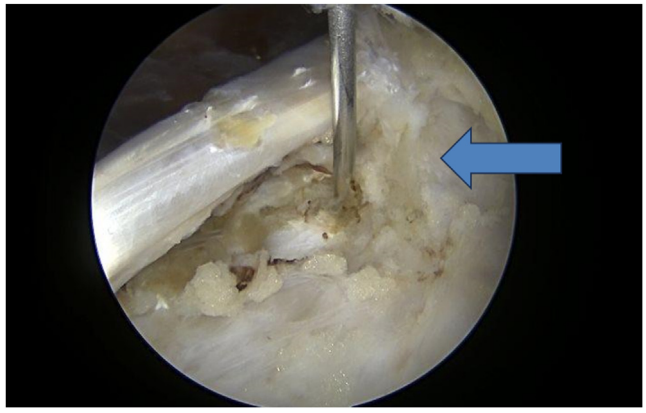

Fig 4. Viewing through the modified lateral portal in the subdeltoid space of a right shoulder in lateral decubitus position, a spinal needle is used to localize a perpendicular trajectory to the anterior aspect of the humerus just above the pectoralis major tendon insertion (blue arrow). This will be the approximate site of the long head of the biceps tenodesis using the portal of Willingboro.

Relevant Neurovascular and Muscular Anatomy

The axillary nerve courses off the posterior cord of the brachial plexus, then crosses perpendicular to the humeral shaft before diving posteriorly behind the surgical neck into the deep fascia of the deltoid. At the point where the axillary nerve passes the coracoid process, it is located approximately 3.2 cm distal and lies inferior and anterior to the subscapularis tendon before diving posteriorly.[5,6] Careful attention must be paid when placing the POW to be lateral to the coracoid process to avoid axillary nerve injury.[6] The musculocutaneous nerve also can be a concern. At the level of the coracoid process, the musculocutaneous nerve travels a median of 2.55 cm distal before branching and penetrating coracobrachialis musculature.[6] Similar to the axillary nerve, remaining lateral to the coracoid with portal placement can help avoid injury to the nerve.

Care also must be taken to avoid vascular structures that are in close proximity to the portal. The subclavian artery transitions to the axillary artery at the border of the first rib. The axillary artery then gives off many branches that contribute to vascularity of the upper extremity, namely the circumflex humeral arteries and arcuate branches.[5] The blood supply to the LHBT, the anterior humeral head, and the bicipital groove arises primarily from the anterior circumflex humeral artery. The anterior circumflex humeral artery bypasses the bicipital groove below the LHBT and provides an anterolateral branch proximally along with the LHBT. This branch is easily visualized during the preparation of the LHBT and should be either avoided or cauterized before tenodesis (Fig 6). These branches are proximal to the working area of this tenodesis technique. Paying

Fig 5. After localization of a perpendicular plane to the anterior aspect of the humerus, the portal of Willingboro is created at the site of the spinal needle. The desired drill hole used for tenodesis can be created centered on the bone to allow for optimal drill depth and placement.

Table 1. Relevant Neurovascular and Tendinous Anatomy in Relation to the POW

Axillary nerve	An average of 3.1 cm inferior to the lateral edge of the acromion at most lateral point of the course of the nerve 3.2 cm inferior to the coracoid, anterior to subscapularis tendon as it courses off the posterior cord of the brachial plexus
Pectoralis major tendon	Superior edge of tendon is 2 cm directly inferior to the POW Mean distance between superomedial tip of the greater tuberosity to the superior edge of the pectoralis tendon: 46.8 ± 0.9 mm
Musculocutaneous nerve	2.5 cm inferior to the coracoid process as it courses off the lateral cord of the brachial plexus, medial the proximal humeral shaft at its closest point to the POW
Axillary artery	1-1.8 cm directly inferior to the inferior aspect of the glenoid and medial to the proximal humeral shaft at its closest point to the POW

POW, portal of Willingboro.

special attention to the proximity of the shoulder, the axillary artery runs about 1 to 1.8 cm inferior to the inferior aspect of the glenoid.[8]

The tenodesis site used through the POW is subgroove, distal to the rotator interval, and suprapectoral. The superior edge of the pectoralis major tendon and the superomedial tip of the greater tuberosity is a mean distance of 46.8 ± 0.9 mm.[9] Working and viewing portals for this approach can safely be placed less than 45.9 mm distal to the superior border of the humeral head to avoid damage to the pectoralis major tendon. During preincision skin marking, the biceps tendon often can be palpated and marked directly off the anterolateral border of the acromion. Similarly, the inferior border of the pectoralis tendon can be palpated and marked adjacent to the axilla. These external landmarks are helpful when localizing the accessory portal(s) within the suprapectoral region. Keeping portals directly over the biceps tendon or lateral will ensure safety from damaging the inferior edge of the subscapularis tendon.[3] Similarly, avoiding plunging deep to the anterior aspect of the proximal humerus will avoid damage to the latissimus dorsi tendon and posterior neurovascular bundles.[10] Tables 1 and 2 summarize the relevant anatomy and portals used and their relationship to the POW.

Discussion

Biceps tenodesis to address associated pain is a viable treatment option that can be performed either via open or arthroscopic techniques. An ideal approach to bicep tenodesis provides significant patient pain reduction, reliable tendon fixation, maximized functional preservation, and minimal morbidity. Keen awareness and knowledge of relevant anatomy during arthroscopic intervention can allow for advanced procedural treatment for biceps pathology.

The POW was designed to provide these attributes while demonstrating low technical demand for the surgeon via an all-arthroscopic approach. The location of the portal can be identified in a safe and reliable manner using trusted anatomical landmarks and standard arthroscopic portals for an easily reproducible triangulation. This anatomical overview should be used

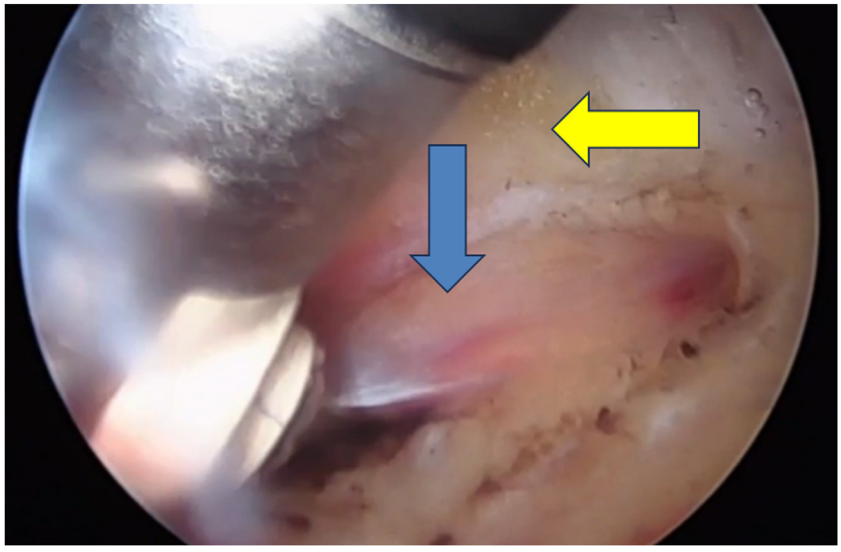

Fig 6. Viewing through the modified lateral portal in the right shoulder subdeltoid space, the arcuate branch of the anterior circumflex humeral artery is visualized (blue arrow) along the lateral border of the long head of the biceps tendon (yellow arrow) just inferior to the bicipital groove. It is important to identify this vessel while using this technique to avoid injury.

Table 2. Location of the Necessary Arthroscopy Portals Using Anatomical Landmarks

Modified lateral portal	Anterior one-third of the lateral border of the acromion, 2 cm inferior from the edge
Standard anterior portal	1-2 cm inferomedial to the anterolateral edge of the acromion
Portal of Willingboro	4 cm, or 3 fingerbreadths from the standard portal at a 45° angle down the humeral shaft

as a reference to avoid any iatrogenic neurovascular injury when creating and operating through this unique portal. Associated complications are more related to the preferred method of fixation, that is, humeral shaft fractures caused by large drill holes or bicortical pin placement, which is not specific to the POW. This technique otherwise provides clear viewership of the LHBT within the subdeltoid space and adequate working room for ease of tenodesis.[4]

Disclosures

All authors (S.M., D.C., E.F.) declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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