Acta Biomed 2023; Vol. 94, Supplement 2: e2023176 DOI: 10.23750/abm.v94iS2.13832

The use of computer navigation in reverse shoulder arthroplasty revision: a case report

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Abstract. Revision shoulder surgery is always a challenge, especially in the management of periprosthetic joint infection. Staged surgery with antibiotic-loaded cement spacer, seems to yield satisfactory and encouraging results. New technologies such as computer navigation are additional tools that could aid surgeons in particular conditions where the native anatomy is distorted. This study presents the unique experience of revision shoulder surgery with computer navigation assistance. Benefits related to this approach could lead to better prosthesis longevity and survivorship. (www.actabiomedica.it)

Key words: Revision shoulder surgery, GPS navigation, two-stage surgery, infection.

Introduction

Periprosthetic shoulder infections have a reported incidence of 0.4 - 2.9%, and this rate increase for each subsequent revision (1); the most common microorganisms involved are *Staphylococcus epidermidis* and *Propionibacterium acnes* (2). Strong evidences regarding the correct management of these cases are limited and controversial and often the therapeutic treatment options derive from algorithms used in the management of hips and knees' periprosthetic infections (3,4). On the basis of the timing of symptoms onset, several strategies are purposed: i) suppressive antibiotic therapy which, however, has a failure rate greater than 60%; ii) joint washing and debridement with replacement of the polyethylene liner; iii) prosthesis revision that can be carried out in one-stage or two-stage, after the placement of an antibiotic spacer (5). Despite the variety of options available, the specific indications and the expected clinical results remain debated and the revision rate after reimplantation is unfortunately nearly 30% (6,7). Common complications are joint dislocation, chronic instability, acromion fracture, lack of superficial wound healing or formation of hematomas (8). In particular, the glenoid bone-stock in revision surgery seems to be a limiting factor for conventional reverse shoulder arthroplasty (RSA) implants, leading to instability, poor positioning of the components and implant failure during revision (9). Moreover, prosthesis longevity is considered highly dependent on accurate positioning (10,11) and for all these reasons we try to take advantage of GPS navigation technology in revision shoulder surgery. Reporting this clinical case, we want to describe the history, the clinical signs and the two-stage treatment of a prosthetic septic failure and how we have managed the revision with GPS navigation assistance.

Case report

A 52-year-old patient with cuff tear arthropathy underwent reverse total shoulder arthroplasty with the aid of GPS navigation in July 2020. Preoperatively CT scans were uploaded with Orthoblue software (Exactech, Gainsville, FL, USA) for bone 3D evaluation and GPS reconstruction. In our case, the native glenoid

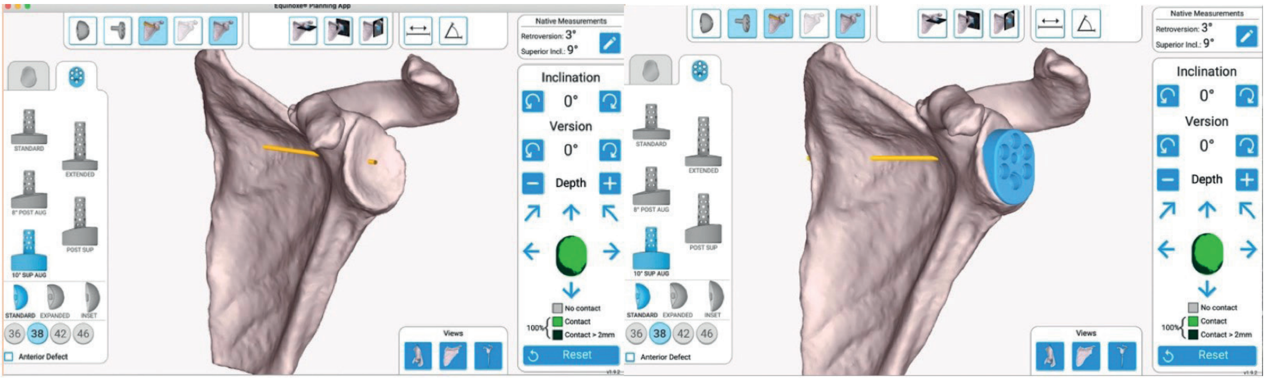

Figure 1. On the left side preoperative 3D reconstruction of the glenoid and on the right side the planned implant.

had a superior inclination of 9 degrees and a retroversion of 3 degrees

Based on the pre-operative data, we decided to implant a metaglene with 10° superior augment (after asymmetric medialization of 2 mm) with a 38mm glenosphere (Equinoxe reverse system,Exactech, Gainsville, FL, USA). Planned final version and inclination were both 0 degrees (Figure 1).

Once in the operative room, deltoid-pectoral approach was performed, widened proximally of about 1.5 cm to allow a better view of the coracoid process. Flake osteotomy of the lesser tuberosity was performed. Humeral osteotomy and broaching were performed with standard instrumentation. Before glenoid exposition, the superior face of the coracoid process was prepared to coracoid tracker positioning. After the glenoid exposition the landmarks acquisition started. Pilot hole, glenoid reaming and cage hole were subsequently performed with proper toolkit following navigation guide. Glenoid component was then implanted as planned. At last, humeral component size 9 was implanted with traditional instrumentation, as well as reduction and transosseous suture of the lesser tuberosity.

The clinical and radiological post-operative follow-up was carried out without complications (Figure 2): the patient regularly performed the rehabilitation program, and at the clinical evaluation after 3 months he was satisfied without complaining pain and discomfort.

Six months after surgery, the patient reported an ingrowth of shoulder pain symptoms and redness of the skin at the surgical scar. Elevation of serum CRP (2.3 mg / dl) was recorded. A radiographic examination

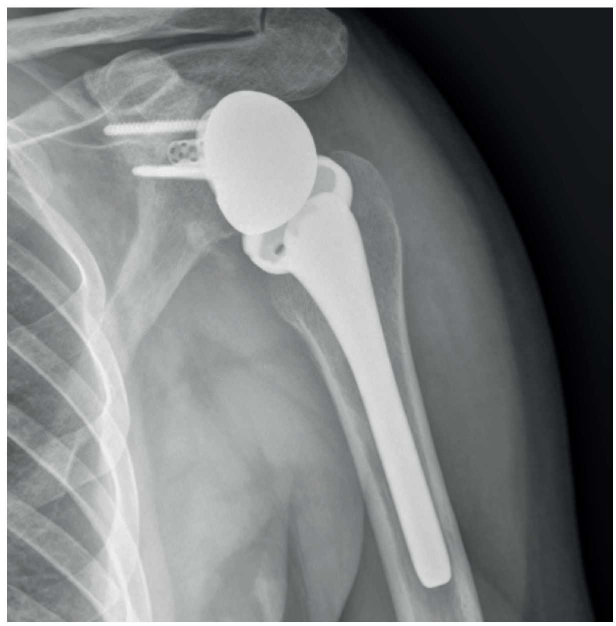

Figure 2. Post-operative x-rays examination

showed no signs of implant loosening, while the ultrasound examination showed a periprosthetic fluid area with corpuscle content.

We removed the RSA implant, replaced with modular antibiotic (Gentamycine 3gr + Tobramycine 3gr) loaded spacer (Spaceflex, G21, Italy). Intraoperatively, the stem and glenoid components showed no signs of loosening, however prosthetic components were removed gently and fortunately without significant bone loss (Figure 3A). Screw holes and cage hole were filled with morselized cancellous bone (Figure 3B,C), aiming to recover the bone stock and mimic the native glenoid. Extensive tissue debridement was

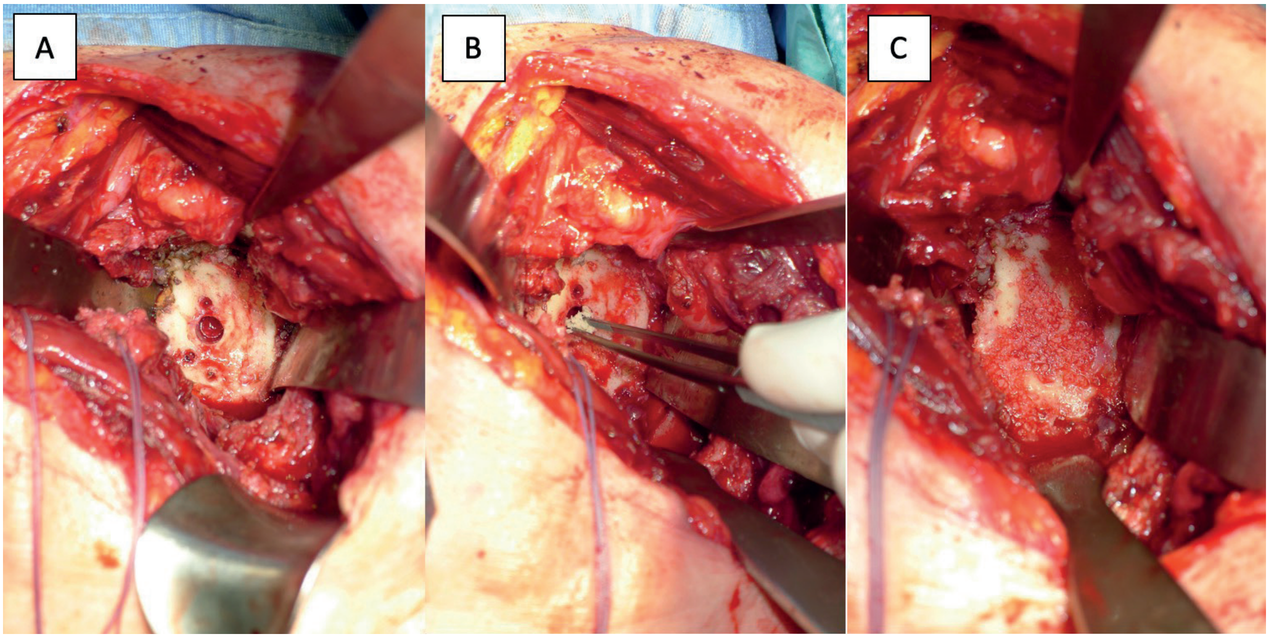

Figure 3. Central and screws hole after implant removal (A). All holes were filled with bone allograft (B) in order to restore the native bone stock (C)

performed. Multiple samples for microbiological examinations were performed.

Microbiological colture tests were positive for Propionibacterium Acnes. Antibiotic therapy (based on sensitivity) with Rifampicin 600mg was administered for 6 weeks. The patient was then evaluated monthly with radiographs exams and serum inflammatory markers (Figure 4).

At the normalization of CRP values, as well as signs of clinical infection, obtained after 3 months from the first stage surgery, surgical revision was performed. The patient underwent a new CT scan examination, that was uploaded with Orthoblue software (Exactech, Gainsville, FL, USA) for GPS reconstruction. Preoperative data showed a superior inclination of 6 degrees and an anteversion of 12 degrees.

Based on the pre-operative data, the surgeon decides to perform a 10° superior augment metaglene (medialization of 3mm) with a 38mm glenosphere (Equinoxe reverse system,Exactech, Gainsville, FL, USA). Planned version and inclination were respectively 0° e -3° (inferior inclination) (Figure 5).

The same surgical approach was then performed. The antibiotic spacer was removed. Real time histological limphocyte count was performed intraoperatively (2 neutrophils per high-powered field).

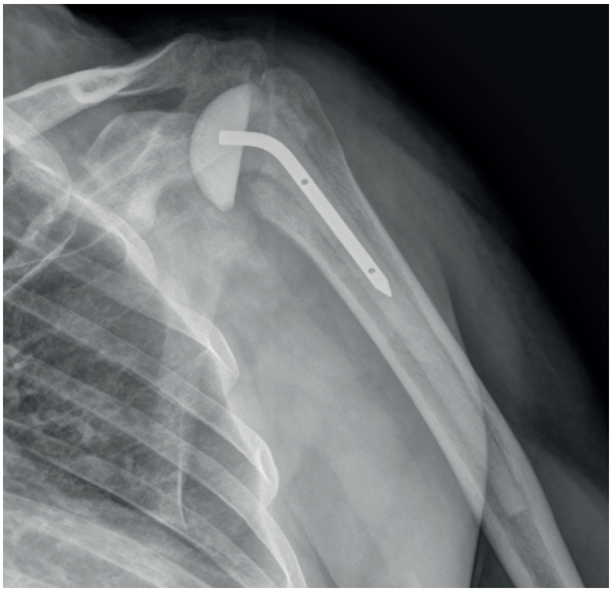

Figure 4. Post-operative x-rays examination after spacer positioning

The superior face of the coracoid process was prepared again to coracoid tracker positioning. At the level

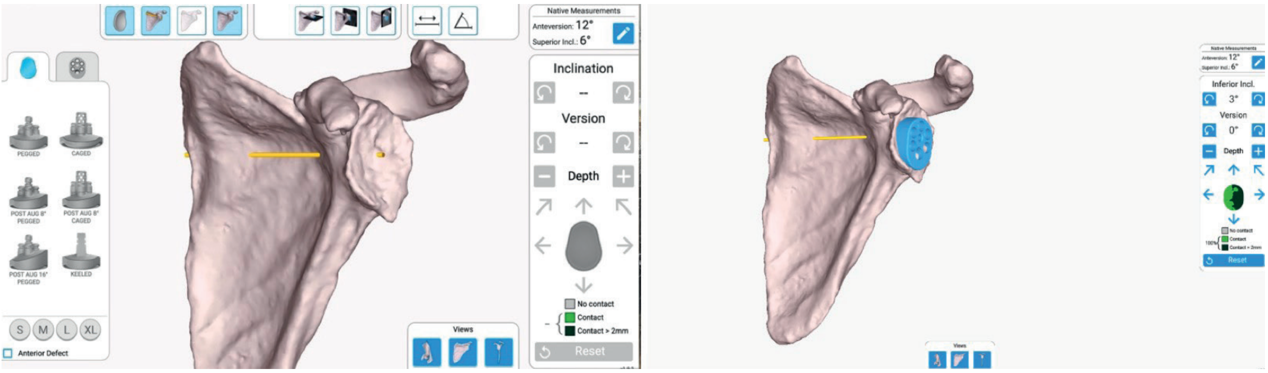

Figure 5. On the left side preoperative (second-stage surgery) 3D reconstruction of the glenoid and on the right side the planned implant.

of the glenoid surface we observed the complete integration of the cancellous bone previously placed with a satisfying bone stock (Figure 6). Glenoid reaming and cage hole were subsequently performed with proper toolkit following navigation guide. Glenoid component was then implanted as planned. At last, humeral component size 11 was implanted. Post-operative radiographs showed a prosthetic implant well positioned according to the preoperative planning (Figure 7).

The postoperative follow-up was conducted without complications, no clinical or radiological signs of infection was reported at 3 months evaluation.

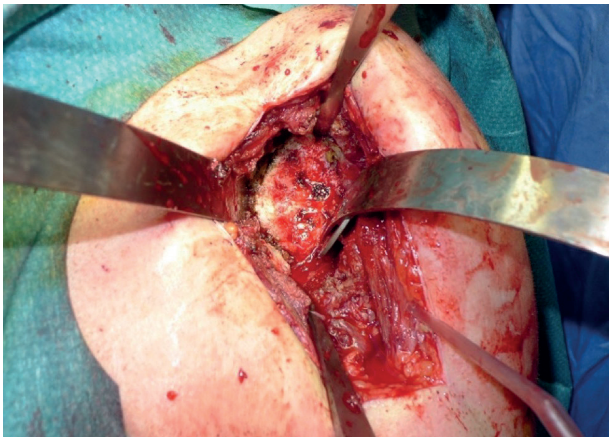

Figure 6. Intraoperative glenoid bone stock in second-stage surgery.

Discussion

The established effectiveness of RSA in the treatment of glenohumeral arthritis has led to an increase of worldwide implants performed and these numbers are estimated to grow up in the next years. Infection after RSA accounts for 13.8% of all complications and this condition is related to high social and health care costs (12).

Glenoid bone loss is one of the greatest issues in reverse shoulder revision surgery, that lead to relatively high rates of loosening and reoperation (13). Usually, a revision implant is used to obtain better stability of metaglene, by using a deeper central hole or tailored implants.

The literature reported cases of two-stage shoulder revision where the first purpose was to restore the glenoid bone stock with bone graft (14).

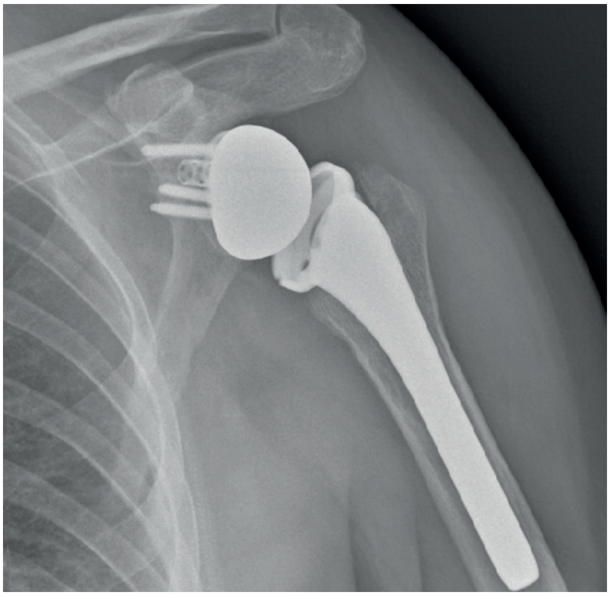

Figure 7. Post-operative x-rays examination after revision surgery

Filling the glenoid surface with bone graft could augment the revision implant-bone contact, potentially increasing component stability after graft incorporation.

Risks of bone allograft application in septic revision could be overcome by advantages related to avoiding long pegged or custom-made implants.

In our case, in second-stage surgery, we performed a standard pegged metaglene and standard stem avoiding the use of revision implants. This should allow to save bone stock for future surgical procedures.

The changes in glenoid morphology, in particular the anteversion (from 0° obtained after the first surgery to 12°, before the second stage), observed in TC examination could be due to an anterior erosion caused by the spacer. This is only our hypothesis and the cinematic of the spacer movement is far from our understanding, however future studies should clarify this relevant issue.

The literature does not report cases of two-stage procedures with GPS navigation assistance. In our case, we considered computer-assisted reimplantation as a valid technique in order to improve the accuracy of the glenoid implant positioning and potentially reduce the risk of reoperation due to this cause.

The goal of navigation is to increase surgical accuracy and reduce the change of malposition, and allows surgeons to obtain real-time feedback, while decreasing the potential intraoperative errors, in order to make the adequate prosthesis placement (15-17). This case demonstrate that GPS navigation technology and its potential benefit could be applied also in revision surgery; further clinical large-scale studies are necessary to confirm our experience.

Conflicts of interest: Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Authors Contributions: All authors contributed to the study conception, design and manuscript. All authors wrote, read and approved the final manuscript.

Funding: No funding was received for conducting this study.

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Received: 18 October 2022
Accepted: 18 May 2023
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