

## As reverse shoulder arthroplasty gains popularity, surgeons consider indications, revision methods

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Since the first reverse shoulder prosthesis gained FDA approval in 2004, reverse shoulder arthroplasty has given surgeons an opportunity to improve function and pain relief in elderly patients with rotator cuff deficiencies and for patients with indications that may leave little in the way of other surgical options.

Although the FDA recommends that reverse shoulder arthroplasty (RSA) be performed in patients 70 years or older, the success of the procedure has led some surgeons to expand their indications, particularly in younger more active patients.

**Anthony A. Romeo, MD**, head of the Shoulder & Elbow Surgery section at Rush University Medical Center, told *Orthopedics Today* that he primarily uses RSA in patients with rotator cuff tear arthropathy, but he also treats patients with the procedure if they have had failed shoulder arthroplasty.



Anthony A. Romeo, MD, noted that reverse shoulder arthroplasty can lead to stabilized shoulders in at least 75% of treated cases.

Image: Robert Levy Photography

“Our patients with failed arthroplasty probably represent the most challenging cases we treat with reverse shoulder arthroplasty, but the results are much better than what historically was possible for these people,” Romeo said. “If you had failed a shoulder replacement, that now included a problem with the rotator cuff, the operations that were done to try to salvage that shoulder were successful in less than 50% of cases. With reverse shoulder arthroplasty, we are able to stabilize the shoulder and we are able to substantially reduce their pain in nine out of 10 patients.”

**Michael A. Wirth, MD**, professor of orthopedics at the University of Texas Health Science Center at the San Antonio Department of Orthopaedics in Texas, told *Orthopedics Today* that using RSA for the treatment of elderly patients with fractures has been a breakthrough in his practice.

“If somebody had been treated for a fracture and ended up with arthrofibrosis and they had pain and poor function, there was little we could offer with respect to revision surgery until the advent of RSA in North America,” Wirth said.

### Off-label indications

**Brian J. Cole, MD, MBA**, also in the Section of Shoulder and Elbow Surgery at Midwest Orthopedics at Rush University Medical Center in Chicago and Chairman of the Department of Surgery at Rush's Oak Park Hospital told *Orthopedics Today* that age, in and of itself, is not a indicator for determining whether a patient is a candidate for RSA.

"You have patients, for example, who undergo hip or knee replacement at a young age where the decision is made based upon the profound nature of their pain and associated quality of life issues against the potential downside of implant or component failure, you cannot discount the importance of those otherwise healthy years weighed against the potential for complication," Cole said. "There is a time and a place for every patient in this category, and it is directly related to the level of pain and impairment they are experiencing."

However, he noted the danger of rushing into RSA as an initial solution for pain and function issues without consideration of nonoperative management.

"Many patients with rotator cuff arthropathy can be managed without surgery. Proper rehab, counseling and educating the patient that it is okay to live with a non-intact cuff and live in some discomfort [is acceptable]. It is not a scenario where if you do not manage it now, you will not be able to manage it later," Cole said.



Brian J. Cole

Performing the RSA in more active patients can lead to complications down the road, **Joseph P. Iannotti, MD, PhD**, chairman of the Orthopaedic and Rheumatologic Institute at the Cleveland Clinic Foundation in Ohio and Section Editor, Shoulder & Elbow for *Orthopedics Today*, said.

"Age is a guideline that ought to be respected. This is not a prosthesis that should be used in 50-year-old people who are otherwise still employed, actively working and doing aggressive activities, because it will fail prematurely," he said.

## Determinants of success

For primary and revision RSA, good preoperative planning and implant placement, knowledge of glenoid bone loss and shoulder anatomy is paramount to minimize complications like notching and dislocation, Iannotti said.

"I would pay close attention to why they fail, watching those that have been doing this for 10 years or longer and the reports of when, how and why they fail to help better ourselves and our decision-making in terms of the technical aspects of performing the surgery," Cole said.

Iannotti said he sees malpositioning of components and inadequate soft tissue exposure as common reasons for failure.

"In the revision world, it is all about soft tissue management and the excision of scar tissue and soft tissue releases, so that you are back to having excellent exposure and having the soft tissue envelope is not a hindrance to reduction or stability of the implant," he said.

## Medialization vs. lateralization

In 1985, Paul M. Grammont, MD, developed the concept of using medialization and lowering the center of rotation in the reverse shoulder prosthesis to solve glenohumeral arthropathy. In a medialized implant design, scapular notching is one of the most common complications.

**Pascal Boileau, MD**, professor and head of the Department of Orthopaedic Surgery and Sports Traumatology at Archet 2 Hospital in Nice, France, recalled the early problems of RSA with *Orthopedics Today's* sister publication, *Orthopaedics Today Europe*.

“One of the problems we observed initially with the reverse prosthesis was scapular notching and instability, because once the shoulder is stabilized, the remaining muscles in the deltoid are under less tension and the prosthesis can be unstable with dislocation,” Boileau said. “The fact that the shoulder is medialized [and] the humerus is medialized [means] less movement and rotation because the humeral cap is impinging, not only inferiorly but also anteriorly and [proximally] against the neck of the scapula. The most frightening problem initially was inferior impingement, [which] leads to a notch on the pillar of the scapula and also to bone lysis and loosening of the prosthesis.”

A metallic or prosthetic lateralization method, developed by Mark A. Frankle, MD, increases the offset of the glenosphere or the baseplate and is an alternative to the medialized method. However, lateralizing the center of rotation has the disadvantage of increasing the risk for glenoid loosening as well as increasing torque and shear force on the glenoid, Boileau said.

Boileau developed a bony lateralization method called the bony-increased offset technique (BIO-RSA) to combat this problem. By positioning the glenoid component against the native glenoid's inferior edge, scapular notching is reduced, he said.

“One day I was in the OR, and I had an idea. Instead of throwing away the humeral head that I had just cut, [I wanted] to use the bone of the humeral head, to do a graft from the glenoid side and by doing this create a scapula with a long neck and bone graft. In addition to [the] special base, there is a longer peg and longer screws. I was able to obtain a scapula with a long neck and therefore, I was able to avoid the impingement of the cup against the scapula,” Boileau said.

Romeo said knowing the nuances of both Grammont and Frankle designs should be a part of any surgeon's arsenal when performing RSA.

“The shoulder surgeon should become aware of the many variations of the reverse shoulder arthroplasty available, including the French concept of medialization and inferior placement of the humerus vs. the more American model of lateralization of the center of rotation and anatomic inclination of the humeral socket,” Romeo said. “They are distinctly different ways to perform the operation, and a true shoulder expert should have an understanding of both models and be able to apply that to the specific patient problem.”

Additionally, implants vary in their mechanics based on whether they are lateralized or medialized, Iannotti said. Placing the glenosphere in a way to minimize notching is critical, he said.

“That is related specifically to implant position inferiorly, so that you have an overhang of the glenosphere and to try to minimize tilt superiorly or inferiorly,” Iannotti said.

In a lateral offset prosthesis, good bone fixation, bone quality and implant fixation are essential. However, there is a risk of loosening depending on the amount of lateral offset, Iannotti added.

The Grammont design, with a large hemisphere on the glenoid side, places the center of rotation at the surface of the glenoid bone, Wirth noted. This feature reduces the torque forces on the component and decreases the risk of loosening. Presently, many of the implants are hydroxyapatite-coated titanium alloys that are designed to optimize prosthetic fixation while obviating the need for cement, Wirth said.



Michael A. Wirth

## **Bone grafting**

Compared to total shoulder arthroplasty (TSA), RSA has a higher rate of bone graft incorporation, according to Romeo. Using structural bone grafts with a cemented TSA implant on the glenoid side will result in high complications with little bone incorporation, he said.

“When we use a reverse arthroplasty and we do not use cement on the glenoid side, we are able to generate a construct that compresses our bone graft against the patient’s native glenoid and scapula. The results of bone grafting are excellent and consistent among many surgeon’s hands. Using glenoid bone grafts with reverse arthroplasty has been a major value for us, allowing better alignment of the glenoid to its more natural state in conjunction with the placement of the metaglenoid or glenoid base plate.”

While the graft is often successful, there is currently no consensus on the best graft type. Autograft is used by most surgeons for primary RSA, but insufficient results using allograft, autograft and bone graft substitutes has lead many surgeons to choose a method that works best for them, Iannotti said.

## **Steep learning curve**

Even after learning the basic tenets of RSA, there is a steep learning curve associated with the procedure.

“Mainly, I think the first learning curve is understanding who is the proper patient, so the learning curve related to decision-making is clearly an inclination, if you will, relative to how we choose proper patients, how we educate them and what their expectations should be,” Cole said. “The technical aspect is clearly there in achieving proper soft tissue management, capsule release, glenoid exposure, faceplate position and screw position. I believe that has been the learning curve, and there is no question that time, for me anyway, has made me comfortable with all those issues.”

More complex cases and patient volume will also affect the learning curve, Iannotti said.

Romeo said many of the tools used by orthopedists for conventional TSA can also be applied to RSA.

“Much of the surgical technique, including the exposure of the humerus and the glenoid are the same with what we use with total shoulder replacements. Once the surgeon understands the biomechanics and design features of the reverse arthroplasty and they have had the opportunity to witness the various steps performed by an expert, they can extrapolate their skills with total shoulder arthroplasty in terms of the exposure and management of the soft tissues and apply this to the reverse arthroplasty.”

## **Decrease complication rates**

Some initial published reports noted high complication rates with RSA. In a retrospective study of 506 patients who underwent the surgery between 1985 and 2003, Favard and colleagues showed 89% implant survivorship at 10 years. After adjusting for Constant and Murley scores lower than 30, 10-year survivorship decreased to 72%. The investigators found noticeable radiographic changes in the implant at 5 years.

The rate of short-term complications has decreased in recent years due to increased surgical experience with the procedure, Wirth said. In his first year of performing RSA, he had five cases of instability. However, he noted that during the past 4 years, he has not had a case of dislocation. Milder complications, such as hematomas, often do not warrant another surgical intervention, he added.

“You are going to see complication rates that will vary and you need to understand that it is not necessarily a function of the surgeon, but the patient base he or she is treating. Those who are most likely reporting

complications are also most likely to have the most mature orthopedic shoulder practices,” Cole said. “The most mature orthopedic shoulder practices have the most difficult patient base. I would say [complications are] considerably lower if you look at the mainstream patient group who meets the primary indication.”

## **Options for failed RSA**

Revising a reverse can be difficult based on the lack of glenoid bone, as opposed to the humeral-side bone loss, which can be solved with a long RSA stem or intercalary allograft. In these cases, Iannotti said he uses a two-stage salvage procedure that manages components based on bone incorporation.

“In the worst case scenario, you can do a two-stage revision: take out all the failed parts from the first reverse, bone graft the glenoid side — usually autograft if you can get iliac crest graft or sometimes allograft. If you put in a hemi replacement, you can use a reverse stem with a hemi head, wait for the bone graft to incorporate and when the graft is incorporated, usually 9 months to 18 months after surgery, you can go back in and put in the rest of the components for your second stage surgery,” he said.

Conservative pain management, resection arthroplasty and fusion are options for failed RSA procedures in elderly patients or in patients with severe bone loss or comorbidities. The key to determining the next step in managing a failed RSA is to find out the cause of implant failure, Iannotti said.

In some cases, the answer for a failed RSA is a revision with bone grafting on the glenoid side, Romeo said.

“There is sort of a knee jerk response that if you have a failed reverse shoulder arthroplasty that everything has to come out on the glenoid side, and maybe on the humeral side. Instead of putting in a new socket, we put in a larger humeral head and perform a hemiarthroplasty, which was the standard of care for many years for patients without a functioning rotator cuff and arthritis before reverse arthroplasty was available,” Romeo said. “That procedure was part of the reason we switched to reverse shoulder arthroplasty, because it did not work well in those patients.”

A revision RSA with bone grafting as needed is a better fix, he said.

“It requires some different strategies for fixation of the glenoid baseplate to the patient’s scapula, and may also require bone grafting including large allograft prosthetic composites on the humeral side to get a successful result,” Romeo said.

## **Reimbursement issues**

Although the prices of reverse shoulder implants are often twice that of traditional shoulder implants, hospitals receive the same reimbursement regardless of which procedure is performed.

“It is a huge problem when the implant can be greater than 30% to 50% of the entire process, yet represent 10% to 15% of the reimbursement; you have got a huge issue on your hands,” Cole said.

Although Wirth said there is no discussion about reimbursement for RSA at his university hospital, he noted that several colleagues working in for-profit hospitals have been asked to limit the number of RSAs performed per year because the hospitals lose money with each procedure.

“The data is so overwhelming and convincing that it improves the quality of life of so many patients, that we are going to have to try to work out the economics with the hospital and the implant companies,” he said. “Failure to accomplish this in a responsible manner may deprive patients from a procedure that has been shown to positively impact their lives in a measurable way.”

## Future of RSA

“This discussion around lateral offset prosthesis vs. medial offset prosthesis is going to go away,” Iannotti said of the future for RSA. “I think inventory will probably come to a point where there are options to use one or the other depending upon the patient’s needs. It will be less of a controversial issue of [whether] I use a Grammont style prosthesis or do I use a lateral offset prosthesis.”

He also sees a future in the development of more modular components.

“My guess is most companies will have a modular system for the stem and a modular system for the glenoid side so you can more easily convert from an anatomic to a reverse and maybe back from a reverse to an anatomic as a salvage procedure. Hopefully, there will be fewer stems that have to be removed just to put in a reverse.” – *by Jeff Craven and Nicole Blazek*

### Reference:

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- Disclosures: Boileau is co-inventor of the Aequalis (Tornier Inc.) reverse shoulder prosthesis. Iannotti is a designer for DePuy. Romeo is a consultant, designer and developer of shoulder prosthetics for Arthrex. Wirth is a consultant for and receives royalties from DePuy, Johnson & Johnson. Cole has no relevant financial disclosures.

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## POINT / COUNTER

### In what ways, if any, should the indications for reverse shoulder arthroplasty be changed?

#### POINT

#### Expand indications with experience, data

Initially, my indication for reverse shoulder arthroplasty was limited to rotator cuff arthropathy in patients 70 years old and older. As I have become more comfortable with the outcome and longevity of the procedure, I have lowered the age that I consider performing a reverse arthroplasty. In addition, I have expanded the indications to include massive irreparable rotator cuff tears with pseudoparalysis, inflammatory arthritis with rotator cuff insufficiency and acute four-part proximal humeral fractures in elderly patients. It has also become clear to a number of surgeons that the amount of glenoid bone stock necessary for a reverse arthroplasty is less than that for an anatomic glenoid component. Therefore, reverse arthroplasty may be considered in patients with an intact rotator cuff and severe glenoid bone loss in both the primary and revision setting.



John W. Sperling

Biomechanical and clinical research has significantly improved our understanding of key technical aspects of the procedure to improve survival and minimize complications. The availability of uncemented humeral

designs has also significantly advanced the use of reverse arthroplasty. This has decreased the overall operative time and facilitated the ease of future revision surgery if necessary. Convertible stems that can be used for hemiarthroplasty, total shoulder arthroplasty or reverse arthroplasty have also significantly improved flexibility at the time of surgery. In the younger patient, advanced bearing surfaces have been introduced in an effort to decrease polyethylene wear.

Therefore, encouraging clinical experience coupled with supportive peer-reviewed published data has resulted in the expansion of indications for the reverse arthroplasty.

**John W. Sperling, MD, MBA**, is a professor of orthopedic surgery at the Mayo Clinic in Rochester, Minn., and an Orthopedics Today Editorial Board member.

**Disclosure:** Sperling receives royalties from Biomet.

## COUNTER

### High complication rates remain

There is no question that reverse shoulder arthroplasty has been a significant addition to the armamentarium of the shoulder surgeon in dealing with complicated shoulder problems. The current indications as defined by the FDA are for use “in patients with a grossly rotator cuff deficient shoulder joint with severe arthropathy or a previously failed joint replacement with a grossly rotator cuff deficient shoulder joint. The patient’s joint must be anatomically and structurally suited to receive the selected implant(s), and a functional deltoid muscle is necessary to use the device.”



Stephen C. Weber

Rockwood, in his editorial, said that indications for “an elderly patient (70 years of age and older).” The question is, has data been presented that suggest that these indications should change? Complications remain disturbingly high, occurring in 29% of patients in our review of American Board of Orthopaedic Surgery part 2 participants, even in short-term follow-up, and as high as 80% of cases even in experienced surgeons’ early experience. Survivorship data is limited, but Favard and colleagues have shown a significant drop in function at the 8-year point, with little other long-term follow-up on which to base recommendations.

In summary, complication rates remain high and long-term follow-up data is sparse. While some patients have few options, honest discussion with potential reverse candidates should include a realistic representation of the current data on complications and survivorship. Patients younger than 70 years outside the FDA indications may have other options.

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