Technical Note

Cement Augmentation of Suture Anchor During Arthroscopic Rotator Cuff Repair in Case of Proximal Humeral Bone Deficiency Due to Osteoporosis

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Abstract: One of the technical challenges during arthroscopic rotator cuff repair is bone deficiency in proximal humerus to get adequate fixation of suture anchors. The typical scenarios that result in bone deficiency at rotator cuff footprint are older individuals, females, osteoporosis, and revision rotator cuff repairs with failed anchors from previous surgery. One of the ways to secure fixation of suture anchors in deficient bone is augmentation with polymethyl methacrylate cement. We present a stepwise technique of cement augmentation of suture anchor during arthroscopic rotator cuff repair to achieve secure fixation of suture anchor and avoid spillage of cement in the subacromial space.

Introduction

The success of rotator cuff repair depends on multiple factors including patient demographics, pathology, surgical technique of repair, and physical rehabilitation. An adequate repair of a torn rotator cuff is, indeed, key for healing of torn cuff and functional recovery. An optimal repair of torn rotator cuff can not only be challenged by poor rotator cuff tissue but also by poor bone quality of the proximal humerus. The typical scenarios in which surgeons encounter difficulty in securing adequate suture anchor fixation due to bone deficiency at rotator cuff footprint are older individuals, females, osteoporosis, and revision rotator cuff repairs with failed anchors from previous surgery. Furthermore, previous studies have identified osteoporosis as one of the risk factors for failure of rotator cuff healing.[1] It is imperative that adequate fixation of suture anchors in proximal humerus is key for success in optimal repair and healing of torn rotator cuff.

Several advanced techniques have been described to address poor quality or deficient bone on proximal humerus during rotator cuff repair. One of the ways to fix suture anchors in osteoporotic bone is by using a large-size, fully threaded, and metallic anchors, which are inserted at the deadman angle. Despite these precautions, suture anchor fixation in the bone could fail leaving a bigger bone deficit. Polymethyl methacrylate (PMMA) cement has been widely used in orthopedics for securing implants in patients with poor-quality or deficient bone. Several cadaveric studies have established the efficiency of PMMA augmentation in improving the pull-out strength of suture anchors in proximal humerus.[2] Moreover, during arthroscopic cement augmentation of suture anchors, there are concerns of cement leakage into the subacromial space,[3] which we believe could be avoided by correct surgical technique. We describe here the surgical technique of PMMA cement augmentation of suture anchor fixation in proximal humerus during arthroscopic rotator cuff repair.

Surgical Technique

Patient Evaluation, Imaging, and Indications

Preoperative assessment in patients with rotator cuff tear undergoing rotator cuff repair should identify those who may be at a higher risk of poor bone quality or bone deficiency in proximal humerus (Table 1). The

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Table 1. Pearls and Pitfalls of the Described Technique of Cement Augmentation of Suture Anchor During Arthroscopic Rotator Cuff Repair

Pearls
• The preoperative plain radiograph and magnetic resonance imaging of shoulder should be checked for signs of proximal humeral bone deficiency, such as the presence of bone cyst, osteopenia, and osteolysis around suture anchors from previous surgery.
• The visualization during arthroscopy could be optimized with a mean arterial pressure at 60 mmHg, use of a saline inflow-outflow pump system, and mixing epinephrine 1 mg/mL per 3-liter bag of saline infusion.
• Three key steps to avoid spillage of cement in subacromial space
○ After cement injection into the bone defect, hold the nozzle within the bone defect until the cement becomes nonsticky
○ While removing the syringe from subacromial space, the syringe is rotated until the inserted cement is disconnected from the remaining cement in the syringe
○ The extra cement in subacromial space was removed using an arthroscopic grasper
• Switch off the saline inflow after achieving final position of cement augmented suture anchor until cement curation is done
Pitfalls
• Avoid overtensioning of sutures on lateral row anchor during cement augmentation to avoid creating a new bone defect
• After achieving final position of suture anchor in the cement mantle, avoid movement of the anchor inserted until cement curation

history of osteoporosis, fragility fracture, and previous rotator cuff repair should be noted. A plain radiograph should be done to note the presence of bone cyst in proximal humerus, osteopenia in the bone, and suture anchors from previous surgery. Magnetic resonance images should be assessed for the size and location of the bone cysts (Fig 1) or lucency around previous anchors. A comprehensive preoperative evaluation would enable the surgeon to be prepared with large-size anchors and PMMA cement in case bone defects are encountered during the surgery. The indication for cement augmentation of suture anchors during rotator cuff repair are cystic cavity at the footprint and failure of previous suture anchors, leaving bone defects.

Patient Positioning and Diagnostic Arthroscopy

Patient is given a combination of regional and general anaesthesia and positioned in the beach chair position. To optimize the visualization during arthroscopy, we prefer the mean arterial pressure at 60 mm/Hg, use of a saline inflow-outflow pump system, and mixing epinephrine 1 mg/mL per 3-liter bag of saline infusion (Table 1). We do not use cannula for shoulder arthroscopic procedures. A standard posterior portal is first created, which initially is a viewing portal for diagnostic arthroscopy of glenohumeral joint, but would later be used as a working portal during rotator cuff repair in subacromial space (Video 1). The rotator cuff tendons, long head of biceps, and labrum are inspected for tears and retraction from the intra-articular space. The arthroscope is then introduced in the subacromial space through a posterolateral portal, which is the main viewing portal for rotator cuff repair. The subacromial decompression is done with bursectomy and acromioplasty to remove bony spurs, and the rotator cuff tear is delineated.

Rotator Cuff repair and Cement Augmentation of Suture Anchor

An anterolateral working portal is created for insertion of the suture anchors (Video 1). The soft tissue over greater tuberosity underlying cuff tear is debrided using a shaver and radio frequency device. A burr is used to create a bleeding bone surface for the rotator cuff repair. The supraspinatus tendon is mobilized by performing releases under and over the muscle to ensure it covers the footprint. A double-row repair is then performed using knotless suture bridge configuration. Two double-loaded medial row anchors (4.5-mm CorkScrew with FiberTape; Arthrex, Naples, FL) are inserted just lateral to the articular cartilage. The suture limbs are passed sequentially from posterior to anterior through rotator cuff tendons at multiple entry points using retrograde suture passer (SutureLasso, Arthrex). Four suture limbs, two from each anterior and posterior medial anchors, are fixed as the lateral row on the posterior part of greater tuberosity using knotless anchor (PushLock 4.5 mm; Arthrex). Although

Fig 1. Preoperative magnetic resonance image of a patient in T2-weighted coronal image shows cyst (red arrows) in the supraspinatus footprint region with a near-full-thickness supraspinatus tear. The presence of cyst in the proximal humeral region prompts a possible requirement of cement augmentation of the suture anchor fixation during rotator cuff repair.

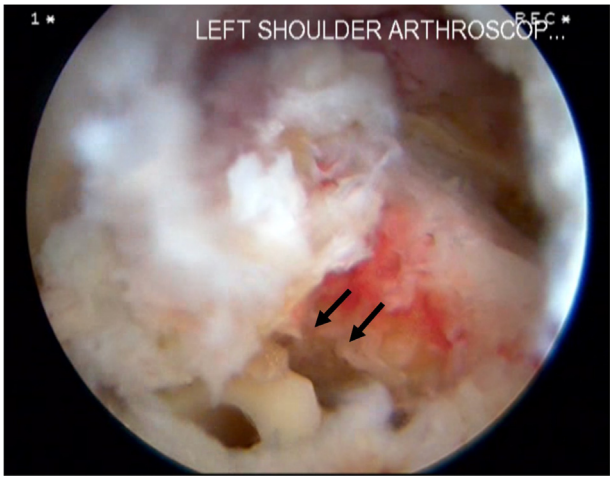

Fig 2. Arthroscopic image of subacromial space during rotator cuff repair, as seen from posterolateral portal showing a failed suture anchor (black arrows) that was intended as lateral row-anterior anchor. The suture anchor screw became loose after insertion due to poor quality bone.

a similar step is attempted for anterior lateral row anchor, the anchor screw becomes loose due to poor-quality bone (Fig 2). About 10 mm × 10 mm of cortical bone chip also comes off adjacent to the suture insertion which is removed (Fig 3). The failed anchor is then removed (Fig 4). Overall, we are left with a cortical bone deficit of about 2 cm × 2 cm with depth of 2.5 cm (Fig. 5).

We choose to proceed with cement augmentation for fixation of the lateral row anchor in the bony defect. A 40-g, high-viscosity PMMA cement Palacos (Heraeus Medical, Berkshire, UK) is used for augmentation. The powder and liquid components of the cement are

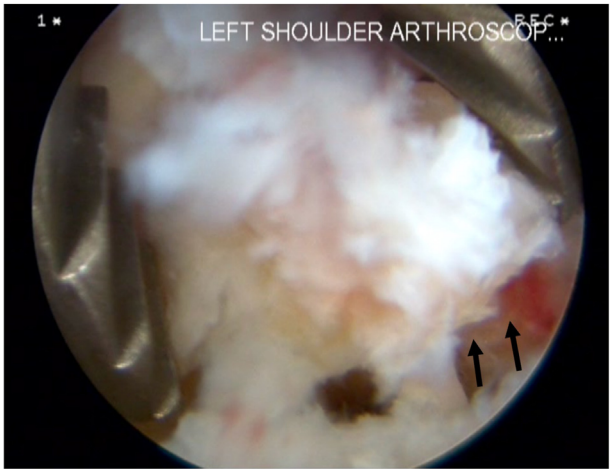

Fig 3. Arthroscopic image of subacromial space during rotator cuff repair, as seen from posterolateral portal, showing an arthroscopic grasper being used to remove the cortical bone chip (black arrows) that became loose after failure of suture anchor.

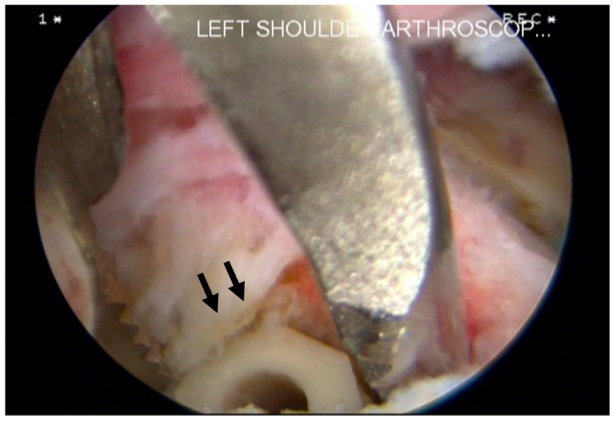

Fig 4. Arthroscopic image of subacromial space during rotator cuff repair as seen from posterolateral portal, showing an arthroscopic grasper device used to remove the failed anchor from the bone defect (black arrows).

mixed using a vacuum technique for uniform consistency. While in liquid state, the mixed cement is transferred into a 60 cc plastic syringe. The nozzle of the syringe is introduced in the subacromial space from anterolateral portal. The pressure of arthroscopic saline pump inflow is reduced to 30 mm/Hg to minimize saline in the field before cementation, while maintaining adequate visualization of the surgical field. At 2 minutes after cement mixing, under arthroscopic visualization, the cement is injected in the bony defect. While injecting the cement, it is important to ensure that the nozzle is inserted inside the cortical bone defect to allow for cement to be pressurized, inducing its interdigitation with cancellous bone and also to avoid spillover of cement in the subacromial space (Fig 6). Adequate cement injection is assured when cement starts to

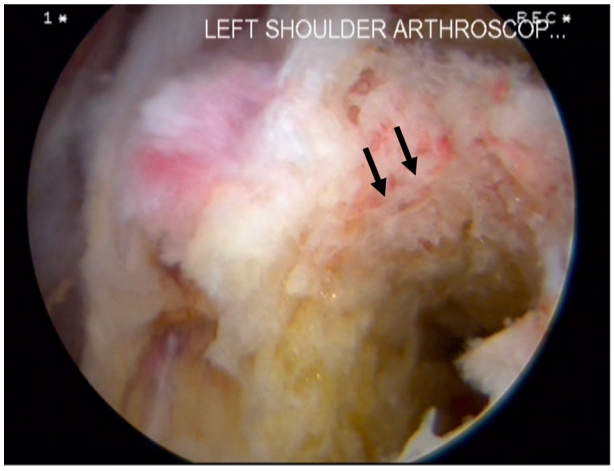

Fig 5. Arthroscopic image of subacromial space during rotator cuff repair, as seen from posterolateral portal, showing a total cortical bone loss (black arrows) after removing the anchor measuring 2 × 2 cm and depth of about 2.5 cm. This is a substantial bone defect in the rotator cuff footprint, requiring cement augmentation to hold the lateral row suture anchor.

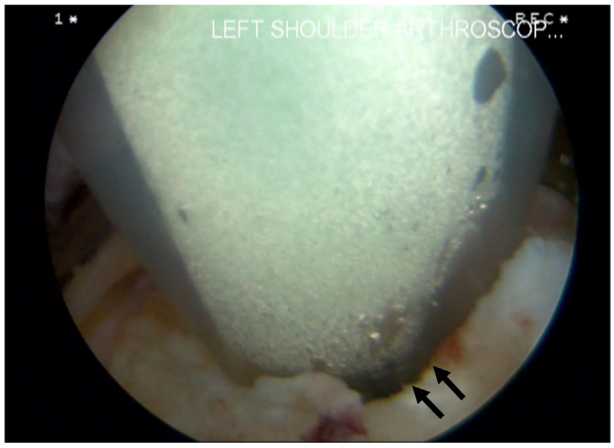

Fig 6. Arthroscopic image of subacromial space during cement augmentation of suture anchor for rotator cuff repair, as seen from posterolateral portal. The image shows the nozzle of a 60-cc syringe loaded with polymethyl methacrylate cement, which is inserted inside the cortical bone defect of footprint (black arrows) to allow for the cement to be pressurized in cancellous bone as we insert it.

overflow between the nozzle and the bone defect (Fig 7). There are three key steps to avoid spillage of cement in subacromial space when removing the syringe (Table 1). First, after adequate cement injection, the syringe is held in the same position with the nozzle within the bone defect until cement becomes nonsticky. Second, while removing the syringe from subacromial space, the syringe is rotated until the inserted cement is

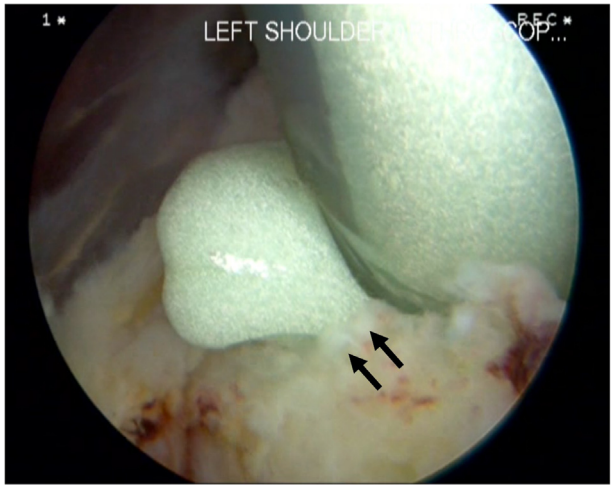

Fig 7. Arthroscopic image of subacromial space during cement augmentation of suture anchor for rotator cuff repair, as seen from posterolateral portal. After pushing the cement in the bone defect, adequate amount of cement injection is indicated when cement starts to overflow between the nozzle and the bone defect. The syringe should be held in the same position with the nozzle within the bone defect until 6 minutes or when cement was nonsticky to avoid cement spillage in subacromial space while removing the syringe.

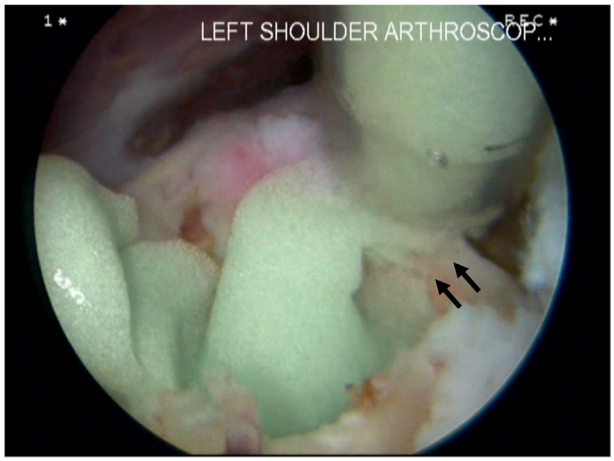

Fig 8. Arthroscopic image of subacromial space during cement augmentation of suture anchor for rotator cuff repair, as seen from posterolateral portal. After adequate cement is injected in the bone defect and the cement is nonsticky, the syringe is removed from the subacromial space. While removing the syringe, to avoid cement spillage in subacromial space, the syringe is rotated until the inserted cement is disconnected (black arrows) from the remaining cement in the syringe.

disconnected from the remaining cement in the syringe (Fig 8). Third, the extra cement in subacromial space is removed using arthroscopic grasper (Fig 9). The lateral row Pushlock anchor loaded with medial row suture tapes is then quickly inserted in the cemented bone defect (Fig 10). The suture tapes are tightened to ensure that the cuff tendon is reduced to the footprint. Once

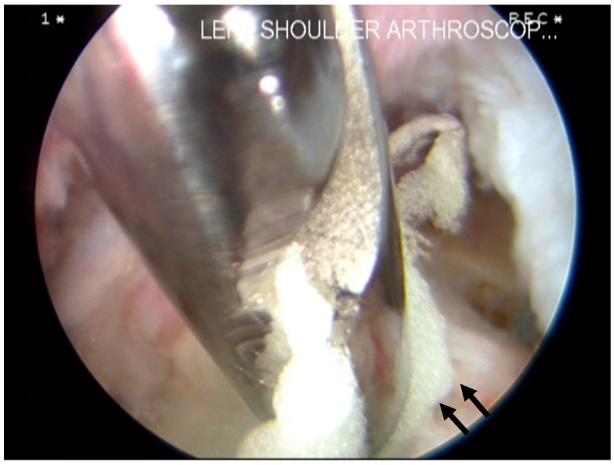

Fig 9. Arthroscopic image of subacromial space during cement augmentation of suture anchor for rotator cuff repair as seen from posterolateral portal showing extra cement (black arrows) after cement injection in bone defect being removed using arthroscopic grasper. The removal of extra cement in subacromial space is important to prevent it from acting as a foreign body, causing shoulder impingement during range of motion.

Fig 10. Arthroscopic image of subacromial space during cement augmentation of suture anchor for rotator cuff repair, as seen from posterolateral portal. After cement injection in bone defect, the lateral row suture anchor (black arrows) should be quickly inserted in the cemented bone defect and held in that position until cement curation. The saline inflow should be stopped after anchor insertion until cement curation.

final position of the anchor is achieved, the saline inflow is stopped, and the anchor is firmly held in the same position until the cement curation. An arthroscopic probe is used to confirm the cement curation and tension of the sutures after repair (Fig 11). Once ensured that the cement has cured, the subacromial space is inspected for any spillover cement, which is removed. This concluded the cement augmentation of suture anchor.

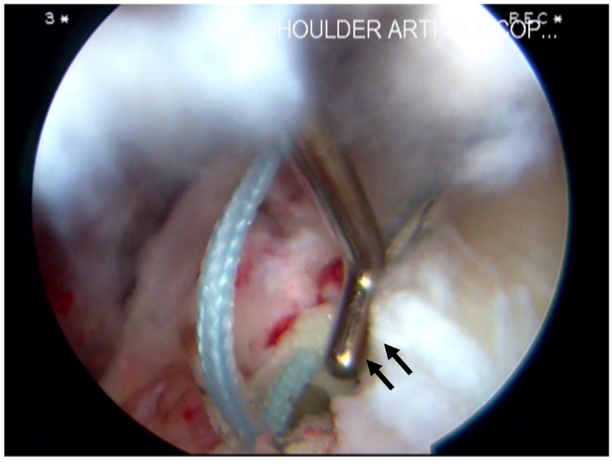

Fig 11. Arthroscopic image of subacromial space after cement augmentation of suture anchor for rotator cuff repair as seen from posterolateral portal. An arthroscopic probe (black arrows) was used to confirm the cement curation after the cement augmentation of the suture anchor in the bone defect.

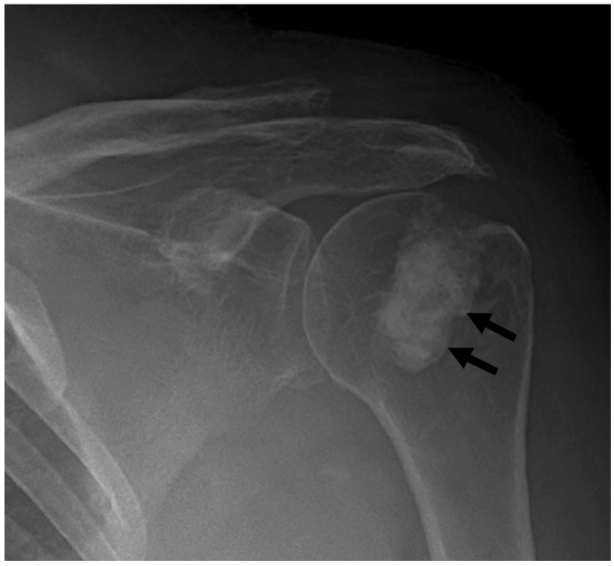

Fig 12. The plain radiograph of shoulder of patient at 2 years follow up after cement augmentation of medial row suture anchor during arthroscopic rotator cuff repair showing uniform distribution of cement (black arrows) in proximal humeral bone defect.

Postoperative Rehabilitation

The postoperative rehabilitation protocol in cases of cement augmentation of suture anchor does not need to be changed from that applied for routine rotator cuff repair. The postoperative radiographs could be done to confirm the uniform cement mantle around the suture

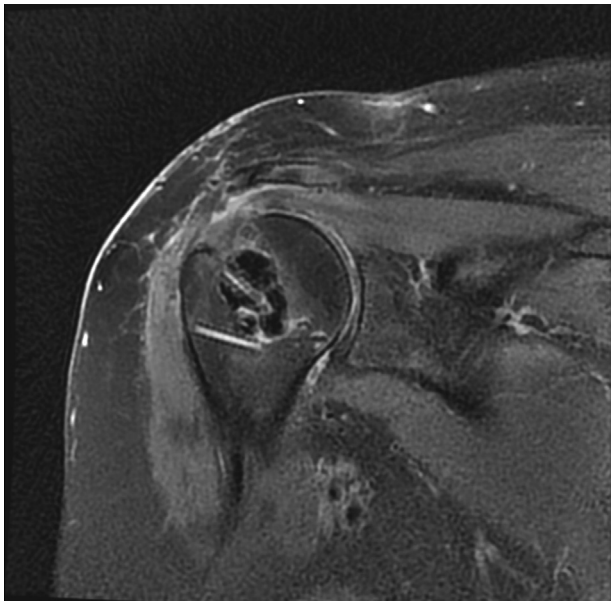

Fig 13. Magnetic resonance imaging of shoulder (T2 fat supressed coronal section) of patient at 2 years follow-up after cement augmentation of medial row suture anchor during arthroscopic rotator cuff repair showing healed rotator cuff tear with anchor fixation within the cement mantle.

Table 2. Advantages and Disadvantages of the Described Technique of Cement Augmentation of Suture Anchor During Arthroscopic Rotator Cuff Repair

Advantages
• Arthroscopic technique
• Single stage
• Avoids donor site morbidity of autograft use
• Cement augmentation is relatively less expensive than using other techniques to address bone deficiency during suture fixation during rotator cuff repair like buddy anchor[5] and augmentation with human dermal allograft[6]
Disadvantages
• The procedure may take longer than the usual rotator cuff repair and may be associated with swelling of the shoulder
• The technique may require advanced arthroscopy skill

anchor and cement incorporation in the bone defect (Fig 12). The magnetic resonance imaging could be done after 6 months to ensure healing of rotator cuff tear with intact cement-suture-bone construct (Fig 13).

Discussion

The bone defects in proximal humerus during arthroscopic rotator cuff repair pose a technical challenge for suture anchor fixation. We present the surgical technique of cement augmentation of bone defects for adequate suture anchor fixation and, thereby, secure the rotator cuff repair. The key step for cement augmentation is use of a 60-cc syringe with a long nozzle for cement insertion, ensuring low pump flow, and placing the syringe nozzle inside the cortical margin of bone defect before cement insertion. To prevent cement spillage in subacromial space, it is important to rotate the syringe to disconnect the inserted cement from that remaining in the nozzle before removing the syringe from subacromial space.

One of the key steps in the preoperative evaluation of patients undergoing rotator cuff repair is to be vigilant for signs of bone deficiency on plain radiographs and magnetic resonance imaging, especially in cases of bone cyst and revision rotator cuff repair with anchors in situ. Of note, even all suture anchors that are considered to be bone preserving and facilitate easier revision cuff repair may present with peri-anchor cystic lesion in 40% revision cases.[4] For patients suspected of having osteoporosis, we do not routinely advise conventional dual-energy radiograph absorptiometry to measure bone mineral density (BMD) for patients undergoing rotator cuff repair as previous studies have shown, poor correlation of hip and lumbar spine BMD with that of proximal humerus.[5] However, Lee et al. in a study have shown a good correlation of preoperative greater tuberosity BMD with intraoperative suture cut through from the greater tuberosity bone during rotator cuff repair.[6] Preoperative greater tuberosity BMD could be a helpful tool in elderly patients to predict failure of suture anchors during rotator cuff repair and requirement of cement augmentation.

Denard and Burkhart described several technical tips to secure suture anchor fixation in cases with pull out of anchors due to poor bone quality. These techniques include compaction bone grafting, buddy anchor, rescue anchor, and lateral cortical fixation.[7] Reda et al. described a technique of filling the bone defect with demineralized bone matrix while bridging the defect by inserting anchor lateral to it.[8] One advantage of cement augmentation to address bone defect over above described techniques is that it prevents the host site morbidity for autograft and higher cost of allograft, additional anchors, and demineralized bone matrix as compared to PMMA cement (Table 2). The cement augmentation technique described is quick, reproducible, and backed by previous biomechanical studies to provide adequate fixation of suture anchors in cases with bone defect in proximal humerus. Future case series and comparative studies will help to clarify the efficacy and generalizability of this technique.

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