RESEARCH PAPER

Glenoid Radiolucent Lines in Anatomic Total Shoulder Arthroplasty are Unaffected by Thrombin Glenoid Preparation

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Abstract

Background: Modern glenoid cementing techniques for anatomic total shoulder arthroplasty has improved the ability to achieve a stable cement mantle, but the efficacy of adjunctive agents in glenoid preparation is unclear. The purpose of this study is to compare the early radiolucency rates of glenoids prepared with and without thrombin.

Methods: We identified patients between January 2017 and February 2019 undergoing primary anatomic TSA using two glenoid types. Group A glenoids had a cemented central peg without peripheral peg cementation, and Group B glenoids had cemented peripheral pegs without central peg cementation. The first postoperative radiograph was assessed for radiolucent lines. All patients had the same glenoid preparation except some had the addition of thrombin as a preparation agent.

Results: We identified 83 Group A glenoids with and 63 without thrombin glenoid preparation, and109 Group B glenoids with and 48 without thrombin preparation. All Group A glenoids had no radiolucent lines and 5 (3%) Group B glenoids had radiolucent lines. Use of thrombin showed no difference in early radiolucencies (p=1.00) in either Group.

Conclusion: The addition of thrombin as a preparation agent had no effect on early glenoid radiolucent lines in anatomic TSA, and its routine use should be reconsidered.

Level of evidence: III

Keywords: Anatomic Total Shoulder Arthroplasty, Glenoid Preparation, Glenoid Loosening, Glenoid Radiolucency, Thrombin

Introduction

Anatomic total shoulder arthroplasty (TSA) with an all-polyethylene glenoid component has been shown as an effective, durable treatment for glenohumeral arthritis (1,2). However, these glenoid components require cementation for placement, and the quality of the glenoid preparation and cement mantle are important to long-term glenoid stability (3,4). Although, the relationship between postoperative radiolucencies of the glenoid component and clinical loosening are incompletely understood, there is evidence that radiolucent lines are associated with implant loosening and failure (5–7). With radiolucency rates reported between 30-96% (3,8–10), glenoid preparation for cementation has been a focus of technique. Modern cementing techniques include pulsatile lavage, vacuum mixing, cement pressurization (11,12), and drying to achieve stable cement mantles (13–15). Drying agents such as thrombin(16) and hydrogen peroxide (17) have been proposed as important adjuncts prior to glenoid cementation, although the clinical utility of these agents in reducing early radiolucencies has not been evaluated with modern-day (pegged, hybrid) implants. The primary goal of our study was to compare the early radiolucent lines around all-polyethylene glenoid components prepared with and without thrombin. We hypothesized that the addition of thrombin to glenoid preparation would have no effect on early radiolucency rates.

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Materials and Methods

We identified all patients between January 2017 and February 2019 undergoing primary anatomic total shoulder arthroplasty by two fellowship-trained shoulder surgeons. Two all-polyethylene, pegged glenoid implant types were chosen that were implanted with hybrid fixation. Group A was a glenoid where the central peg was cemented without peripheral peg cementation [Figure 1] (DJO Surgical, Austin, TX), and Group B was a glenoid where the peripheral pegs were cemented without central peg cementation [Figure 2] (Depuy-Synthes, Warsaw, IN). Group A glenoids were implanted by the same surgeon at three different hospitals, one where thrombin was used and two where thrombin was not used. Group B glenoids were implanted by one surgeon who routinely used thrombin and another surgeon who did not at the same hospital. The first postoperative true AP (Grashey view) radiograph taken 10-21 days after surgery was collected for review to evaluate cement mantle preparation. Four blinded reviewers (all fellowship-trained shoulder surgeons) were asked to assess the ability to grade either the central or peripheral pegs, and then if possible, reviewers assessed for the presence of radiolucencies [Figure 1-2]. Group A glenoids were cemented only in the central peg in all cases, and thus central peg radiolucencies were evaluated. Group B glenoids were cemented only in the peripheral three pegs, were evaluated for radiolucency, and given a Lazarus grading score (4).

All patients in this study underwent surgery in a hospital setting in the beach chair position. All surgeries were done through a deltopectoral approach. After reaming the glenoid, all glenoids were irrigated with pulsatile lavage and suction dried. Next, all glenoids in Groups A and B had either Surgicel (Ethicon, Johnson & Johnson, Somerville, NJ) alone or Surgicel soaked in thrombin for preparation. The Surgicel was placed into the peg holes that were to be cemented and then removed prior to cementing. Poly-methyl methacrylate cement (Simplex, Stryker, Kalamazoo, MI) (without adjunctive antibiotics) was applied using a catheter-tipped syringe for pressurization. Excess cement was removed prior to implant insertion. All patients underwent immobilization in a sling and taught self-directed passive stretching exercises to start postoperative day 1. All patients had a routine 10 to 21-day follow-up after surgery for wound evaluation and radiographs. A Grashey view and axillary view radiograph were routinely obtained at this visit.

Images were first assessed as being interpretable for radiolucencies (yes/no). Three or more observers had to agree that images were interpretable in order to be included in the analysis. If images were considered to be interpretable, the presence of radiolucent lines was assessed. If >50% of the reviewers (3/4 or 2/3) considered there to be radiolucent lines, then a positive radiolucent line was considered. Group B glenoids were

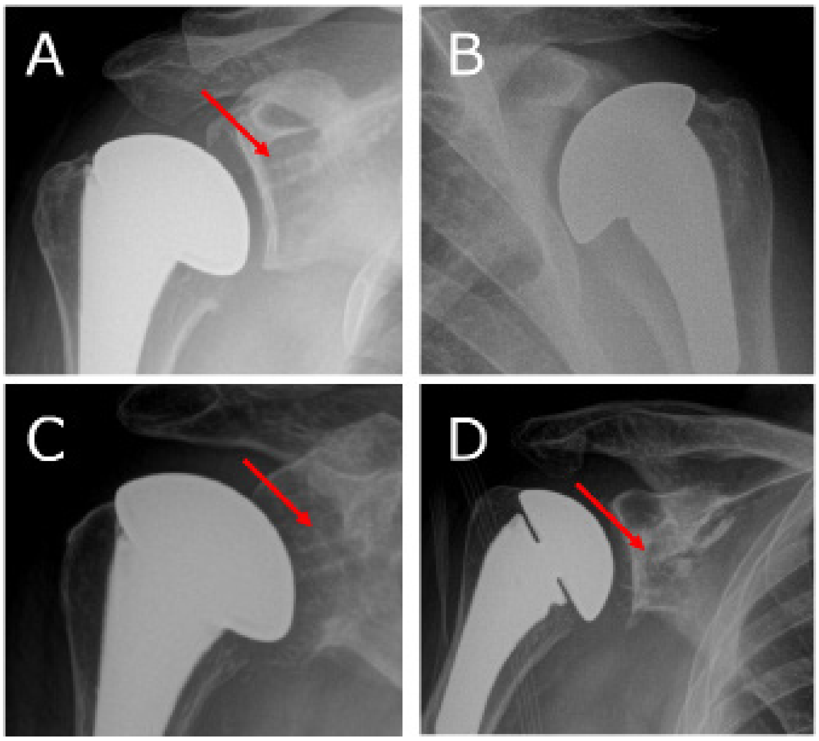

Figure 1. Examples of Group A glenoids, with red arrows indicating the central peg cement mantle we are evaluating. A) Shows no radiolucent lines, with good image quality. B) Shows a poor quality image due to bone overlap and an uninterpretable center peg. C) Shows no radiolucent lines, with adequate image quality due to malrotation. D) Shows a poor image quality due to rotation and overlying structures, but able to see no radiolucent lines around the center peg.

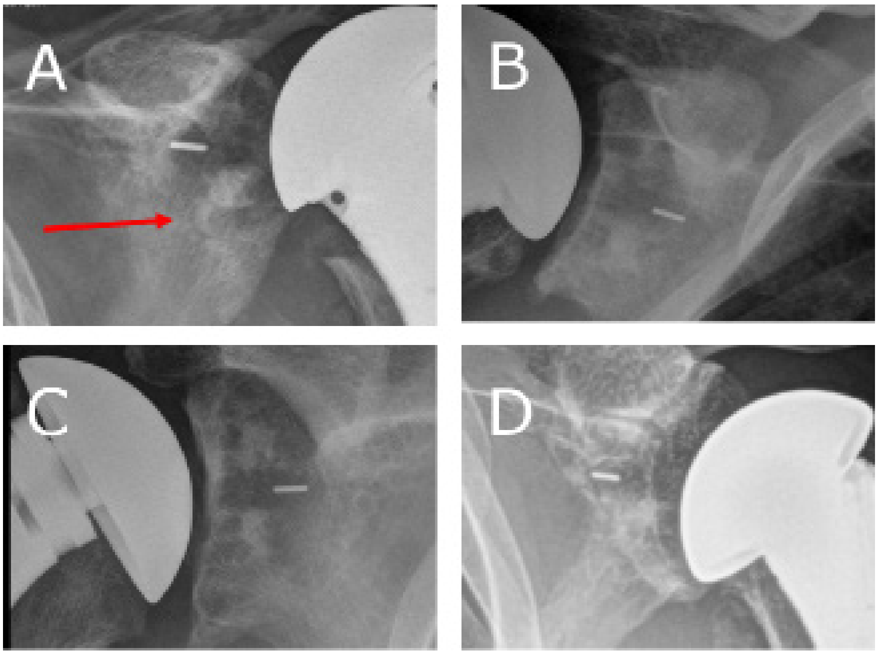

Figure 2. Examples of Group B glenoids. A) Shows a radiolucent line (red arrow) around in the inferior peripheral peg, Lazarus Grade 1 radiolucency, and an adequate image due to some malrotation. B) Shows no radiolucent lines with an adequate quality image due to minor bony overlap of the superior peg. C) Shows no radiolucent lines with good image quality. D) Shows a poor image quality due to malrotation and an inability to assess the peripheral pegs.

additionally evaluated for Lazarus grades (4). Image quality was graded as good, adequate or poor based on penetration, rotation, bony overlap and ability to assess the cement mantle [1-2]. Demographic variables of age and gender were retrieved from the electronic medical record.

Fisher's exact, chi-square, Wilcoxon rank-sum, and Student's t-tests were completed between patients that had thrombin glenoid preparation versus those that did not dependent on the variable of interest. Multivariate analysis on radiolucency rates was unable to be completed due to the low incidence of radiolucent lines. We calculated agreement amongst reviewers for presence of radiolucency rates. JMP 14 PRO (SAS, Cary, NC) was used for statistical analysis.

Results

We identified 146 of 147 Group A glenoids with interpretable radiographs, 83 with thrombin and 63 without thrombin. The average age of Group A glenoids was 67±7 years (range 37-84) at time of surgery, with 67/146 (46%) female and 79/146 (54%) male. We identified 157 of 163 Group B glenoids with interpretable radiographs, 109 with thrombin and 48 without thrombin. The average age of Group B glenoids was 66±10 years (range 31-84), with 77/157 (49%) female and 80/157 (51%) male.

In Group A glenoids, there were zero radiolucencies of the center peg. There was also no difference between age (67±8, range 37-82 vs. 67±7 range 53-84 *P=0.72*), gender (31/63, 49% vs. 36/83, 43% female, *P=0.51*), or image quality (*P=0.89*) in patients that did or did not undergo thrombin glenoid preparation. In 12 patients (8%), one of four reviewers found a radiolucency. If we considered one reviewer finding a radiolucent line as positive in Group A glenoids, there was no difference of radiolucent lines in patients that had thrombin preparation (5/83, 6%) and those without (7/63, 11%) (*P=0.36*), and also no difference in age (*P=0.10*), gender (*P=0.14*), or image quality (*P=0.38*). The agreement percentage overall for radiolucency presence was 91% (95% CI: 85-95%), and for each individual rater was 96% (95% CI: 96-97%), 94% (95% CI: 94-95%), 95% (95% CI: 94-95%), 97% (95% CI: 96-97%).

In Group B glenoids, there were 5/157 (3%) patients with radiolucent lines. When comparing radiolucent lines in patients that had thrombin preparation (4/109, 4%) to those without (1/48, 2%), there was no difference in early radiolucencies (*P=1.00*). There was also no difference between age (66±10 range 36-82 vs. 66±11 range 31-84 *P=0.92*), gender (26/48, 54% vs. 51/109, 47% female, *P=0.49*), or image quality (*P=0.10*) in patients that did or did not undergo thrombin glenoid preparation. There was no relationship between radiolucent lines and Lazarus grade (*P=0.20*), age (*P=0.27*) or gender (*P=0.20*) for Group B glenoids. However, poor image quality was associated with presence of radiolucent lines (*P=0.03*). The agreement percentage overall for radiolucency presence was 48% (95% CI: 40-55%), and for each individual rater was

76% (95% CI: 74-77%), 78% (95% CI: 77-80%), 70% (95% CI: 68-72%), 62% (95% CI: 60-64%).

Discussion

We have evaluated two different all-polyethylene, hybrid glenoid designs both using modern cementing techniques with and without thrombin during glenoid preparation and found no difference in early radiolucency rates. As a result, thrombin does not appear to have substantial value in preventing early radiolucent lines.

Previous literature has established the importance of the cement mantle for implant stability (3,14). The importance of pressurization of the bone-cement interface reduces radiolucent lines as compared to manual packing of the holes(9), and using a vacuum-assisted weep hole technique has demonstrated improved cement interdigitation(12). A previous clinical study evaluating three techniques of glenoid drying (gelfoam soaked thrombin, CO2 gas jet lavage and irrigation and drying) found no difference in radiolucency rates in a keeled glenoid design, but a significant difference in costs(16). Our current data appears to agree with these results in the pegged glenoid design for both centrally and peripherally cemented, hybrid designs. A more recent study from 2013 using pegged components found again that pressurization with a luer-lock tip versus manual packing of peg holes was superior in preventing early radiolucency rates in a series of 100 consecutive patients (11).

The cost for a 5000-unit vial of thrombin was $42.48 in these cases, and has been reported up to $80-100(18). This could represent an annual cost-savings per case in the tens of thousands of dollars for a single-institution and/or surgeon without adverse effects on glenoid component radiolucency. While this number is small in comparison to the overall cost of the episode of care, the additive impact of eliminating multiple, small extraneous costs can lead to more cost-effective care.

This study did have some limitations. This study was retrospective and non-randomized. We attempted to control for certain confounders by demonstrating no differences in age, gender or implant between groups. Additionally, we were able to control for many technique variables by limiting the study to a single surgeon series for Group A glenoids, and a single hospital and two-surgeon series for Group B glenoids. Unfortunately, we did not obtain longer-term follow-up of radiographs to evaluate for late radiolucent lines. However, the objective of this study was to evaluate the different cementing techniques on the initial cement mantle observed. Later radiographs would have to consider confounding factors of glenoid-humeral head mismatch biomechanics, rotator cuff function, joint-line restoration, among many other variables. We did not have perfect agreement among reviewers for the variables we measured, although Group A glenoids had very high agreement rates (>90%) compared to Group B glenoids (60-70%). We attempted to alleviate this issue by including more reviewers and raising our threshold for a "true" finding.

Glenoid preparation is an important step prior to cementing and implanting an all-polyethylene, pegged glenoid component. Vacuum mixing, good hemostasis, irrigation and cement pressurization have all been implicated in reducing cement-related complications in orthopaedic literature. In the current era of cost-effective procedures, use of expensive products that may have no clinical benefit should be carefully scrutinized. Our study demonstrates that the addition of thrombin as a hemostatic agent had no effect on early glenoid radiolucent lines in anatomic total shoulder arthroplasty, and its routine use should be reconsidered.

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