Early results with the Delta Xtend shoulder arthroplasty as primary treatment or proximal humerus reoperation

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Abstract— Summary: Reverse total shoulder arthroplasty (RTSA) has established itself as the standard of care for the treatment of rotator cuff arthropathy (RCA). Gradually, its share increased in relation to all used shoulder arthroplasties mainly in cases of complex proximal humeral fractures (PHFx).

Method: From November 2019 to December 2021, 39 patients at mean age of 72.8 years were operated via RTSA Delta Xtend by one surgeon in our clinic. 32 of them were followed for a period between 12 ÷ 30 months. At postoperative visits, function and pain were assessed using the Constant-Murley score (CMS), DASH score and recorded range of motion (ROM). Level of satisfaction was assessed using the visual analogue scale (VAS).

Results: The mean CMS recorded at the last visit was 82.6, and the relative one 90.8%. The achieved anterior elevation 145.9° and lateral elevation 136.6°. A significantly lower mean value of external rotation (39.8°) was found compared to the inner one (50.6°).

Conclusion: This study confirms those described by other authors promising early results with Delta Xtend RTSA. Longer follow-up is needed with a view to assessment of the dynamics of registered results, possible late complications and revision interventions.

Keywords— shoulder arthroplasty, reversed total shoulder arthroplasty, Delta Xtend

1. Introduction

Introduced in 1987 by Grammont, RTSA is a reliable method of treating RCA. Allows optimal restoration of function and quality of life in adult patients with this medical condition. In the last two decades, indications for the application of this type endoprosthesis have greatly expanded to include conditions that are difficult to treat with the anatomical total endoprosthesis as chronic pseudoparalysis caused by irreversible damage to rotator cuff (RC) without arthrosis, gleno-humeral arthritis with bone loss, complex PHFx, chronic locked dislocation of the gleno-humeral joint, immunogenic arthritis, mal-union of PHFx, tumors and revisions of complex or failed previous shoulder arthroplasties as well (**Fig1**). After the approval by the FDA in 2004 began its use in the USA. According to a study by **Yamaguchi et al.**[1] for the following 8 years the RTSA share reaches 42% of endoprostheses of the shoulder joint or 30 thousand in 2012. Similar trends can be observed in other countries, incl. Bulgaria. The purpose of our study was to analyze the short-term results and our up to present day experience

with Delta Xtend given the majority of literature data regarding expectations for increased application of this endoprosthesis design.

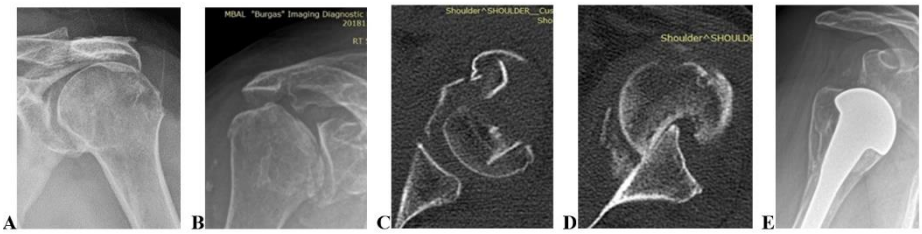


Fig.1 RTSA indications: **A.** chronic pseudoparalysis; **B.** gleno-humeral arthritis with bone loss; **C.** complex PHFx; **D.** chronic locked dislocation of the gleno-humeral joint; **E.** failed previous shoulder arthroplasty

2. Material and methods

For the period from November, 2019 - December, 2021, 39 RTSA procedures in patients with a mean age of 72.8 years (65÷82) were carried out by the same team at UMBAL Burgas. In 32 (82%) of the patients, the cause was a 3- or 4-fragment PHFx, 2 with humeral head defect, 2 for revision after failed hemiarthroplasty and 1 each due to implant-related complication after osteosynthesis for PHFx, mal-union of PHFx and RCA (**Fig.2**).

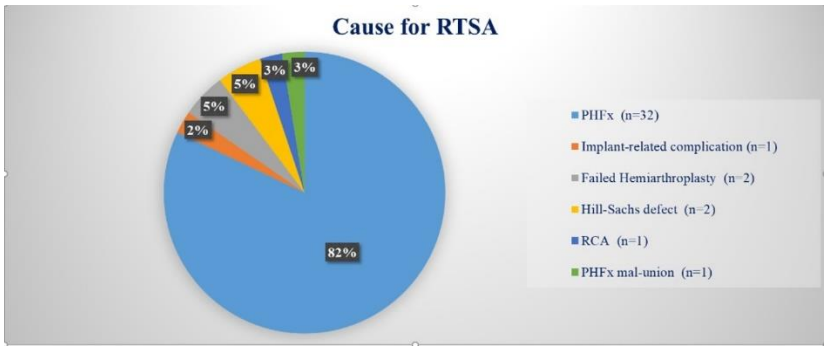


Fig. 2 Cause for RTSA in our study

In 4 cases of patients concomitant fractures of the limbs were registered, one patient was with bilateral PHFx. All patients underwent imaging with X-rays and CT scan to assess fracture morphology and quality the bone. The selection process of the patients was guided both by the pre-traumatic state of activity of the patient as well as the expectations regarding the result. Inclusion criteria were age over 65 years, ASA up to 3, omarthrosis, 3- and 4- fragment PHFx with the risk of developing AVN, fractures -

dislocations of the gleno-humeral joint with a defect of the humeral head and / or instability, failed osteosynthesis or its complications, as well as a revision procedure after hemiarthroplasty.

In all patients we used the Delta Xtend reverse shoulder system with a cobalt-chromium stem for cement placement in the humerus. The system has a non-anatomic neck-shaft angle of 155° for improving stability. The glenoid component is plate-coated with hydroxyapatite (metaglene) with 4 screw holes - two locking with variable direction and another two compression in combination with central peg. The Metaglene hydroxyapatite coating allows bone ingrowth and additional secondary fixation. The center of rotation is positioned on the glenoid-bone surface to diminish the shear stresses that contribute to loosening of the baseplate. The articulation between the components consist of a polyethylene cup, available in different sizes and depths. An important difference between the former Delta III system and the Delta Xtend in favor of the latter is the metaglene with 4 screw holes and the smaller central peg reducing glenoid bone loss. Additionally, in this system an eccentric glenosphere is avaliable, which significantly diminishes the conflict with the scapular neck (scapular notching) without the need for greater distalization of the metaglene.

All interventions were performed by one surgeon under general anesthesia and "beach chair" patient position. In all cases we used a deltopectoral approach with a V. cephalica medial retraction. In 23 patients we used an eccentric glenosphere to reduce the risk of scapular impingement. In 31 of the patients, we used a humeral cup spacer to restore the height of the humerus in PHFx, respectively the muscle tone and the stability of the joint. In all patients we performed a subscapularis tendon reattachment after joint reduction (**Fig.3**).

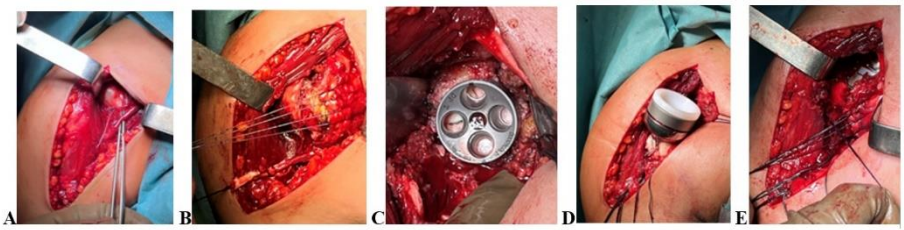


Fig. 3 Operative technique. A. Deltopectoral approach; B. Subscapular muscle with stay suture; C. Metaglene positioning; D. Humeral cup spacer in-between the stem and polyethylene cup; E. Subscapular tendon repairing

All patients were evaluated at 6 weeks, 3-, 6-, 12-months, and as late as possible. The control examinations consisted of radiographs in 3 projections, pain assessment (VAS), shoulder function assessment (CMS and modified DASH score), as well as achieved range of motion using a goniometer. In all patients, an identical postoperative protocol was followed, namely, a sling for 3÷6 weeks, beginning of pendular movements after the 2nd week together with passive-assisted movements. Active

flexion of the elbow joint is allowed after the 6th week. At that point assisted active movements in the prosthetic joint start as well.

3. Results

Patients operated during the period included 6 men vs. 33 women, each of them followed between 12÷30 months. 7 patients were excluded from the study – 4 were lost for the study and unfollowed and 3 died due to unrelated to shoulder arthroplasty conditions. At the 3rd month follow-up the average CMS achieved was 66.7 (SD 23) and relative %CMS 73.7 (SD 24.1) respectively. These records at the last control reached 82.6 (SD 16.8) and respectively 90.8 (SD 14). No significant difference was reported in longer-followed patients between the data from the last and 12-month control probably also due to the short period of observation. The modified DASH score by the 3rd month showed an average value of 23 and underwent dynamics to an average value of 12.6 on the last one follow-up visit. The achieved range of motion in the gleno-humeral joint at the patient's last visit are also indicated in **Table. 1**. The measurement of lateral (external) and medial (internal) rotation has been performed at maximum possible abduction of the limb and was measured with a goniometer. We registered the significantly lower mean value of external rotation compared to internal as we also recorded one patient with lack of external rotation (**Fig.4**).

Table 1. Mean values registered at last visit assessment

	Min	Max	Mean
CMS	47	93	82.6
% CMS	50	114	90.8
DASH	2.5	40.2	12.6
Forward elevation	80°	170°	145.9°
Lateral elevation	80°	170°	136.6°
ER	0°	60°	39.8°
IR	30°	70°	50.6°

In order to optimize the method of functional assessment, we have divided the relative CMS results in four groups – excellent (>90%), good (70-90%), satisfactory (50-70%) and poor (<50%). We found that 28 (87.5%) of the followed patients had an excellent and good results. In two cases – bad result due to non-conducted rehabilitation

and exacerbations of accompanying diseases (**Fig.5**). The pain assessment registered by means of the VAS underwent dynamics from an average value 4.3 at 6 weeks postoperatively to 1.4 at last visit.



Fig. 4 A. External Rotation Loss **;** **B.** Internal Rotation

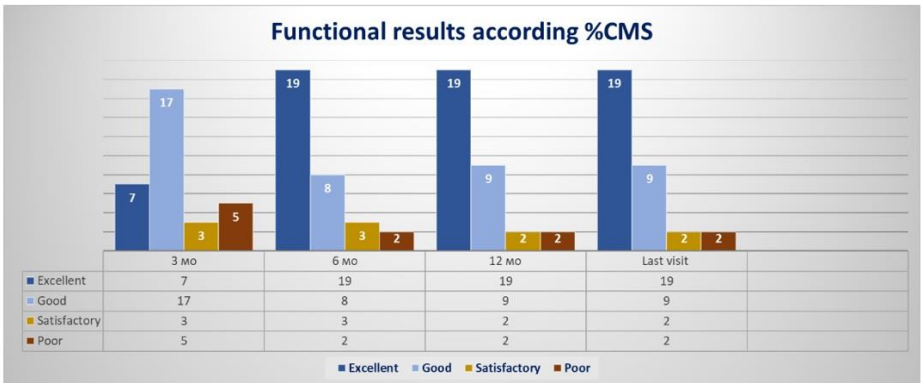


Fig. 5 Registered functional outcome according %CMS

During the follow-up period, no revision procedures were necessary, as complications with different severity and duration in 5 patients were reported - pain in the insertion zone of deltoid muscle in two patients, functional damage of Axillar nerve (n=1), which subsided after about 3 months, suspected incipient ectopic ossification in

the insertion zone of the long head of brachial triceps muscle (n=1). As the most severe complication, we recorded thrombosis of the Axillar artery in a patient with a concomitant neck of femur fracture. A thrombectomy was performed urgently by a vascular surgery team and without residual symptomatology for the patient.

4. Clinical cases

#1 – 79 y. F sustained low-energy 4-parts PHFx and following radiological and functional outcome 2 years postoperatively (**Fig.6**).

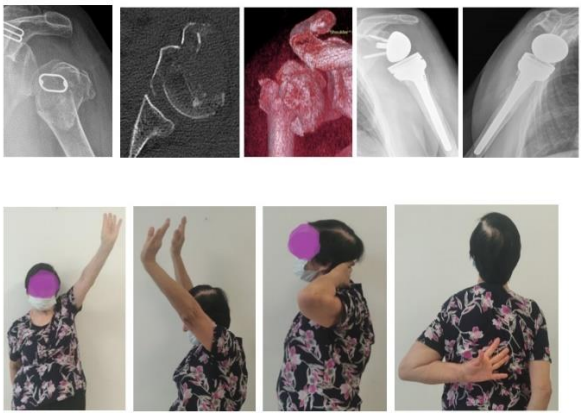


Fig.6 – Preoperative X-ray and CT scans of PHFx treated with RTSA and radiological and functional outcome 2 y. postoperatively

 # 2 – 73 y. M sustained low-energy 3-parts split Fx and following radiological and functional outcome 14 months postoperatively (**Fig.7**)



Fig.7 – Preoperative X-ray and CT scan showing head- split 3-parts PHF treated with RTSA and following radiological and functional outcome 14 mo postoperatively

 # 3 – 68 y. M sustained chronic locked Fx-dislocation lasting approximately 1 mo and following radiological and functional outcome 13 mo postoperatively. (**Fig.8**).



Fig.8 – CT scans showing locked Fx-dislocation with massive humeral head defect treated with RTSA and following radiological and functional outcome 13 mo postoperatively. Red arrow points to suspected incipient ectopic ossification in the insertion zone of the long head of brachial triceps muscle

5. Discussion

The majority of patients in our group (82%) were patients operated due to PHFx. Naturally the question arose as to whether it is better to perform a hemiarthroplasty instead of RTSA. It is well known that hemiarthroplasty is a technically complex procedure with more unpredictable results and is in pronounced dependence on the bone-union of the tubercles. On the other hand, RTSA requires short immobilization, it allows early rehabilitation, avoids painful complications and last but not least, there is the support of a large number of studies indicating a better functional outcome. In a meta-analysis, **Shukla et al.**[2] compared 130 patients with RTSA with 125 with hemiarthroplasty with a mean age of 75.6 and 73.4 years, respectively, and a mean follow-up period 25.4 and 28.7 months, respectively. The author indicates better results in the group with RTSA in terms of anterior elevation and abduction, despite the absence of a significant difference in the external rotation. They also emphasize that the union of the tubercles is a major consideration on which the optimal functional outcome depends. Similar is the position of **Michael van der Merwe et al.**[3], who based on the

New Zealand registry compared 218 patients with RTSA and 427 hemiarthroplasties of average age 78.2 and 71.6 years respectively for a 5-year period. The author points out categorically better functional results in RTSA, but the difference is not significant and therefore does not completely reject the possibility of applying hemiarthroplasty. In our opinion the application of hemiarthroplasty is a suitable strategy for relatively young patients with complex PHFx and proved intact rotator cuff. For all other cases, RTSA is the method of choice with literature-proven advantages.

The choice of an appropriate operative approach for the application of RTSA - deltopectoral (DP) or antero-superior (AS) can also be discussed? When we talk about optimal choice of operative approach we need to pay attention to the technical goals of RTSA implementation - glenosphere positioning, humeral shaft access, deltoid muscle state, role of subscapularis muscle and the plans regarding its postoperative role. The antero-superior approach (**Fig. 9A**) allows better exposure of the glenoid, subscapularis muscle preserving and easier axial preparing of proximal humerus. Its disadvantages are, that the integrity of the deltoid muscle is affected, access to the humeral shaft is limited and there is significant risk of glenosphere mal-positioning. Experience shows that it is important to put glenosphere low to minimize scapular notching – neutral or with inferior tilt (**Fig.9B**).

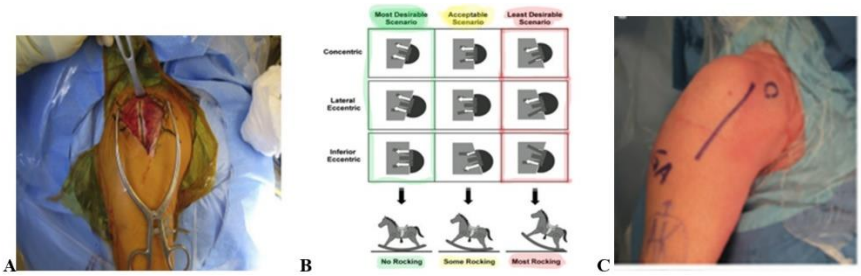


Fig.9 A. Antero-superior approach **B.** Metaglene positioning consequences [4] **C.** Delto-pectoral approach

A very common problem in RTSA cases is radiological scapular notching - 35÷76% in the various larger series (**Fig.10**). This complication is a registered phenomenon due to mechanical impingement of the medial rim of the humeral cup against the scapular neck in adduction. In biomechanical cadaver study **Nyffeler et al[4]**. found out that the placement of the glenosphere distally below the inferior glenoid rim results in significant improvement allowing considerable greater volume of adduction before impingement occurs. **Zumstein, Matthias A. et al.[5]** analyzing 617 cases with the delto-pectoral and 137 with the antero-superior approach indicated poorer visualization of the inferior positioning of the glenoid component when choosing the second approach.

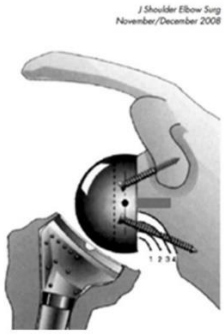


Fig.10 Scapular notching

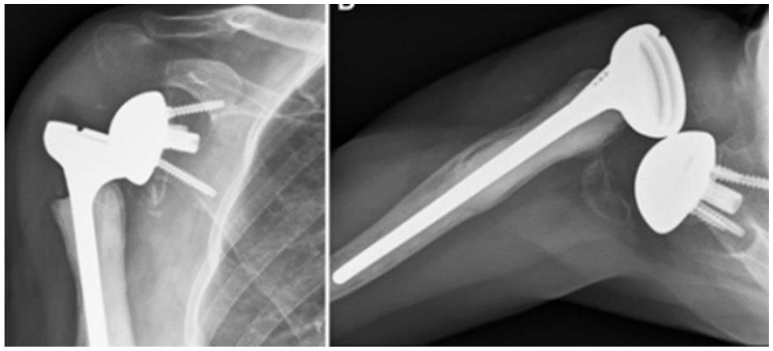


Fig. 11 RSA Instability

In the same study, another common complication was extensively discussed, namely instability, reaching up to 9% (**Fig. 11**). The author states that in 97.3% of patients with instability delto-pectoral approach was used. It is assumed that DP is associated with an increased risk of instability, which it is probably a consequence of the weakness of the anterior restraints after release of the subscapularis muscle and the associated lower and middle gleno-humeral ligaments. In another study, **Mole et al.**[6] indicate significant difference ($p<0.001$) between the frequency of instability in the two approaches 5.1% and 0.8% respectively for DP and AS.

Our choice in all patients in the observed series is the delto-pectoral approach, for several unavoidable reasons, namely that it is well known in practice, allows work in internervous plan, ensures correct positioning of the glenosphere. Also, this access gives us a good overview of the humeral shaft in case of complications, preserves deltoid muscle and facilitates latissimus dorsi muscle transfer when required.

Another point of discussion is the surgeon's decision whether or not to repair the subscapularis muscle. In order this to be our choice we need to consider only cases where the tendon is intact and reinsertion is possible. Proponents of the reattachment strategy emphasize its contribution for range of motion after RTSA and the impact on stability as well. **Ackland et al.**[7] in a biomechanical cadaver study after RTSA showed that the subscapularis muscle contributes to adduction, abduction, extension and internal rotation. In addition, the upper part of the muscle functions as an abductor, while the middle and lower third as an adductor. Center of rotation shifting medially causes subscapularis muscle tone loss and reducement of its ability to act as an internal rotator. **Hansen et al.**[8] demonstrated how shifting of the center of rotation makes this muscle more of an adductor (**Fig.12**). On the other hand, **Onstot et al.**[9] indicated that as a result of subscapularis reattachment, 132% greater deltoid muscle strength was required to achieve 15° of abduction. As a result, the load on the acromion increases with a subsequent higher risk of stress fracture, as well as the time to fatigue of the muscle decreases.

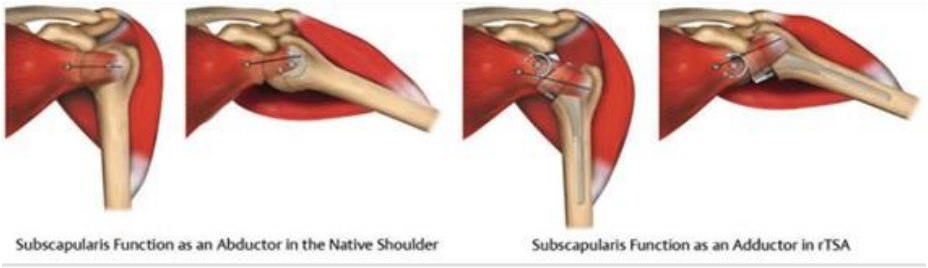


Fig.12 Function of subscapular muscle as native abductor and change to adductor after RSA[8]

The question of the influence of subscapularis muscle on the stability of RTSA is of no less importance. According to **Ackland et al.**[7], the contractions of the different regions of the muscle after arthroplasty generate compressive forces in abduction and potentially increase gleno-humeral stability in this endoprosthesis design. Other authors prove that patients with unrepaired subscapularis tendon report a higher level of instability after RTSA. **Edwards et al.**[10] followed 138 patients operated with DP access and a mean follow-up period of 36 months. All 7 dislocations were registered in patients with unrepaired subscapularis muscle (7 out of 76 in the group). No dislocations were found in the patients with repaired muscle (n=62). Similar conclusions were drawn by **Trappey et al.**[11], who followed 284 patients for an average of 24 months. The author proved that patients with non-repaired subscapularis muscle demonstrated a significantly higher level of instability compared to the group of patients with restored subscapularis (p=0.001), respectively 14 (12%) of 123 patients versus only one of 161 patients. In contrast, further studies by other authors such as **Clark et al.**[12] highlighted

that there was no significant difference in the incidence of dislocation comparing patients with and without subscapularis muscle repair. Similar are the results in the retrospective study by **Grassi et al.**[13], who did not register a dislocation in the series with unrepaired subscapularis muscle.

Based on the analysis of data and publications, our team finds no major disadvantages of subscapular muscle repair and we strive for it whenever possible. Some surgeons support the position that subscapular repair limits postoperative range of motion, but the data to support this are not abundant. In addition, the procedure itself does not require a significant increase in the average operative time.

6. Conclusion

The study outcome shows that the application of the Delta Xtend RTSA contributes to very good early results in correctly selected patients and the low level of complications is explainable in view of the short follow-up period. Failure to repair the tubercles leads to imbalance in the horizontal plane and limitation of external rotation to varying degrees, and reinsertion of the subscapularis muscle probably plays a stabilizing role postoperatively against the risk of dislocation.

In our opinion, despite the good functional results in the short term, it is necessary to deepen the study and prepare for the challenges of possible complications in the future.

7. References

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