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REVIEW ARTICLE

AUGMENTED GLENOID COMPONENTS IN REVERSE TOTAL SHOULDER ARTHROPLASTY

WZMOCNIONE KOMPONENTY PANEWKOWE W ODWRÓCONEJ ENDOPROTEZOPLASTYCE STAWU RAMIENNEGO

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ABSTRACT
Over the last several years, multiple commercially-available implant systems have begun to feature augmented glenoid components for reverse total shoulder arthroplasty (RTSA). Augmented glenoid baseplate components can have a flat-backed geometry or a wedge-backed geometry. Flat-backed options serve primarily to lateralize the center of rotation of the arthroplasty. Wedge-backed options, however, can provide for quick, simple, and reliable correction of multi-planar angular deformity that otherwise would prevent appropriate version and inclination of the glenoid baseplate. Bony structural deformity of the glenoid presents a significant challenge to shoulder surgeons performing RTSA, but wedge-backed augmented glenoid components enable us to attack this problem with confidence. A growing body of literature about these components continues to expand with multiple studies showing favorable outcomes using this technology.

Keywords: reverse total shoulder arthroplasty, augmented glenoid component, wedge glenoid component, RTSA, wedge, augment

STRESZCZENIE
Przez ostatnie kilka lat wiele dostępnych komercyjnie systemów implantów zaczęło wykorzystywać wzmocnione komponenty panewkowe w odwróconej endoprotezoplastyce stawu ramiennego (RTSA). Wzmocnione podstawy panewkowe mogą mieć geometrię z płaskim podparciem lub klinowym podparciem. Opcje z płaskim podparciem służą głównie do lateralizacji środka obrotu endoprotezy. Natomiast opcje z klinowym podparciem umożliwiają szybkie, proste i niezawodne skorygowanie wielopłaszczyznowych deformacji kątowych, które w przeciwnym razie uniemożliwiłyby uzyskanie odpowiedniej wersji i inklinacji podstawy panewkowej. Deformacje strukturalne panewki stanowią istotne wyzwanie dla chirurgów wykonujących RTSA, jednak wzmocnione komponenty panewkowe z klinowym podparciem pozwalają skutecznie stawić czoła temu problemowi. Coraz liczniejsze publikacje na temat tych komponentów wskazują na ich korzystne wyniki kliniczne, co potwierdzają liczne badania dotyczące tej technologii.

Słowa kluczowe: odwrócona endoprotezoplastyka stawu ramiennego, wzmocniony komponent panewkowy, komponent panewkowy z klinowym podparciem, RTSA, klin, augmentacja

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Introduction

Glenoid deformity and bone loss presents one of the most common challenges in performing total shoulder arthroplasty (TSA). Whether from chronic glenoid wear or as sequelae from a traumatic event, bony structural abnormalities can cause inappropriate glenoid version and/or inclination. Retroversion and superior inclination of the glenoid tend to occur most frequently in cases of rotator cuff tears and/or rotator cuff arthropathy as well as with primary arthritis, but other bony deformities such as medialization, anteversion, and inferior wear can occur with advanced primary arthritis or traumatic arthritis. Surgeons must correct these multiplanar angular deformities during glenoid component implantation for both anatomic (aTSA) and reverse (RTSA) total shoulder arthroplasty procedures in order to obtain and maintain soft-tissue balance, prevent asymmetric glenoid loading, and maximize the longevity of the arthroplasty.

The simplest means of deformity correction involves the use of a glenoid reamer to take down the "high side" of the native glenoid, usually anterior and/or inferior. This technique, however, is limited to low levels of angular deformity and can also result in bone loss which will compromise the fixation of the implant. The reamer, furthermore, is hard to control – exemplifying the old orthopedic adage of "measuring with a micrometer, but cutting with a chainsaw" Especially in cases of osteoporosis or small native glenoid architecture, glenoid reaming can quickly create problems without a good solution. Finally, glenoid reaming serves to medialize the overall construct center of rotation – running counter to the usual goal of lateralization.

Pascal Boileau popularized the use of the Bony Increased Offset-Reversed Shoulder Arthroplasty (BIO-RSA) as a means of achieving lateralization and correcting glenoid multiplanar angular deformities when implanting the glenoid component (Boileau *et al.,* 2017). Some subsequent studies have shown similar biomechanical performance and clinical outcomes when comparing BIO-RSA to augmented glenoid components (Van de Kleut *et al.,* 2022). Drawbacks of bone grafting, however, include technical difficulty, increased surgical time and cost, and risk of nonunion of the graft (Contreras *et al.,* 2023, Malahias *et al.,* 2020).

Over the last several years, the orthopedic community has witnessed a proverbial explosion of options for glenoid design in total shoulder arthroplasty (Mourad *et al.,* 2020, Wright *et al.*, 2025). Over a decade ago, researchers began using trabecular metal augments to glenoid components in aTSA for correction of glenoid retroversion (Sandow & Schutz, 2016). Implant design for aTSA has also addressed the problem of glenoid multiplanar angular deformity with wedged polyethylene glenoid components (Grey *et al.,* 2020, Shields, *et al.,* 2024).

In addition to wedge-augmented glenoid design in aTSA systems, several manufacturers have developed wedge-backed glenoid components for RTSA as well. Across the world, the use of RTSA has seen a meteoric ascent over the last decade – likely driven in no small part by the availability of these implants. While individual system designs may vary, the overall concept remains fairly similar: a circular glenoid baseplate with holes for screw fixation sits atop a monoblock metallic wedge with varying degrees of inclination (Figure 1) (Endell *et al.,* 2020). The advent of wedge-backed glenoid components has arguably revolutionized RTSA techniques and made the surgery substantially more user-friendly.

Technique

Debate still lingers over the supremacy of lateralized implants versus medialized (Grammont-style) implants in RTSA, and such discussion extends beyond the scope of this article. Likewise, I will refrain from delving into a detailed comparison of biological (graft-based) lateralization versus metallic

(implant-based) lateralization, but the technique of metallic-augmented component implantation is inarguably relatively simple compared to biologic augmentation procedures (Maggini *et al.,* 2024).

Once the surgeon has made the decision to lateralize via the implant, metallic lateralization can be accomplished with either a flat-back augment or a wedge-back augment. Most companies offer multiple sizes of lateralized flat-back designs (such as 0, +3, and +6 mm options), but these models cannot correct angular deformity without differential reaming. In cases involving minimal angular bony deformity but still requiring lateralization, a flat-back augment can easily accomplish the intended biomechanical goals. Wedge-back augmented baseplates, however, have been shown to require less bone reaming and provide more lateralization than standard baseplates (Abdic *et al.,* 2020, Shah *et al.,* 2024). Because of their ease of use and effectiveness, wedge-backed glenoid components have quickly become the standard of care in cases of deformities greater than ten degrees in any plane.

With the widespread availability of computed-tomography (CT) based templating software for RTSA from most implant companies, surgeons will typically plan for implementation of a flat-backed augment or a wedge as part of their preoperative preparation. Alternatively, intra-operative findings may drive the selection of an augmented or wedged implant if the surgeon encounters unexpected levels of deformity or surprisingly poor bone quality. In a study of surgical planning, Werner and colleagues found that wedge-augmented glenoid components resulted in statistically significantly greater correction of glenoid deformity, improved total and cortical baseplate contact area, less cancellous reamed bone, and greater glenoid lateralization (Werner *et al.,* 2024). Many commercially-available systems offer varying degrees and designs of wedges – such as "half" versus "full" wedge, or wedges that are designed for superior versus posterior placement (Figure 2). Templating can help surgeons determine the appropriate wedge design option for each individual case.

Most cases requiring use of a wedge-back glenoid component involve glenoid wear in the posterosuperior quadrant of the glenoid. As such, placement of the wedge usually occurs posteriorly and cranially, roughly between the 10:00 and 12:00 o'clock positions on the native glenoid (Abdic *et al.,* 2020, Guehring *et al.,* 2023). Surgeons can choose to ream selectively to improve the fit of the wedge against the bone – combining preoperative templating with intraoperative assessment. After appropriate glenoid preparation, the surgeon then simply matches the shape of the wedge to the shape of the deformity (Figure 3). Most implants involve a central screw design for primary fixation, and the surgeon should take care to ensure that the wedge does not mal-rotate during initial screw fixation (Bobko *et al.,* 2021). The wedge-backed glenoid component can also be used for anterior-based bone loss, simply by spinning it in the other direction to match the required area for augmentation (Anastasio *et al.,* 2024).

Outcomes

Over the last few years, a growing body of literature has appeared in support of wedge-backed glenoid components. Most studies have been smaller retrospective cohorts, but journals have also recently published studies that are larger, prospective, multi-center, and even randomized. As surgeons perform further research on these implants and as they continue to grow in popularity, the availability of more compelling scientific support of their use seems highly likely.

Liuzza and colleagues reported in 2020 that a high percentage of patients achieved minimum clinically important difference (MCID) and substantial clinical benefit (SCB) thresholds with use of posterosuperior wedge augmentation for cases of superior glenoid wear (Favard E1, E2, and E3 deformities) (Liuzza *et al.,* 2020). Virk and associates published a study in 2020 of 67 RTSA patients with posteriorly augmented glenoid

components that showed excellent clinical and radiographic outcomes out to a mean follow-up of 3.5 years (Virk *et al.,* 2020).

Sandow and Tu performed a prospective review in 2020 of 75 shoulders that underwent wedge-backed glenoid component RTSA with correction of Walsh B2 or C glenoids (Sandow & Tu, 2020). They reported excellent radiographic and clinical outcomes with no major complications related to the implants. Kirsh and colleagues showed significant correction of glenoid retroversion, glenoid inclination, and multiple outcome scores with the use of augmented baseplates in a small 2021 retrospective review (Kirsch *et al.,* 2021).

In a 2022 retrospective multi-center trial, Levin, *et al.,* found that augmented baseplates offered greater postoperative improvements in multiple planes of AROM and greater improvement of multiple clinical outcome metric scores in comparison to standard baseplates (Levin *et al.,* 2022). Another multi-center study by Levin and colleagues in 2024 found improved patient-reported outcomes and shorter operative times with superior-wedge-augmented baseplates compared to standard baseplates (Levin *et al.,* 2024).

Parker, *et al.,* prospectively followed 73 wedge-baseplate patients for a minimum of two years and found increased active elevation, increased external rotation, and good clinical outcomes in their study published in 2024 (Parker *et al.,* 2024). Baumgarten and Max performed a prospective study in of 187 patients undergoing RTSA and divided them into Standard and Lateralized Baseplate groups (Baumgarten *et al.,* 2024). The Lateralized group in this 2024 report included full-wedged baseplates, and at two years, the Lateralized constructs had better patient-determined outcome scores and lower rates of scapular notching.

Complications

The most commonly reported complications of wedge-backed glenoid baseplate use are stress reactions and stress fractures, usually of the acromion or the coracoid (Parker *et al.,* 2024). Some authors have postulated that lateralization of any kind can lead to increased stress on these areas, and often these complications relate more to the patient's bone density than to the specifics of the implant design. Many other studies have shown no difference in complication risk with augmented components compared to other glenoid implant options, and some have even shown improvement in postoperative scapular notching (Baumgarten *et al.,* 2024). Because metallic-augmented glenoid components do not require the additional bone healing necessary for BIO-RSA, nonunion, malunion, and collapse are essentially not a problem with this technique.

Conclusion

Augmented glenoid components have revolutionized shoulder arthroplasty over the last several years. Metal-backed augmentation in RTSA has helped the orthopedic community conquer the challenges of lateralization and multi-planar angular deformity without the unpredictability of selective reaming or the added time, cost, risk, and complexity of graft-based biologic augmentation. Multiple commercially-available systems exist for both flat-back and wedge-back glenoid components, with several options for the size, angle, and location of the augmentation. Operative techniques for augmented glenoid implantation remain surprisingly simple, and reported outcomes show that these implants perform as well or better than standard glenoid components, especially in certain situations involving complex wear or bone loss. It seems likely that outcomes will continue to improve as we refine our understanding of this technology and it appropriate applications in the years ahead.

Appendix

Description of surgical technique by Endell, *et al.* for preparation and implantation of a wedge-backed glenoid component (Endell *et al.,* 2020).

The patient is placed in conventional beach-chair position. After marking all bony landmarks

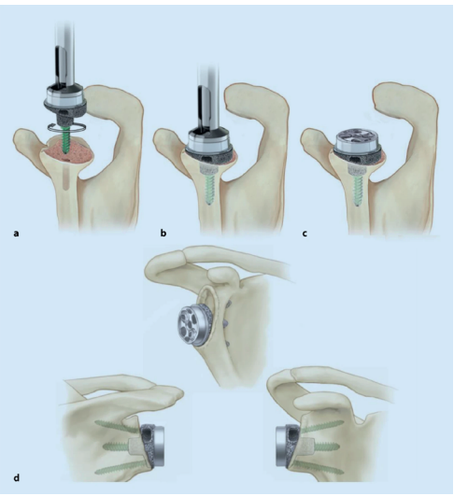

Figure 1. Concept of Implantaion of Monoblock Metallic Wedge-Backed Glenoid Component (Reprinted as Open-Source Access from Endell, *et al.*, Endell *et al.*, 2020)

Figure 2A shows 25 mm and 29 mm Flat-Backed Glenoids with + 3 mm and + 6 mm Augmentation (Stryker).

Figure 2B shows glenoid options for both superior and posterior augmentation in various combinations (Exactech).

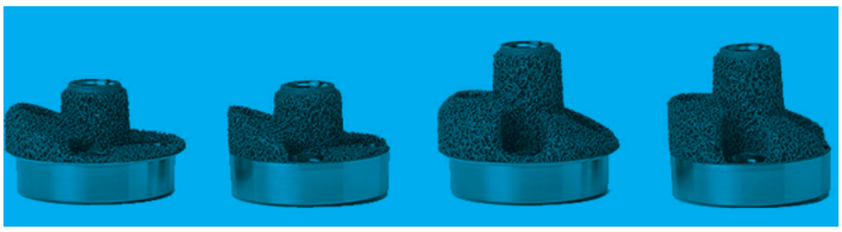

Figure 2C shows 25 mm and 29 mm Half-Wedge and Full-Wedge Options (Stryker).

Figure 2D shows Small, Medium, and Large Half-Wedge Buildup options (Zimmer-Biomet).

Figure 2. Examples of Varying Sizes of Flat-Backed Metallic Augmented Glenoid Components (A) and Varying Types of Metallic Wedge-Backed Augmented Glenoid Components (B–D)

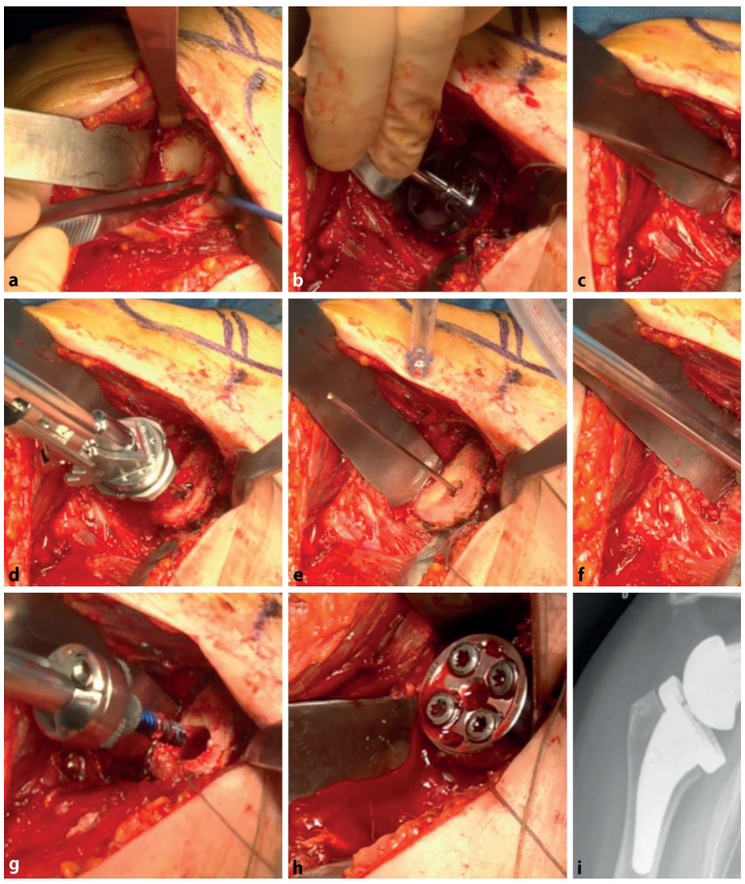

Figure 3. Glenoid Preparation and Implantation of Metallic Wedge-Backed Glenoid Component (a–h) and Post-Operative Radiograph (i). (Reprinted as Open-Source Access from Endell, *et al.*, Endell *et al.*, 2020). See Appendix for text describing the technique in detail

a standard deltopectoral approach is used, with retraction of the deltoid muscle laterally and the pectoralis major and the conjoined tendon medially. The subdeltoid mobilization and resection of its bursa follows in order to achieve sufficient lateralization of the deltoid muscle. The tendon of the subscapularis muscle is detached close to its insertion and armed using FiberWire® sutures (Arthrex, Naples, FL, USA) in an adapted Mason-Allen technique. After careful dislocation of the humerus and tenotomy of the long head of the biceps tendon, the resection of the humeral head is performed in preparation for the humeral stem component (e.g., Aequalis™ Ascend Flex™ or Aequalis™ Reversed II, Wright Medical Group, Arlington, TN, USA). After impaction of the metaphysis, a protection device is placed. Using retractors, the humerus is pushed posteriorly to allow for sufficient glenoid exposure. Under protection of the axillary nerve, residual labral tissue is excised (Fig. 2a), and the capsule is released superiorly, posteriorly, and inferiorly. Initially, the size and slope of the paleo- and neoglenoid, using full-wedge templates, have to be assessed (Fig. 2b). The template is used to estimate the size and alignment of the wedge implant. Ideally, intraoperative measures match the preoperatively planned 3D-CT simulation. After placing the central guiding pin (Fig. 2c), the asymmetric reamer is now used cautiously (Fig. 2d). Under constant supervision the reaming is completed (Fig. 3e) until full alignment of the asymmetric reamer onto the glenoid surface is achieved. Excessive reaming and glenoid fractures ought to be prevented. A drill bit is used over the central guiding pin to create the cylindrical seat for the post of the baseplate (Fig. 3f). Subsequently, the pilot hole for the central screw is over-drilled and its length measured. An optional tap may be used and is recommended for central screws with a wider diameter in order to prevent fractures around the screw. The full-wedge baseplate (Aequalis™ Perform™ Reversed, Wright Medical Group) is now assembled. Multiple 1.6-mm holes are drilled into the glenoid for better bony integration of the implant. Now the wedge baseplate is set in place (Fig. 3g). Special attention is needed when placing the central screw to prevent rotation and false alignment of the wedge onto the glenoid (Fig. 1a–c). Further stabilization is achieved by using up to four fixation screws, which can either be used as compression or locking screws (Fig. 3h). In the thick portion of the full-wedge augmentation, the choice is limited to a compression screw due to the implant design. In order to achieve optimal stabilization of the additional offset created by the wedge augmentation, the peripheral screws ideally are longer than the central one (Fig. 3i).

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