



Circumferential Rotator Cuff Repair With the N+4 Portal, Subclavian Portal, and High Posteromedial Portal

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Abstract: Passing suture during a rotator cuff repair requires proper orientation and purchase of the rotator cuff tendon. Our technique uses a new portal to improve access to the supraspinatus and infraspinatus and uses additional portals for a circumferential repair of the tear, thereby restoring the footprint. Using a penetrating suture passer through the anterior, posterior, and superomedial portals allows 270° of coverage. The lateral anchors complete the circumferential repair. Sutures from the medial anchors are passed in a retrograde fashion using 3 small incisions with no cannula. A spinal needle is used to localize the orientation of each portal. The N+4 portal is the workhorse portal, allowing access to the supraspinatus and infraspinatus. The suture retriever enters the trapezius 5 cm from the medial border of the acromion and 1 cm anterior to the spine of the scapula. It enters the subacromial space on top of the supraspinatus. This provides protection to the suprascapular nerve in the supraspinatus fossa. The cuff is lifted with a grasper to allow perpendicular passage of suture. The suture is retrieved for tying. The tissue purchase and location of suture placement help restore the footprint of the supraspinatus and infraspinatus. Additional sutures are passed anteriorly through the subclavian portal and posteriorly through the high posteromedial portal. The repair is completed with lateral-row anchors as needed.

A successful rotator cuff repair requires good surgical technique, good apposition of the tendon to bone, stimulation of the initial inflammatory healing response, and holding of the tendon against the bone securely during the healing process. To gain the best apposition of tissue to bone, passing sutures through many portals is necessary, followed by good knot-tying techniques or use of knotless anchors that securely hold the tendon to the bone over a broad surface. Using several portals with a retrograde suture passer can enhance the technique of suture passage and improve the amount of tendon incorporated in the repair.¹ This optimizes the placement of sutures around the tear that

we describe as a circumferential repair (Fig 1). The purpose of this study is to show the use of anterior, posterior, and superomedial portals to improve placement of suture passers to obtain good spacing of sutures and provide a circumferential repair.

Surgical Technique

Standard arthroscopy is performed with the patient in the lateral decubitus position, which is the preferred patient position for using the N+4 portal with a retrograde penetrating suture passer (Arthrex, Naples, FL).²⁻⁵ The beach-chair position can be used, but a banana-style passer would be necessary (Table 1). The arthroscope is typically placed through the posterior portal.⁶⁻⁹ Anchors are typically inserted through an anterolateral portal.⁹

Numerous portals can be used for passing sutures during rotator cuff repair.¹⁰⁻¹⁷ To achieve good spacing of sutures during suture passing, it is optimal to approach the tear from multiple angles.¹⁸ Most frequently, posterior, anterior, and superomedial portals work best for achieving the desired approach.¹⁹ Our preferred portals for introducing a penetrating suture retriever are the high posteromedial portal, the

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Fig 1. Left shoulder viewed in the beach-chair orientation showing suture retrieval through the subclavian portal with the Penetrator suture retriever (Arthrex) as seen from the posterior arthroscopic viewing portal.

subclavian portal, and our newly introduced N+4 portal (Fig 2).

The subclavian portal, which has been previously described, is located anteriorly and is superior and 1 to 2 cm medial to the coracoid and inferior to the clavicle.^{5,15,20} A spinal needle is used for localization. A 2-mm skin incision is performed, and a penetrating suture retriever is used with the surgeon's hand medial on the chest and the instrument aimed laterally (Fig 3). It is this lateral trajectory that makes this portal safe (Fig 4). The brachial plexus is more than 6 cm away from this portal.

The senior author (K.D.N.) previously described the modified Neviaser portal using the same entry point as the Neviaser portal, 1 cm medial to the acromion in the supraclavicular region.^{15,20} The angle of instrument insertion was more horizontal to enter the subacromial space. The newly described N+4 portal is an improvement on the entrance point for a supraclavicular portal that provides a better angle of attack for passing suture through the supraspinatus and infraspinatus tendons (Fig 5). This portal is named the N+4 portal because it is placed 4 cm from the original Neviaser portal (Fig 6). In reality, it is 5 cm from the medial border of the acromion and 1 cm anterior to the spine of the scapula. A small skin incision is made, and a penetrating suture passer is

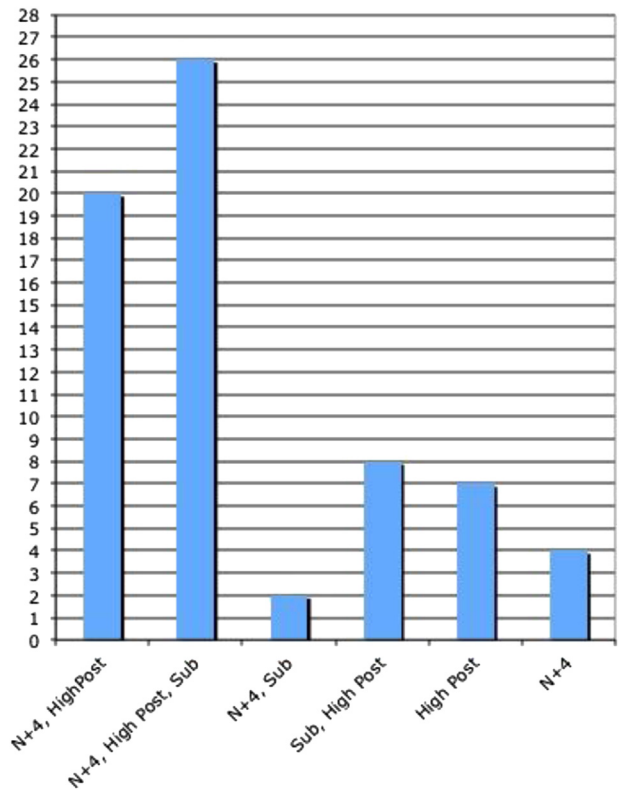


Fig 2. One hundred fifteen rotator cuff repairs were performed by the primary author (K.D.N.) using various portals between July 1, 2012, and July 31, 2013. (Post, posteromedial portal; Sub, subclavian portal.)

placed after a spinal needle. The angle is approximately 20° up from horizontal and aimed 20° anteriorly, directly toward the sutures in the suture anchor (Fig 7). Using cadaveric specimens and needle placement at various angles, we identified this

Table 1. Indications and Contraindications

Indications	
Any complete rotator cuff tear involving the supraspinatus or infraspinatus	
Contraindications	
Although not an absolute contraindication, it is more difficult to use the N+4 portal in the beach-chair position. Banana-style suture passers can be used in the beach-chair position.	

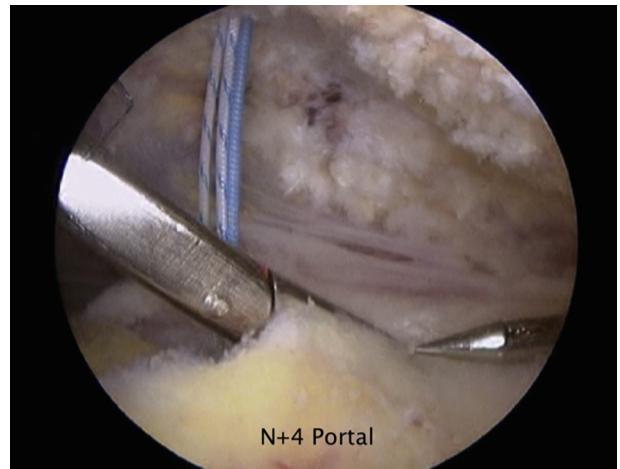


Fig 3. Left shoulder viewed in the beach-chair orientation through the posterior portal while surgery was performed in the lateral decubitus position showing the N+4 portal used for suture passage.



Fig 4. Left shoulder viewed in the beach-chair orientation showing suture passage through the high posteromedial portal for rotator cuff repair as viewed arthroscopically. The cuff is being lifted with a rotator cuff grasper (Arthrex) while the Penetrator passes through the rotator cuff.

location (Fig 8). The track of the penetrating suture grasper is through the trapezius and over the top of the supraspinatus muscle. It passes under the acromioclavicular joint and into the subacromial space. The N+4 portal uses the supraspinatus muscle to

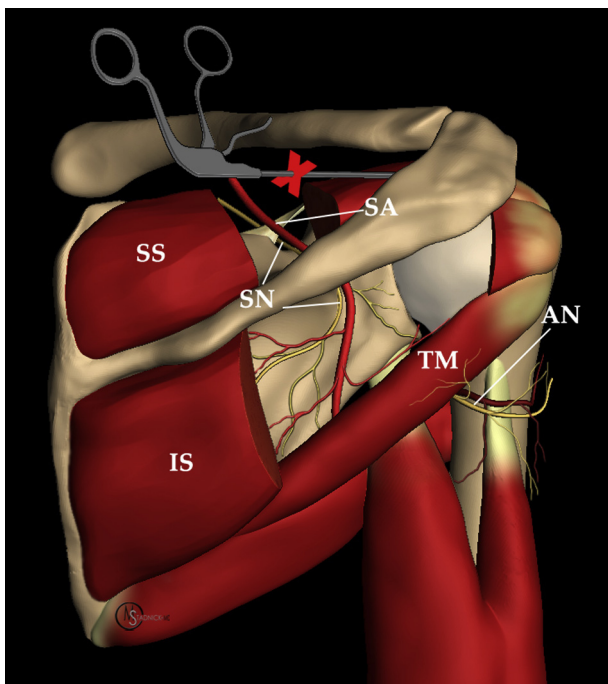


Fig 5. Digital rendering of a right shoulder depicting the neurovascular structures at risk during suture passage using the new N+4 portal for rotator cuff repair as viewed posteriorly. (AN, axillary nerve; IS, infraspinatus; SA, suprascapular artery; SN, suprascapular nerve; SS, supraspinatus; TM, teres minor.)

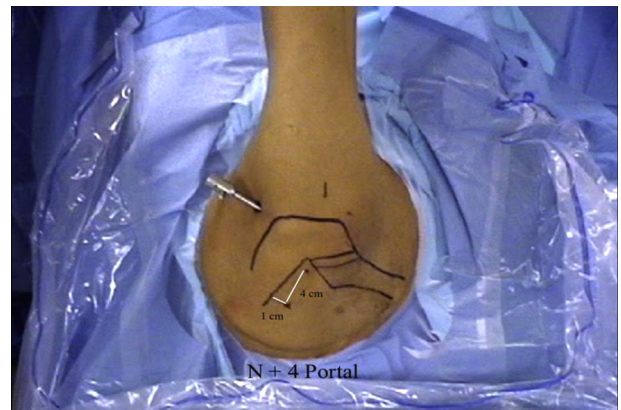


Fig 6. Left shoulder in the lateral decubitus position showing the N+4 portal. The measurements are 4 cm lateral to the traditional Neviasser portal and 1 cm anterior to the spine of the scapula.

protect the suprascapular nerve that runs deep to this muscle. The tendon can be lifted laterally for passage of the penetrating suture retriever, making the passage more perpendicular, and the exact location of suture passage is easily adjusted.

The high posteromedial portal is located 2 to 3 cm inferior to the spine of the scapula and 2 to 3 cm medial to the posterior portal.^{15,21} It is optimal for reaching the posterior aspect of the infraspinatus.

Suture pairs are retrieved laterally and tied through the lateral cannula. They can be retrieved back through any of the aforementioned portals for suture management and can be used later in the lateral row after all sutures are tied. This completes the repair in a nice hemispherical fashion and restores the footprint as the sutures are incorporated into the lateral row (Video 1).

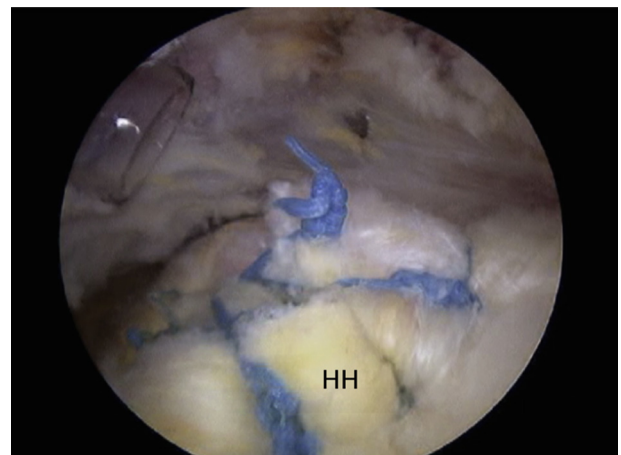


Fig 7. Left shoulder in the beach-chair orientation viewed arthroscopically from the posterior portal showing a hemispherical rotator cuff repair achieved with the use of the N+4, subclavian, and high posteromedial portals. (HH, humeral head.)

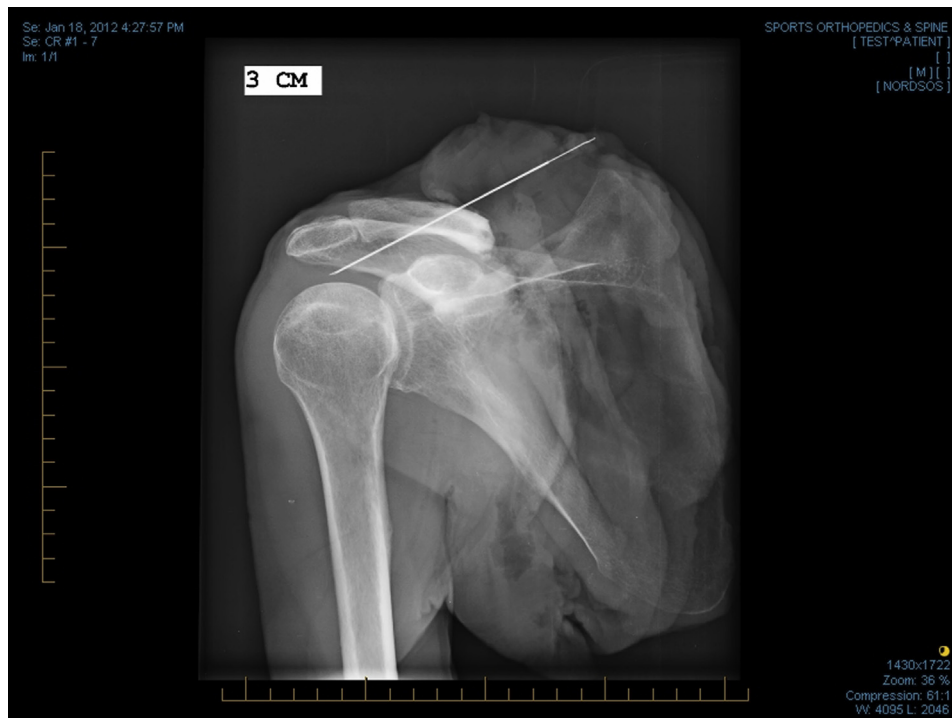


Fig 8. Cadaveric radiographic image of a right shoulder in the beach-chair position showing the N+4 portal with a 20° angle of approach from the sagittal plane for a rotator cuff repair.

With the addition of the lateral row, a circumferential repair is obtained.

Discussion

Our goal was to introduce a new portal, the N+4 portal, and review older portals that allow the surgeon to obtain a better, balanced repair with nice spacing of sutures (Table 2). The N+4 portal can be a workhorse portal, reaching the supraspinatus and infraspinatus very easily. By adding the subclavian and high posteromedial portals, every aspect of a rotator cuff tear can be reached and suture can be passed through the area of better-quality tendon (Table 1). Poor-quality tendon can be a limiting factor in any repair. The circumferential technique spreads the sutures out, allowing for good restoration of the footprint.

Table 2. Tips and Pearls of Procedure

Multiple portals are used and located with a spinal needle.
The N+4 portal can be used for supraspinatus and infraspinatus tears.
The N+4 portal uses the supraspinatus muscle to protect the suprascapular nerve.
Suture is passed through optimal locations by choosing the entry point.
Instruments are passed through the N+4 portal 20° from the transverse plane or 70° from the sagittal plane and aimed toward the suture anchor.
The high posteromedial portal is useful for margin convergence and posterior infraspinatus tears.
The footprint is restored with a double-row repair.

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