Reverse Total Shoulder Arthroplasty in Patients >60 Years of Age With Rotator Cuff Tear Arthropathy. Short-Term Outcomes and Complications

Diego Gómez, Tamara Dainotto, Gonzalo Viollaz, Gustavo Teruya, Alejandro Tedeschi, Rafael Durán, Álvaro Muratore
Upper Limb Team, Orthopedics and Traumatology Service, Hospital Británico de Buenos Aires, Autonomous City of Buenos Aires, Argentina

ABSTRACT

Background: The purpose of this study is to show the short-term results and complications in a series of patients >60 who underwent a reverse arthroplasty for the treatment of rotator cuff arthropathy in a high complexity hospital. **Materials and Methods**: We retrospectively analyzed our Service's database to identify patients with rotator cuff arthropathy who had undergone a reverse shoulder arthroplasty between 2015 and 2019. Inclusion criteria: 60 years of age or older, functional deltoid, at least one year of follow-up. The range of motion was measured pre and postoperatively in flexion, external rotation, and internal rotation, as well as Constant score and visual analog scale for pain. The grade of arthritis, scapular notching, and prosthetic loosening was radiographically assessed. We identified complications, satisfaction, and prosthesis survivorship. **Results**: Forty shoulders in 38 patients of 72 years of age on average (61-91) underwent reverse shoulder arthroplasty, with 25 months of follow-up. Flexion increased from 82.86° to 136.71° (p<0,001), external rotation went from 16.59° to 32.11° (p<0,001), and internal rotation from L5 to L3 (p<0,001). Constant score rose from 28.25 to 69.97 (p<0,001) and visual analog scale for pain decreased from 8.34 to 1.26 (p<0,001). The complication rate was 12.5% and a 97.4% prosthesis survivorship was registered. **Conclusions**: We believe that reverse shoulder arthroplasty represents an excellent option in the treatment of rotator cuff arthropathy in patients older than 60 in view of the satisfactory functional outcomes with an acceptable complication rate.

Key words: Lateralized reverse arthroplasty; rotator cuff arthropathy; shoulder arthroplasty.
Level of Evidence: IV

Artroplastia invertida lateralizada para artropatía del manguito rotador en pacientes >60 años. Resultados y complicaciones a corto plazo

RESUMEN

Objetivo: Comunicar los resultados y las complicaciones a corto plazo de la artropatía del manguito rotador tratada con artroplastia invertida lateralizada en pacientes >60 años. **Materiales y Métodos**: Se identificaron retrospectivamente las artropatías del manguito rotador tratadas con prótesis invertida lateralizada entre 2015 y 2019. Criterios de inclusión: edad >60 años, adecuada función deltoidea y seguimiento mínimo de 24 meses. Antes de la cirugía y después, se registraron el rango de movilidad activa, y los puntajes de Constant-Murley y de la escala analógica visual para dolor. En las radiografías, se determinaron los grados de artrosis glenohumeral, de muescas escapulares y de aflojamiento de la prótesis. Se documentaron las complicaciones, la satisfacción con el procedimiento y la supervivencia del implante. **Resultados**: La serie incluyó 40 hombros operados en 38 pacientes (edad promedio 72 años, rango 61-91), con un seguimiento promedio de 25 meses. La elevación anterior aumentó de 82,63° a 136,71° (p <0,001); la rotación externa, de 16,59° a 32,11° (p <0,001) y la rotación interna, de L5 a L3 (p <0,001). El puntaje de Constant-Murley ascendió de 28,25 a 69,97 (p <0,001) y el de dolor disminuyó de 8,34 precirugía a 1,26 en el poscirugía (p <0,001). La tasa de complicaciones fue del 12,5% y la supervivencia del implante, del 97,4%. **Conclusiones**: La artroplastia invertida lateralizada es una excelente alternativa quirúrgica para la artropatía del manguito rotador en pacientes >60 años, los resultados son satisfactorios, la tasa de complicaciones es aceptable y la supervivencia del implante es del 97,4%.

Palabras clave: Artroplastia invertida lateralizada; artropatía; manguito rotador; prótesis invertida.
Nivel de Evidencia: IV

Received on September 25th, 2020. Accepted after evaluation on April 1st, 2021 • Dr. DIEGO GÓMEZ • drdjg@hotmail.com https://orcid.org/0000-0003-0258-6802

How to cite this article: Gómez D, Dainotto T, Viollaz G, Teruya GJ, Tedeschi A, Durán R, Muratore Á, et al. Reverse Total Shoulder Arthroplasty in Patients >60 Years of Age With Rotator Cuff Tear Arthropathy. Short-Term Outcomes and Complications. *Rev Asoc Argent Ortop Traumatol* 2021;86(6):780-789. https://doi.org/10.15417/issn.1852-7434.2021.86.6.1209

INTRODUCTION

Rotator cuff arthropathy (RCA), initially described by Charles Neer,[1] is a challenging condition faced by shoulder surgeons. It is estimated that 4% of rotator cuff injuries are massive and evolve with atrophy and fatty infiltration, glenohumeral osteoarthritis, pain, and limitations in range of motion.[2,3] RCA represents the final stage of this condition, in which the symptoms are intensified and activities of daily living are severely compromised.[4]

Among the surgical alternatives to treat RCA, reverse arthroplasty (RA) has become the gold standard,[5] as it achieves an average improvement on the Constant-Murley scale[6] of 45-55 points[7] and postoperative active elevation values of 138°.[7-12] However, although it is a procedure with predictable outcomes, the complication rate varies between 17% and 20% and the reoperation rate ranges between 3.5% and 11.9%.[7,8,13] The main causes are dislocation of the prosthesis (1.2-4.7%), infection (3-3.8%), loosening of the glenoid component (1.8-8.8%),[14] periprosthetic fracture (1.1-1.5%), and neurological lesions (0.4-1.2%).[8,13]

The original design of the reverse prosthesis, devised by Grammont, consisted of medializing and distalizing the center of rotation of the glenohumeral joint to enhance the deltoid lever arm.[15] These implants caused some specific complications, such as the generation of scapular notches,[15] which decreased thanks to lateralized RAs, contributing, in turn, to a lower incidence of prosthesis dislocation and a greater range of motion in rotations.[11]

At present, the national literature on the treatment of RCA with RA is scarce.[7] For this reason, a clinical study on the outcomes and complications in the local environment can provide the necessary information for planning and decision-making, in order to improve the quality of care for this specific group of patients.

The objective of the study was to evaluate the outcomes and short-term complications derived from lateralized RA in patients >60 years of age with RCA in a highly complex center of the Autonomous City of Buenos Aires.

MATERIALS AND METHODS

The database of our Service was retrospectively analyzed in order to identify cases of RCA treated with a lateralized RA by the same surgical team between January 2015 and January 2019.

The following inclusion criteria were applied: 1) arthropathy due to rotator cuff syndrome (Hamada ≥3), 2) age >60 years, 3) functioning deltoids, 4) minimum follow-up of 24 months, and 5) use of lateralized prostheses.

Patients with post-traumatic sequelae, rheumatoid arthritis, and neurological conditions (Parkinson's disease, multiple sclerosis) were excluded.

Surgical technique

With the patient in a beach chair position, under plexual anesthesia, a deltopectoral approach is performed, with complete insertional tenotomy of the subscapularis and resection of the joint capsule. The humeral head is dislocated in a position of maximum external rotation and the humeral osteotomy is carried out with 20° of retroversion and 135° of inclination. Subsequently, the humeral canal is enlarged with rasps of increasing sizes until a sensation of cortical friction is obtained. The largest gauge rasp used is left in place to protect the proximal humerus during the glenoid stage.

When the glenoid is exposed, the osteophytes and the degenerative labrum are resected, optimizing the vision of the joint surface. Then, the joint cartilage is reamed, preserving as much bone stock as possible. The metaglene is implanted, projecting an inclination <10º with a neutral version. Final fixation is made with two 5.5 mm compression screws. We used 36mm glenospheres for women and small men and reserved the 39mm glenosphere for large men.

The final humeral component is placed uncemented, provided that the metaphyseal bone quality allows it. The final polyethylene liner size is then selected to obtain a balanced and stable prosthetic construction. The subscapularis is reattached with transosseous sutures.

All patients are immobilized for 30 days with a Velpeau sling; passive range of motion exercises begin a week after surgery and physical rehabilitation starts at the fourth week.

Clinical evaluation

Data evaluation and recording were performed by an orthopedic and trauma resident who was not part of the surgical procedures (TD). Preoperative data were obtained, retrospectively, by reviewing the medical records of outpatient clinics. The preoperative and postoperative ranges of motion were recorded at the last control. Active range of motion was evaluated with a goniometer in anterior elevation, external rotation with the limb in adduction, and internal rotation with the hand on the back, the segment reached by the thumb was recorded as the maximum level according to the description by Greene and Heckman.[16] The deltoid muscle function was defined by the treating surgeon, according to the Daniels motor scale, considering a functioning deltoid when equating with a value of M5.[17]

The function was assessed with the Constant-Murley scale[6] and pain was measured with the visual analog scale[18] before and after the procedure.

In addition, the degree of postoperative satisfaction was evaluated by means of two questions: 1. How satisfied are you with the procedure performed? The possible answers were three: dissatisfied, satisfied, very satisfied. 2. Would you recommend this intervention as a treatment to a known person with the same pathology as you? In this case, the options were yes or no.

Intraoperative and postoperative complications were identified in the records of inpatient medical records, surgical protocols, and outpatient clinics. A complication was considered to be minor when it did not alter the final outcome or require a reoperation; otherwise, it was considered a major complication.

A revision was defined as any surgical procedure, closed or open, related to the arthroplasty.

Radiographic evaluation

The Hamada[19] classification was used to determine the degree of glenohumeral osteoarthritis in the preoperative anteroposterior shoulder and axial scapula radiographs. In all cases, the study was completed with a computed tomography to carry out pre-surgical planning, ranking the presence of bone defects, and variations in glenoid inclination and retroversion.

The postoperative radiographic evaluation was carried out at 10 days, 6 weeks, 12 weeks, and 24 weeks after surgery, and then annually. In the last radiographs taken, the presence of scapular notches was evaluated according to the Sirveaux classification,[11] signs of glenoid loosening were assessed according to Cuff et al.,[3] and changes in the positioning of the component with respect to the previous radiographs and radiolucency lines around the stem were evaluated according to Sperling.[20]

Statistical analysis

Continuous variables were expressed in percentages as absolute and relative frequencies. Student's t-test was applied for paired preoperative and postoperative data with normal distribution, focusing on the magnitude of the average differences. The Wilcoxon signed-rank test was used to compare medians with non-normal distribution. A p-value <0.05 was considered statistically significant. The IBM® SPSS® Statistics version 25 program was used.

RESULTS

44 lateralized RAs were analyzed, and the series was made up of 40 RAs performed in 38 patients who had an average age of 72 years (range 61-91) and met the inclusion criteria. The average follow-up was 25 months (range 2–4). Four RAs were excluded because the follow-up was <2 years. The ARROW® prosthesis (FH Orthopedics, Mulhouse, France) was used in all cases. The glenosphere was 36 mm in 37 shoulders and 39 mm in the remaining three. The dimension was defined by the surgeon in charge according to the size of the patient. The demographic characteristics of the sample are detailed in Table 1.

We recorded a postoperative anterior elevation of 136.7° (range 30-160°), with an increase of 54.08° (range 80-170°) compared to the initial value (p <0.001), as well as a preoperative external rotation that increased from 16.59° (range 0-60°) to 32.11° (range 5-70 °) (p <0.001), and a postoperative internal rotation to L3 on average, which represented an improvement of two body segments (p <0.001) (Figure 1).

Table 1. Demographic characteristics

Total	40 shoulders
Age	72 years (range 61-91)
Follow-up	25 months [range 2-4 years)
Sex	
Male	11 (29%)
Female	27 (71%)
Side	
Right	25
Left	13

Figure 1. Left shoulder lateralized reverse arthroplasty, follow-up at a year and a half. Range of motion of anterior elevation: 170°; external rotation: 45°; and internal rotation: up to T10.

The average score of the Constant-Murley scale improved from 28.25 (range 12-40) to 69.97 (range 44-83) in the last follow-up (p <0.001) and that of the visual analog scale, from 8.34 (range 7-10) before surgery to 1.26 (range 0-6) postoperatively (p <0.001) (Table 2).

Table 2. Functional outcomes

	Preoperative	Postoperative
Constant scale	28.2	70 (p <0.001)
Visual analog scale	8.4	1.2 (p <0.001)
Anterior elevation	82.6º	136.7º (p <0.001)
External rotation	16.6º	32.1º (p <0.001)
Internal rotation	L5	L3

The complication rate was 12.5% (5 cases). Four were intraoperative (2 minor and 2 major complications). Two minor complications (5%) were a glenoid fracture that required the placement of a revision glenoid in the same surgical stage, without affecting the obtained outcome. One patient suffered two major complications. It was one of the first cases in our center, at the beginning of the learning curve. The patient suffered an intraoperative periprosthetic fracture of the humeral shaft, synthesized with cerclages and treated with a brace, which evolved with radial nerve neuropraxia and partial resolution. Another patient evolved with a picture of acromial insufficiency, due to a preoperative acromial fragility that affected the range of mobility (Figure 2).

Figure 2. Anteroposterior right shoulder radiograph. Acromial embrittlement is observed.

On radiographs, two patients were found to have grade I glenoid notches (Figure 3). There were no cases of humeral component loosening. The only major postoperative complication was a mechanical loosening of the glenoid component in a patient 14 months after the initial surgery; in this case, the revision was carried out with the placement of a revision glenoid (Figure 4). The implant survival rate was 97.5%.

Regarding satisfaction with surgery, 28 patients (74%) reported being very satisfied; eight, satisfied (21%). Only two (5%) were dissatisfied with the outcome: the patient who suffered the two major complications and the patient with preoperative acromial embrittlement. Furthermore, 95% said they would recommend RA to a known person with RCA.

Figure 3. Anteroposterior left shoulder radiograph. A grade 1 scapular notch is observed.

Figure 4. Anteroposterior and lateral left shoulder radiograph, six months after the revision of the glenoid component.

DISCUSSION

The most important finding of the study is the 95% satisfaction rate, with an implant survival of 97.5% and an overall complication rate of 12.5%.

The high survival rate is consistent with the results found in the literature. With the review as the cut-off point, the studies report survival rates of approximately 95% at 5 years[21] and 91% at 10 years[22]. As the published series show their records after five years of follow-up, as opposed to the minimum two years in our series, our results may be affected when compared with the literature. This study, with a minimum follow-up of two years, may underestimate the rate of future complications observed in studies with a longer follow-up.

The average values obtained were 136.71° for anterior elevation and 32.11° for external rotation, which are in agreement with those of other authors, such as Nolan et al. and Boileau et al. in 71 and 21 cases, respectively (in both, the anterior elevation obtained was 121° and the external rotation, 15° and 11°, respectively), with medialized prostheses, and even reaching higher values of external rotation in comparison.[12,23] Likewise, in a series of 34 patients, Wiater et al. reported an anterior elevation of 131° and an external rotation of 26.6° on average, using lateralized prostheses.[9]

The resulting Constant-Murley scale score was 69.97, in agreement with that indicated by other authors. According to Boileau et al., it ranged around 59 points in 45 patients controlled for 40 months, and according to Bacle et al., it was 86 points, with a lateralized implant at 10 years of follow-up.[10,12] Likewise, the postoperative score of the visual analog scale was 1.26, similar to those published.[9,12,23]

The complication rate (12.5%) was lower than in other publications, varying between 15% and 22%.[8,11,12,23] Only two grade I glenoid notches were observed, and there were no episodes of dislocation of the prosthesis. We attribute the low rate of notches and instability to the use of lateralized implants, which, unlike the medialized Grammont-type implants, allow a greater range of motion free of bony end feel.[24] Using the same implant, Valenti et al. reported no episodes of dislocation of the prosthesis in 76 shoulders.[24] This is justified both by the magnified tension of the remaining soft tissues and by the pronounced concavity of the polyethylene insert.[24] In addition, the repair of the subscapularis could represent a factor of protection with respect to the prosthesis dislocations. However, this remains a controversial topic.[25]

A humeral shaft fracture occurred when performing the definitive reduction in one of our first patients, who also evolved with radial nerve palsy. In a series of 203 RAs, García-Fernández et al. described three cases of humeral fractures, of which only one was diaphyseal and occurred during medullary reaming in the revision of a hemiarthroplasty.[26] For their part, Chuinard et al. reported 26 intraoperative humeral fractures in 457 RAs. In this series, 25 occurred in revisions and one occurred in a primary arthroplasty, during the reaming of the medullary canal.[27] On the other hand, direct injury to the radial nerve during the RA surgical procedure is infrequent according to the literature. We consider that these infrequent neurological complications, as postulated by Boileau et al., are due to the elongation suffered by the terminal branches of the brachial plexus during surgery due to the lengthening of the humerus.[12]

Among intraoperative glenoid fractures, in a systematic review, Zumstein et al. reported a prevalence of 0.9% in 782 shoulders, which were mainly related to joint reaming.[13] Sirveaux et al. had a prevalence of 1.5% in 1953 RAs, the risk was higher in severe ascents of the humeral head.[11] The 5% of glenoid fractures in our series is slightly higher than that reported by Sirveaux et al.[11] This is justified partly due to the learning curve with this implant, which is also characterized by a more aggressive glenoid bone resection.

One patient had a mechanical loosening of the glenoid component 14 months after surgery. This complication occurs in 1.8-8.8% of cases.[14,28] Although associated risk factors have not yet been identified, in a series of 202 shoulders treated with lateralized prosthesis and an incidence of 1.2 % of this complication in primary surgeries, Bitzer et al. identified as risk factors the use of bone graft to replace glenoid defects and fixation of the baseplate with non-locking screws.[14] In our patient, the loosening was due to insufficient glenoid screw engagement, which was then treated with a revision metaglene. The patient is currently in the sixth postoperative month without added complications. In this series, one patient presented preoperative acromial embrittlement, which had an unfavorable impact on the maximum range of motion at the anterior elevation, it was only 90° in the last postoperative control. This outcome can be explained taking into account that the acromial insertion of the deltoid is a key element in the function of the RA.[15] The descent and the medialization of the glenohumeral center of rotation to restore deltoid tension are essential to improve active anterior elevation. It has been proposed that preoperative acromial pathology can compromise deltoid function and affect the correct functioning of the prosthesis. Conversely, Walch et al. evaluated 28 patients with RCA treated by RA and with acromial pathology, and compared the functional outcomes with those obtained in patients without acromial lesions. These authors found no differences in the postoperative range of motion and Constant-Murley scale score.[28]

Some limitations must be considered before analyzing these data, taking into account the limitations inherent to the retrospective descriptive methodology. Likewise, the fact of not having a control group made it impossible to compare the outcomes of lateralized prostheses with those obtained with medialized implants. The minimum follow-up time of two years does not allow the long-term complication rate to be reliably identified, this justifies the low frequency of complications recorded in this series. Among the strengths of our study, we highlight that it is the first national report on this type of implants which includes a considerable number of patients who have an accurate record of functional outcomes and immediate postoperative complications, as well as the evaluation of patient satisfaction.

A comparative series with medialized prostheses and a longer follow-up is pending for a future line of research.

CONCLUSIONS

We consider lateralized RA as an excellent surgical alternative for RCA in patients >60 years of age, as it provides satisfactory clinical and radiographic outcomes, with an acceptable complication rate and an implant survival of 97.4% at an average 25-month follow-up. We believe that our study represents a contribution to the national literature, as it provides a better foundation for surgical planning and decision-making in order to improve the quality of life of patients suffering from this condition.

Conflict of interest: The authors have no conflicts of interest to declare.

T. Dainotto ORCID ID: https://orcid.org/0000-0002-6645-9928
G. Viollaz ORCID ID: https://orcid.org/0000-0002-4573-883X
G. J. Teruya ORCID ID: https://orcid.org/0000-0001-7342-1859
A. Tedeschi ORCID ID: https://orcid.org/0000-0001-5704-3122
R. Durán ORCID ID: https://orcid.org/0000-0002-8789-3221
Á. Muratore ORCID ID: https://orcid.org/0000-0001-7540-7137

REFERENCES

1. Neer CS, Craig E V, Fukuda H. Cuff-tear arthropathy. *J Bone Joint Surg* 1983;65(9):1232-44. PMID: 6654936
2. Boileau P, Watkinson DJ, Hatzidakis AM, Balg F. Grammont reverse prosthesis: design, rationale, and biomechanics. *J Shoulder Elbow Surg* 2005;14(1 Suppl.):S147-S61. https://doi.org/10.1016/j.jse.2009.03.011
3. Cuff D, Pupello D, Virani N, Levy J, Frankle M. Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency. *J Bone Joint Surg Am* 2008;90(6):1244-51. https://doi.org/10.2106/JBJS.G.00775
4. Giráldez EÁ, Gavilán F. Efectividad y seguridad de las prótesis invertidas de hombro en artropatía del manguito rotador. Revisión sistemática de la literatura y criterios de uso adecuado. In: *Informes, estudios e investigación*. Ministerio de Sanidad, Servicios Sociales e Igualdad. Serie: Informes de Evaluación de Tecnologías Sanitarias. Agencia de Evaluación de Tecnologías Sanitarias de Andalucía. Available at: https://www.aetsa.org/download/publicaciones/antiguas/AETSA_2011_12_ProtesisInvertida.pdf
5. Chawla H, Gamradt S. Reverse total shoulder arthroplasty: technique, decision-making and exposure tips. *Curr Rev Musculoskelet Med* 2020;13(2):180-5. https://doi.org/10.1007/s12178-020-09613-3
6. Constant CR, Murley AHG. A clinical method of functional assessment of the shoulder. C*lin Orthop Relat Res* 1987(214):160-4. PMID: 3791738
7. Bertona Altieri BA, Rossi L, Oñativia JI, Tanoira I, Bongiovanni SL, Maignon G, et al. Resultados a corto plazo de la prótesis inversa de hombro según la patología. *Rev Asoc Argentina Ortop Traumatol* 2017;82(4):278-86. https://doi.org/10.15417/683
8. Petrillo S, Longo UG, Papalia R, Denaro V. Reverse shoulder arthroplasty for massive irreparable rotator cuff tears and cuff tear arthropathy: a systematic review. *Musculoskelet Surg* 2017;101(2):105-12. https://doi.org/10.1007/s12306-017-0474-z
9. Wiater JM, Moravek JE, Budge MD, Koueiter DM, Marcantonio D, Wiater BP. Clinical and radiographic results of cementless reverse total shoulder arthroplasty: A comparative study with 2 to 5years of follow-up. *J Shoulder Elbow Surg* 2014;23(8):1208-14. http://doi.org/10.1016/j.jse.2013.11.032
10. Bacle G, Nové-Josserand L, Garaud P, Walch G. Long-term outcomes of reverse total shoulder arthroplasty. *J Bone Joint Surg Am* 2017;99(6):454-61. http://doi.org/10.2106/JBJS.16.00223
11. Sirveaux F, Favard L, Oudet D, Huquet D, Walch G, Molé D. Grammont inverted total shoulder arthroplasty in the treatment of glenohumeral osteoarthritis with massive rupture of the cuff. Results of a multicentre study of 80 shoulders. *J Bone Joint Surg Br* 2004;86(3):388-95. https://doi.org/10.1302/0301-620x.86b3.14024
12. Boileau P, Watkinson D, Hatzidakis AM, Hovorka I. Neer Award 2005: The Grammont reverse shoulder prosthesis: Results in cuff tear arthritis, fracture sequelae, and revision arthroplasty. *J Shoulder Elbow Surg* 2006;15:527-40. https://doi.org/10.1016/j.jse.2006.01.003
13. Zumstein M, Pinedo M, Old J, Boileau P. Problems, complications, reoperations, and revisions in reverse total shoulder arthroplasty: A systematic review. *J Shoulder Elbow Surg* 2011;20(1):146-57. https://doi.org/10.1016/j.jse.2010.08.001
14. Bitzer A, Rojas J, Patten I, Joseph J, McFarland E. Incidence and risk factors for aseptic baseplate loosening of reverse total shoulder arthroplasty. *J Shoulder Elbow Surg* 2018;(12):2145-52. https://doi.org/10.1016/j.jse.2018.05.034
15. Grammont PM, Baulot E. Delta shoulder prosthesis for rotator cuff rupture. *Orthopedics*1992;16(1):65-8. PMID: 8421661
16. Greene WB, Heckman JD. The shoulder. En: *The clinical measurement of joint motion.* Rosemont: American Academy Orthopaedic Surgeons; 1994:15-26.
17. Hislop HJ, Avers D, Brown M. *Daniels y Worthingham. Técnicas de balance muscular*, 9th ed. Philadelphia: Elsevier; 2014.
18. Huskisson EC. Measurement for pain. *Lancet* 1974;2(7889):1127-31. https://doi.org/10.1016/s0140-6736(74)90884-8
19. Hamada K, Fukuda H, Mikasa M, Kobayashi Y. Roentgenographic findings in massive rotator cuff tears. A long-term observation. *Clin Orthop Relat Res* 1990;(254):92-6. https://doi.org/10.1097/00003086-199005000-00014

20. Sperling JW, Cofield RH, O'Driscoll SW, Torchia ME, Rowland CM. Radiographic assessment of ingrowth total shoulder arthroplasty. *J Shoulder Elbow Surg* 2000;9(6):507-13. https://doi.org/10.1067/mse.2000.109384
21. Cuff D, Clark R, Pupello D, Frankle M. Reverse shoulder arthroplasty for the treatment of rotator cuff deficiency: a concise follow-up, at a minimum of five years, of a previous report. *J Bone Joint Surg Am* 2012;94(21):1996-2000. https://doi.org/10.2106/JBJS.K.01206
22. Guery J, Favard L, Sirveaux F, Oudet D, Mole D, Walch G. Reverse total shoulder arthroplasty. Survivorship analysis of eighty replacements followed for five to ten years. *J Bone Joint Surg Am* 2006;(8):1742-7. https://doi.org/10.2106/JBJS.E.00851
23. Nolan BM, Ankerson E, Wiater MJ. Reverse total shoulder arthroplasty improves function in cuff tear arthropathy. *Clin Orthop Relat Res* 2011;469(9):2476-82. https://doi.org/10.1007/s11999-010-1683-z
24. Valenti P, Sauzières P, Katz D, Kalouche I, Kilinc AS. Do less medialized reverse shoulder prostheses increase motion and reduce notching? *Clin Orthop Relat Res* 2011;469(9):2550-7. https://doi.org/10.1007/s11999-011-1844-8
25. Cheung E, Sarkissian E, Sox-Harris A, Comer G, Saleh J, Diaz R, Costouros J. Instability after reverse total shoulder Arthroplasty. *J Shoulder Elbow Surg* 2018,(11):1946-52. https://doi.org/10.1016/j.jse.2018.04.015
26. García-Fernández C, Lópiz-Morales Y, Rodríguez A, López-Durán L, Martínez FM. Periprosthetic humeral fractures associated with reverse total shoulder arthroplasty: incidence and management. *Int Orthop* 2015;(10):1965-9. https://doi.org/10.1007/s00264-015-2972-7
27. Chuinard C, Trojani C, Brassart N BP. Humeral problems in reverse shoulder arthroplasty. En: Walch G, Boileau P, Molé D, et al (eds.) *Reverse shoulder arthroplasty. Clinical results, complications, revisions*. Montpellier, France: Sauramps Medical; 2006:275-88. https://doi.org/10.1007/978-3-030-19285-3
28. Walch G, Mottier F, Wall B, Boileau P, Molé D, Favard L. Acromial insufficiency in reverse shoulder arthroplasties. *J Shoulder Elbow Surg* 2009;18(3):495-50. https://doi.org/10.1016/j.jse.2008.12.002