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# No difference in 2-year outcomes of arthroscopic rotator cuff repair in patients with osteoporosis

**Stephen J. Sierra, MD[a], Adam Lutz, PT, DPT, PhD, MBA[b], Samantha A. Piergiovanni, BS[c], Ellen Shanley, PhD, PT, OCS[b], Charles A. Thigpen, PhD, PT, ATC[b], Michael J. Kissenberth, MD[a], Stephan G. Pill, MD, MSPT[a,*]**

[a]*Steadman Hawkins Clinic of the Carolinas, Prisma Health, Greenville, SC, USA*
[b]*ATI Physical Therapy, Greenville, SC, USA*
[c]*Hawkins Foundation, Greenville, SC, USA*

**Background:** Many prognostic factors associated with healing after arthroscopic rotator cuff repair have been evaluated. It has been shown from previous literature that osteoporosis is an independent risk factor for poor healing and increased need for revision surgery. To our knowledge, there has not been a study reporting patient reported outcomes (PROs) for arthroscopic rotator cuff repair in patients with osteoporosis. The purpose of this study was to compare PROs of arthroscopic rotator cuff repair (RCR) in patients with decreased bone mineral density to those with normal bone mineral density. We hypothesized that patients with decreased bone mineral density would have worse outcomes.

**Methods:** A retrospective chart review identified patients who had arthroscopic RCR with preoperative and minimum 2-year postoperative PROs. Demographic data and rotator cuff tear size were recorded, and the PROs included American Shoulder and Elbow Surgeons (ASES), visual analog scale pain score, Single Assessment Numeric Evaluation, Veterans RAND 12-Item Health Survey (VR-12) physical component score (PCS), and VR-12 mental component score (MCS). Each patient record was queried for an osteoporosis, osteopenia, or osteoporotic fracture diagnosis within a year before or after RCR. Patients with one of these diagnoses comprised the decreased bone mineral density group; whereas, patients without these diagnoses comprised the control group. An analysis of covariance was used to compare 2-year PROs while controlling for age, sex, tear size, preop ASES, preop VR-12 MCS, preop VR-12 PCS, and Charlson Comorbidity Index. Significance was set at $\alpha = 0.05$.

**Results:** Three-hundred fifty-seven patients were included. The mean age was 59.8 ± 10.0 years, and 191 (53.5%) were male. There were 30 patients (8.4%) in the decreased bone mineral density group and 327 patients (91.6%) in the control group. One hundred eighty-two (51.0%) patients had large or massive tears, and 175 patients (49.0%) had small or medium tears. There were no baseline differences between groups based on Charlson Comorbidity Index ($P = .092$), VR-12 MCS mean scores ($P = .924$), and initial ASES mean scores ($P = .183$). A small baseline difference existed in VR-12 PCS mean scores ($P = .032$). As expected, the decreased bone mineral density group had more females (28 of 30, $P < .001$) and older patients (67.6 ± 7.6 years vs. 59.1 ± 10.0 years, $P < .001$). Analysis of covariance identified no significant difference in 2-year ASES scores between groups ($P = .216$).

**Conclusion:** Despite previous literature showing the negative effect of osteoporosis on rotator cuff healing, our data showed no relationship between decreased bone mineral density and 2-year clinical outcomes following RCR. Patients with decreased bone mineral density can still achieve excellent 2-year outcomes.

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*Reprint requests: Stephan G. Pill, MD, MSPT, Steadman Hawkins Clinic of the Carolinas, Prisma Health, 200 Patewood Dr, Suite C100, Greenville, SC 29615, USA.

E-mail address: pillmd@gmail.com (S.G. Pill).



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The World Health Organization defines osteoporosis as bone mineral density (BMD) 2.5 standard deviations or more below the average value for a young healthy female and osteopenia as a reduction BMD not yet reaching this threshold.[3,6,19,23] Approximately 10 million Americans over 50 years of age have osteoporosis and over 34 million have osteopenia, and the incidence of both is expected to increase as the population ages.[6,8,10] Postmenopausal hormonal changes cause primary low BMD; whereas, secondary causes include medications (ie, glucocorticoids and anticonvulsant therapy), endocrine abnormalities (ie, hypogonadism and hyperthyroidism), and malnutrition (ie, low calcium and vitamin D, alcohol abuse, and smoking).[10]

In addition to pathologic fracture burden, several studies have shown a high incidence rotator cuff tears in patients with low BMD of the greater tuberosity.[4,8,11,16,22,25] Recent literature has also shown decreased BMD to be a negative prognostic factor for healing in patients undergoing rotator cuff repair surgery.[12] However, there is a paucity of prior studies assessing whether patients with a diagnosis of osteoporosis or osteopenia have worse patient reported outcomes (PROs) than those without after arthroscopic rotator cuff repair (RCR). The purpose of this study was to compare PROs of arthroscopic RCR in patients with osteoporosis or osteopenia to those with normal bone mineral density. We hypothesized that patients with decreased BMD would have worse outcomes based on the presumed reduction in tissue healing.

## Methods

The study was an institutional review board-approved retrospective chart review identifying consecutive patients who had arthroscopic RCR with preoperative and minimum 2-year postoperative PROs. Using the Orthopedic Patient Data Repository (OPDR), each patient record was queried for an osteoporosis, osteopenia, or osteoporotic fracture diagnosis within a year before or after RCR, and these patients were considered the low BMD group. The OPDR is a joint effort between the Center for Effectiveness Research in Orthopedics and Prisma Health that prospectively and unobtrusively collects clinical and healthcare utilization data for all orthopedic patients in Prisma Health throughout their episodes of care. The comprehensive structure of the OPDR enables us to ensure our study inclusion/exclusion criteria are met.

Patients without one of these diagnoses were considered as the normal BMD group and served as controls. Demographic data and rotator cuff tear size were also recorded in attempts to determine if other confounding variables to outcomes could exist between groups.

The PROs collected included the following: American Shoulder and Elbow Surgeons (ASES), visual analog scale pain score, Single Assessment Numeric Evaluation, and Veterans RAND 12-Item Health Survey (VR-12) physical and mental component scores (VR-12 physical component score [PCS] and VR-12 physical component score [MCS]). An analysis of covariance was used to compare 2-year PROs while controlling for age, sex, tear size, preop ASES, preop VR-12 MCS, preop VR-12 PCS, and Charlson Comorbidity Index (CCI). Significance was set a priori at $\alpha = 0.05$.

## Results

Three-hundred fifty-seven patients were included. There were 30 patients (8.4%) in the low BMD group and 327 patients (91.6%) in the control group (Table I). The mean age of the control group was 59.8 ± 10.0 years and the mean age of the low BMD group as 67.6 ± 7.6 years ($P < .001$). There were 151 females and 176 males in the control group and 28 females and 2 males in the low BMD ($P < .001$). One-hundred eighty-two (51.0%) patients had large or massive tears, and 175 patients (49.0%) had small or medium tears. The entire cohort had a weighted CCI of 0.3 ± 0.8, VR-12 MCS 52.2 ± 10.9, VR-12 PCS 36.7 ± 8.2, preop ASES 47.7 ± 18.4, and 2-year ASES 88.0 ± 15.3 (Table II). There were no significant baseline differences between groups with regards to CCI mean scores ($P = .092$), VR-12 MCS mean scores ($P = .924$), and preop ASES mean scores ($P = .183$). A small baseline difference existed in VR-12 PCS mean scores ($P = .032$). No significant differences were found in the primary outcome of 2-year ASES scores between groups ($P = .216$).

## Discussion

The main finding of this study was that low BMD did not significantly impact 2-year ASES scores in a consecutive cohort of patients undergoing RCR. Repairing rotator cuff tears in patients with low BMD may still provide favorable outcomes despite previous literature showing more complications, lower healing rates, and higher revision surgery rates in patients with low BMD.[5,8,16,25] Chung et al found a statistically significant correlation between low BMD and failure of rotator cuff healing at mean follow-up of 13 months in 272 patients.[5] They used computed tomography arthrography or ultrasound to verify cuff healing and failure and concluded that BMD was an independent factor affecting rotator cuff healing.[5]

**Table I** Demographics

| Demographics | Osteoporotic cohort mean (SD) N = 30 | Control mean (SD) N = 327 | *P* value |
|---|---|---|---|
| Age | 67.6 (7.6) yr | 59.1 (10.0) yr | .001 |
| Gender | Female 28 (93%) Male 2 (7%) | Female 151 (42%) Male 176 (58%) | .001 |
| RC tear size | Small＼Med:12 (40%) Large＼Massive:18 (60%) | Small＼Med:163 (49.8%) Large＼Massive:164 (50.2%) | .308 |
| Charlson Comorbidly score | 0.6 (0.86) | 0.32 (0.80) | .092 |

*SD*, standard deviation; *RC tear*, rotator cuff tear.

**Table II** Patient-reported outcomes by cohort

| Patient-reported outcomes | Osteoporotic cohort mean (SD) N = 30 | Control mean (SD) N = 327 | *P* value |
|---|---|---|---|
| VR-12 Physical Component score | 33.1 (9.5) | 37.1 (8.1) | .032 |
| VR-12 Mental Component score | 52.0 (11.1) | 52.2 (10.8) | .924 |
| ASES preop | 48.1 (18.3) | 43.3 (18.6) | .183 |
| ASES 2-yr score | 86.1 (15.7) | 88.2 (15.2) | .216 |

*SD*, standard deviation; *ASES*, American Shoulder and Elbow Surgeons.

BMD in the proximal humerus decreases with age and previous studies have shown an association between rotator cuff tears and low BMD of the greater tuberosity.[10,11,17,22] Yackaki et al showed low BMD resulted in higher suture anchor loosening or pullout.[25] Similarly, Lee et al showed that greater tuberosity BMD was an independent risk factor associated with suture cutting through bone in transosseous-equivalent RCR.[13] In contrast, a large public and private national insurance database study involving 41,467 patients did not find osteoporosis to be an independent risk factor for need for revision surgery after primary RCR.[16]

Perhaps some of the discrepancy is whether patient diagnoses of low BMD are considered vs. evaluating more specific analysis of BMD within the proximal humerus. Oh et al evaluated region specific volumetric bone density in the proximal humerus.[17] They divided the greater tuberosity into 7 blocks on computed tomography scans and found that the posterolateral block followed by the anterolateral block had the highest BMD. The lowest BMD was in the anteromedial and posteromedial blocks, suggesting that relying solely on medial row fixation in elderly and osteoporotic patients may be insufficient.[17] It is also possible that current techniques may overcome low BMD of the greater tuberosity, such as compaction bone grafting in degenerative cysts, buddy anchors, larger anchors, and bypassing the normal footprint to find more cortical fixation laterally.[9] In addition, filling defects and poor-quality bone with demineralized bone matrix or cement have also shown benefit.[1] This may suggest why some authors have not found low BMD to be as great of a concern as others.

Another way to measure outcomes is to evaluate revision rates after RCR. Cancienne et al evaluated 2706 patients who underwent RCR and found that osteoporotic patients had higher rates of revision, and treatment with bisphosphonates did not affect the revision rate.[2] This suggests that delaying surgery to begin pharmacologic treatment does not offer much benefit, especially if the tear is acute.[14] This could be explained by the antiresorptive properties of bisphosphonates incapable of improving bone density but only maintaining the bone health in its current state. In a murine model study, Xu et al found that abalaparatide and denosumab, which have a different mechanism of action to bisphosphonates, significantly improved rotator cuff healing and resulted in higher load to failure at 8 weeks compared to no treatment in ovariectomy-induced postmenopausal osteoporotic rats.[24]

Kwon et al developed the rotator cuff healing index (RoHI), which has gained popularity as a tool used by surgeons to predict whether a particular tear can heal with repair.[12] They included BMD as one of their components in the score, as they found it to be an independent risk factor for rotator cuff healing.[12] In contrast, Manop et al showed that BMD was not an independent risk factor of rotator cuff healing after surgical repair in their population and proposed a modified RoHI score that did not include BMD.[15]

It is important to note that our data focused on PROs and not structural healing, as no follow-up advanced imaging was obtained. This important distinction may explain the discrepancy between this study and the findings of the RoHI study.[12] Previous literature has shown mixed results regarding whether structural healing correlates with clinically important differences in PROs.[20,21] It is possible that despite having similar PROs, patients in the low BMD group had a higher structural failure rate.

A limitation of our study is the low incidence of low BMD in our cohort. With the relatively low numbers of

patients with low bone mineral density found, it reduces the power to detect a true effect. This could indicate improper screening. Cotter et al found one-third of patients undergoing RCR in their study met criteria for osteoporosis screening but only one-third of those patients were appropriately screened.[7] For those appropriately screened, 14.7% met criteria for osteoporosis medication but only 15.6% received appropriate treatment.[7] Therefore, it is likely that some patients in the control group may have had unrecognized low BMD. We did not analyze BMD specific to the proximal humerus. However, other authors have found acceptable association between generalized BMD and BMD of the proximal humerus.[18] Even though our results show good outcomes in patients with low BMD, it is still recommended that patients be appropriately screened and treated for low BMD.

Another limitation of the study is its retrospective design, as other confounding factors could affect outcomes. We attempted to control this by collecting demographic data and size of tears, which were controlled through our statistical methods. We also can only comment on 2-year PROs, and longer follow-up may reveal different outcomes. However, a 2-year follow-up is likely sufficient to show clinical differences. We cannot conclude on healing and retear rates, since repeat imaging was not included. In addition, differences in other objective variables such as strength and ROM were not considered.

## Conclusion

Despite previous literature showing the negative effect of osteoporosis on rotator cuff healing, our data provide no clear relationship between decreased BMD and 2-year clinical outcomes following RCR. The clinical success of RCR is multifactorial, and the weighted impact of specific factors such as low BMD needs ongoing study.

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