Degenerative shoulder conditions are most commonly encountered in patients older than 65 years, but serious shoulder pathology may be a cause of significant pain and disability in young patients who are active. Trauma, glenohumeral dislocation, osteochondritis dissecans, avascular necrosis, infection, tumors, arthroscopic surgery, and chondrolysis can all result in a dysfunctional shoulder. Each of these pathologies is significant by itself, but when coupled with a deficient

Reverse total shoulder arthroplasty (TSA) is a useful intervention for older patients with glenohumeral arthritis and a deficient rotator cuff. However, as a semiconstrained prosthesis, conventional reverse TSA implanted in a young patient could fail over time secondary to polyethylene wear and subsequent osteolysis. A metal-on-metal prosthesis may avoid this type of failure. The purpose of this study is to assess the outcomes in an initial cohort of young patients who underwent reverse TSA using a metal-on-metal prosthesis. Surgical indications included age younger than 50 years with a functioning deltoitd and significant impairment of shoulder function with irreparable rotator cuff due to tumor resection, arthritis, or revision surgery. Nine patients with an average age of 37 years underwent implantation of a custom metal-on-metal reverse TSA prosthesis. All patients had a minimum 12-month follow-up or a failure of their procedure requiring revision surgery prior to 1 year. American Shoulder and Elbow Surgeons (ASES) scores, Constant scores, and range of motion were recorded and analyzed pre- and postoperatively to assess improvement, and all complications were noted. Average ASES score improved from 47 points preoperatively to 73.4 points postoperatively ($P=.013$). Average Constant and adjusted Constant scores improved from 20.8 points and 16% preoperatively to 61.8 points and 67.3% postoperatively, respectively ($P=.019$ and $P=.068$). Mean postoperative active forward flexion and active external rotation were 119.4° and 10°, respectively. Complications included the following: 3 patients sustained a postoperative dislocation, 1 patient had a glenoid fracture and complete loss of fixation of the baseplate, and 1 patient experienced dissociation of the glenosphere from the baseplate. Although metal-on-metal reverse TSA may appear to be an attractive choice in the treatment of young patients with limited reconstructive options, postoperative outcomes are disappointing, and the complication rate is high. [Orthopedics. 2016; 39(5):e957-e961.]
rotator cuff, the result can be debilitating. There are currently few surgical treatments that can reliably restore function to these patients, and the treatment of younger patients with these conditions is difficult.

Major reconstructive shoulder surgery in younger patients has no defined algorithm. Most described treatments for shoulder pathology in young patients, such as microfracture and osteochondral grafting, are limited to small, well-contained cartilage lesions. Reverse total shoulder arthroplasty (TSA) has been a useful intervention for older patients with a deficient rotator cuff, but, as a semiconstrained prosthesis, a conventional reverse TSA using a polyethylene spacer could theoretically fail over time in a younger patient due to polyethylene wear and subsequent osteolysis. In an attempt to avoid failure due to polyethylene wear in younger patients with severe shoulder pathology and rotator cuff deficiency, a custom metal-on-metal (MOM) reverse TSA prosthesis was manufactured. The purpose of this study is to report the results of an initial cohort of young patients who have undergone reverse TSA using a MOM reverse shoulder prosthesis.

**MATERIALS AND METHODS**

After receiving approval from the local institutional review board office, the authors retrospectively reviewed 9 patients who underwent reverse TSA using a custom MOM prosthesis between 2008 and 2012. Average patient age at surgery was 37 years (range, 17-49 years), and all patients were men. Seven of the 9 patients underwent surgery in their dominant arm.

Indications for the procedure included patients younger than 50 years with significant impairment of their shoulder function and nonfunctional rotator cuff who maintained sufficient strength and function of their deltoid muscle. Patients satisfying these criteria included 2 with tumors requiring resection of the proximal humerus, including the rotator cuff; 2 with malunion and posttraumatic arthritis with massive irreparable rotator cuff tears; 1 with severe osteoarthritis and a massive irreparable rotator cuff tear; 1 with capsulolabral arthropathy; 1 with a failed arthrodesis; and 2 with resection arthroplasties and chronic rotator cuff insufficiency after removal of their infected implants.

All patients were followed for at least 12 months, unless their primary surgery had failed and they required revision surgery prior to 1 year.

Patients underwent implantation of the reverse prosthesis through a deltopectoral approach in the beach-chair position using a pneumatic arm holder. All components implanted in this study were manufactured by Tornier, Inc (Edina, Minnesota) as a custom MOM variation of the Aequis Reversed TSA System. All humeral components were cemented with nonantibiotic cement and placed in 20° of retroversion in reference to the forearm. All humeral metaphyseal components and glenosphere components were size 36 mm, except for 1 patient who received a 42-mm implant.

The rehabilitation stage focused on 3 phases of rehabilitation that balanced ear- nine as the patients began formal exercises is never allowed because of concerns surrounding acromial stress fractures, particularly in osteoporotic women. All glenoid baseplate components were positioned inferiorly on the glenoid using a guide to reference the inferior osseous border of the glenoid rim (Figure 1).

All clinical and physical examination data were collected in person by the primary surgeons (R.G., B.E.). Pre- and postoperative outcome measures used in this study included the Constant score, sex-specific age-adjusted Constant score, and American Shoulder and Elbow Surgeons (ASES) shoulder index. Postoperative active ROM was measured using a handheld goniometer to evaluate forward flexion, abduction, and external rotation with the arm at the side.

**RESULTS**

Clinical and radiographic follow-up for a minimum of 1 year were available.
for 7 patients. In the remaining 2 patients, failure had occurred prior to 1 year and required revision surgery. Average time to final follow-up was 15.4 months (range, 12-24 months). Average ASES score improved significantly, from 47 points preoperatively to 73.4 points postoperatively ($P=.013$). Average Constant score also improved significantly, from 20.8 preoperatively to 61.8 postoperatively ($P=.019$). Average adjusted Constant score improved from 16% to 67.3%, although this trend was not statistically significant ($P=.068$) (Table 1). Mean postoperative active forward flexion and active external rotation were 119.4° and 10°, respectively (Table 2).

Postoperative complications included 3 patients who sustained a dislocation of the prosthesis, 1 who sustained a glenoid fracture resulting in complete loss of baseplate fixation, and 1 whose glenosphere dissociated from the baseplate. Of the 3 dislocations, 2 occurred more than 12 months postoperatively (Figure 2). Both of the baseplate complications occurred within 3 months postoperatively and were included as early failures (Table 3).

**Discussion**

Total shoulder arthroplasty has grown in popularity as a treatment for a wide variety of shoulder pathology, and the number of TSAs performed annually has increased dramatically in recent years. Despite success in elderly patients, reports indicate less satisfactory results with TSA in young patients. The results of the current study indicate that a MOM reverse TSA prosthesis implanted in a young patient with complex shoulder pathology has a high complication rate and produces inconsistent outcomes.

Total shoulder arthroplasty in young patients is usually performed for complex pathology when all other treatment options have failed or are not feasible. Most of the literature available for young patients undergoing TSA involves patients with an intact rotator cuff. Sperling et al. reported a revision rate of 38% due to glenoid component failure in a series of 33 patients with a mean age of 46 years at the time of TSA. Elhassan et al. studied 13 patients who had been treated with a humeral head arthroplasty and soft tissue resurfacing the glenoid. They reported that 10 of the 13 patients needed revision surgery 14 months postoperatively. Nicholson et al. showed good short-term results after 18 months in 30 young, high-demand patients with bipolar defects using an uncemented hemiarthroplasty and resurfacing of the glenoid with a lateral meniscus allograft. However, they also reported a 17% first-year complication rate, all requiring revision surgery.

Outcomes following reverse TSA in younger patients are, perhaps understandably, even worse than those of hemiarthroplasty and TSA due to the more complicated pathology and lack of functioning rotator cuff. A retrospective multicenter review of reverse TSA outcomes in a younger population was conducted by Muh et al. The authors looked at outcomes in reverse TSA in patients younger than 60 years (mean, 52.2 years) and showed good postoperative improvement with a 15% complication rate at an average 36.5-month follow-up. However, overall patient satisfaction was only 81%, lower than what has previously been reported in the literature for older patient populations (90%-96%). The current study’s clinical outcome measures are similar to those reported by Muh et al. and both studies found that dislocation was the most commonly encountered complication. Of the 67 shoulders included in the study by Muh et al. 5 sustained dislocations, and 3 of those required revision surgery. The complication rate in the current study was much higher. Although Muh et al. studied outcomes in younger patients, their mean age (52.2 years) and the current study’s average age (37 years) are different, which makes direct comparison difficult.

**Table 1**

<table>
<thead>
<tr>
<th>Outcome Score</th>
<th>Preoperative</th>
<th>Postoperative</th>
<th>$P$</th>
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<tbody>
<tr>
<td>ASES</td>
<td>47.0±18.2</td>
<td>73.4±16.0</td>
<td>.013</td>
</tr>
<tr>
<td>Constant total</td>
<td>20.8±10.8</td>
<td>61.8±36.0</td>
<td>.019</td>
</tr>
<tr>
<td>Constant adjusted</td>
<td>16.0%±4.6%</td>
<td>67.3%±36.0%</td>
<td>.068</td>
</tr>
</tbody>
</table>

Abbreviation: ASES, American Shoulder and Elbow Surgeons.

$P<.05$. 

**Table 2**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Mean±SD</th>
</tr>
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<tbody>
<tr>
<td>Flexion</td>
<td>119.4°±58.8°</td>
</tr>
<tr>
<td>Abduction</td>
<td>97°±63.5°</td>
</tr>
<tr>
<td>External rotation</td>
<td>10.0°±11.5°</td>
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**Figure 2**: Postoperative radiograph of a metal-on-metal reverse total shoulder arthroplasty after dislocation.
Metal-on-metal hip resurfacing arthroplasty or total hip arthroplasty has been used successfully to treat hip arthritis in young, active patients. Metal-on-metal bearings have a considerably lower described wear rate than metal-on-polyethylene bearings, with reported linear wear rates of 5 µm per year for MOM bearings at least 20 times less than those of metal-on-polyethylene bearings.16 This decreased wear rate may contribute to the relative increase in instability observed in MOM reverse TSA. As polyethylene components wear, a deeper dish is created and introduces more constraint into the system, which may make them more stable. Retrieved polyethylene particles are approximately 1 order of magnitude larger than cobalt and chromium particles produced, which have been reported as being less than 50 nm in size.17 However, despite the production of smaller wear particles, MOM bearings produce up to 500 times more microparticles than metal-on-polyethylene bearings.16 The long-term consequences of these metal particles are largely unknown. Regardless, there are concerns regarding adverse biological reactions to these metallic particles, including local soft tissue reactions, bone loss, hypersensitivity reactions, and renal and gastrointestinal dysfunction.18–24 At the time of this writing, implant companies have stopped making custom MOM reverse TSA implants due to legal issues with MOM hip components.

The use of a MOM prosthesis in reverse TSA appears to have theoretical value, but not practical value. An increased level of activity in a young patient raises concern for the consequences of premature wear with the use of traditional metal-on-polyethylene TSA because periprosthetic osteolysis could be a cause of metal-on-polyethylene implant failure.25–27 This type of failure has been well documented in the hip and knee literature but remains a theoretical concern for reverse TSA. However, the results of the current study indicate that many young patients undergoing reverse TSA experience early complications and severely limited function that would make late failure due to osteolysis uncommon overall. At this time, the current authors have discontinued use of this prosthesis, and, when the need arises for reverse TSA in a young patient, they use standard metal-on-polyethylene bearings.

To the authors’ knowledge, this is the only study to date investigating MOM reverse TSA in a young population. This study is limited by its retrospective nature and the narrow indications for this type of procedure, which resulted in a small patient population. Also, the follow-up was relatively short, but this was largely due to early failures, which negate the need for longer follow-up to be included.

**CONCLUSION**

Although reverse TSA with a MOM articulation may appear to be an attractive choice in the treatment of young patients with limited reconstructive options secondary to massive rotator cuff insufficiency, postoperative rotator cuff insufficiency, postoperative outcomes are disappointing, and the complication rate is high. This cannot all be attributed to the implant design, with the patient’s young age, activity level, and complex pathology all contributing to diminished outcomes. However, with a high complication rate and the current controversies regarding MOM bearing surfaces, the authors cannot recommend this type of reverse TSA prosthesis.
References


