Trends in Shoulder Arthroplasty in Israel

Noam Rosen MD, Ofir Chechik MD, Yariv Goldstein MD, Oleg Dolkart PhD, Gavriel Mozes MD, Ofer Rak MD, Alison Dalich BSc, Yossi Geron MD and Eran Maman MD

Shoulder Unit, Division of Orthopedic Surgery, Tel Aviv Sourasky Medical Center, affiliated with Sackler Faculty of Medicine, Tel Aviv University, Tel Aviv, Israel

ABSTRACT: **Background:** The number of patients undergoing shoulder arthroplasty is increasing yearly.

Objectives: To evaluate the results of a consecutive series of patients who underwent shoulder replacement for a variety of indications in a single medical center in Israel.

Methods: All shoulder arthroplasty performed in our institution between 2006 and 2015 were retrospectively reviewed. The functional outcomes and satisfaction of 180 shoulder arthroplasties were evaluated for objective and subjective parameters using the American Shoulder and Elbow Surgeons Shoulder Score (ASES), the Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure, and the Short Form Health Survey (SF-12).

Results: The indications for surgery were osteoarthritis (n=35), rotator cuff arthropathy (n=32), fractures (n=99), and other reasons (n=14). The mean follow-up was 52 months. The scores improved markedly among the patients who underwent surgery later in the study period. The mean DASH score before 2012 was 48.8 and improved to 37.2 after 2013. The respective ASES also improved from 54.2 to 68.6. The use of hemiarthroplasty decreased from 85% to 33% as of 2013, while the use of total shoulder arthroplasty increased.

Conclusions: Shoulder arthroplasty represents an effective treatment modality with satisfactory functional outcomes. Our current study demonstrates a shift from hemiarthroplasty to total shoulder arthroplasty, with the number of procedures increasing yearly. Surgeon experience and the expanding volume of operations had a direct positive effect on the functional outcomes of shoulder arthroplasties.

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Shoulder arthroplasty offers an effective solution for a variety of glenohumeral disorders, including osteoarthritis, proximal humerus fractures, irreparable rotator cuff tears, inflammatory arthritis, avascular necrosis (AVN) of the humeral head, and tumors. Neer and colleagues [1] published some of the first studies on shoulder replacement for the treatment of painful glenohumeral arthritis and paved the way for the evolution of new prosthesis designs (Neer prosthesis), which improved surgical techniques. To date, shoulder arthroplasty is the treatment of choice when non-operative treatment or joint-preserving procedures provide unsatisfactory outcomes.

The number of shoulder arthroplasties has increased steadily over the last two decades. The procedure has become the third most common joint replacement surgery after hip and knee arthroplasties in developed countries [2,3]. The 2015 Australian Orthopaedic Association National Joint Replacement Registry reported 43,183 total hip replacement surgeries and 54,277 total knee replacement surgeries [4]. The number of shoulder replacement surgeries in the same year was 4692 (20 per 100,000 persons) [4]. In the United States nearly 47,000 shoulder arthroplasties were performed in 2008 compared to 19,000 in 1998 (6 vs. 14 per 100,000 persons). This growth has been partly attributed to the approval of reverse total shoulder arthroplasty (RTSA) by the U.S. Food and Drug Administration in 2004 [3]. According to the Danish Shoulder Arthroplasty Registry, 2137 shoulder arthroplasties were performed between 2006 and 2008 (14 per 100,000 individuals) [5].

Currently, three major types of shoulder replacement procedures are widely used. Each type uses a different type of prosthesis. The first is hemiarthroplasty (partial shoulder replacement), which only replaces the proximal humerus while preserving the native glenoid. This procedure is primarily indicated for the treatment of humeral head pathologies. The second is anatomic total shoulder arthroplasty (TSA), which uses a prosthesis design based on the bony anatomy of the shoulder to replace both the humeral head and the glenoid. This type is indicated mainly for the treatment of glenohumeral arthritis. The third is RTSA, which was developed in 1985 as a way to overcome rotator cuff deficiency. In the RTSA approach, the ball and the socket are reversed and activation of the shoulder relies on the deltoid muscle instead of the tendons (i.e., the rotator cuff). The RTSA was initially indicated for the treatment of end-stage cuff arthropathy, but positive results in the treatment of other pathologies, such as complex humerus fractures, revision surgeries, and irreparable cuff tears, have led to an increase in its use [6].

Torchia's group [7] reported the rate of survivorship of the Neer prosthesis (anatomic TSA) as 93% after 10 years and 87% after 15 years. This range of survivorship was deemed acceptable for the elderly population. However, survivorship after ≥ 20 years demonstrated promising results (75.6% for hemiarthroplasty and

83.2% for anatomic total shoulder arthroplasty) even in patients younger than 50 years of age, with high demand from those who had been treated with an old-generation prosthesis design [8].

Similar to other joint replacement procedures, there is a risk for complications after shoulder arthroplasty, such as prosthetic loosening, instability, periprosthetic fracture, infection, and nerve injury. The rates of major complications vary among studies (0% to 62%), with mean complication rates ranging from 10% to 16% [9].

The current study presents functional scores and subjective assessments of shoulder replacement surgeries performed at our medical center providing results and trends in shoulder arthroplasty in a large volume Israeli shoulder unit.

PATIENTS AND METHODS

After approval from the hospital's ethics committee, the medical records of patients who underwent shoulder arthroplasties at our institution between 2006 and 2015 were retrospectively reviewed. Demographic and surgical data were retrieved. The patients were then contacted by telephone. Those who agreed to participate in a telephone interview were included. Those who refused or were unable to participate in the study (e.g., deceased, dementia, language differences or deficiencies) were excluded.

Functional outcomes as described in a telephone interview by the patient or a surrogate were recorded by an independent investigator. These data included several objective and subjective scores such as the American Shoulder and Elbow Surgeons Shoulder Score (ASES), the Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure, and the Short Form Health Survey (SF-12). ASES [10] is a patient-rated assessment tool of shoulder pain and function/disability (0–100, with higher scores representing better function). The DASH measure [10] is a 30-item patient-reported questionnaire related to symptoms, as well as physical, social, and psychological effects related to the function of the upper extremity (0–100, with higher scores representing greater disability). The SF-12 [11] measures mental health, physical functioning, and overall health-related quality of life (0–100, with higher scores representing a better quality of life).

The patients were placed into groups based on the indication for surgery (e.g., arthritis, fracture, rotator cuff disease), and the functional scores were compared between groups.

STATISTICAL ANALYSES

Data were analyzed by calculating means and percentages for establishing trends and summarized as means. The chi-square test was implemented when appropriate, otherwise Fisher's exact tests were used. A two-sided P value of 0.05 was considered statistically significant. Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 21 (SPSS, IBM Corp, Armonk, NY, USA).

RESULTS

During the study period, 175 of the 299 patients who underwent shoulder arthroplasty agreed to participate in the study. Five of these patients had bilateral shoulder replacement. Of those who did not participate, 31 died from non-related medical conditions, 88 were lost to follow-up or refused to participate, and 5 had revisions for arthroplasty performed elsewhere. The data of these 124 patients were excluded from analysis.

The indications for surgery in the 180 operated shoulders included osteoarthritis (n=35), RCA (n=32), proximal humerus fracture (n=99), and other diagnoses (n=14) including chronic dislocation, revision of failed open reduction internal fixation, and avascular necrosis.

Sixty-two men (35%) and 113 women (65%) with an average age of 70.8 years (range 34–94 years) underwent surgery. The average length of stay in the hospital was 3.9 days. Patients with fractures stayed an average of 4.2 days compared to 3.2 days for the elective patients ($P < 0.05$). The mean follow-up was 52 months (range 10–115 months).

The number of operations performed due to fractures during the study period increased, while other indications maintained a relatively constant number over the same period.

Patients in the osteoarthritis group were younger than those in the other groups (67.3 years vs. 73.8 years in the RCA group and 71.6 years in the fracture group, $P < 0.05$). The functional results in the osteoarthritis group were significantly better compared to the other groups (ASES 66.7 vs. 59.2 for fracture, 55 for RCA, $P < 0.05$; DASH 33.3 vs. 45.3 for fracture and 49.5 for RCA, $P < 0.05$; SF-12 mental 75.9 vs. 64.2 for fracture and 68.4 for RCA, $P < 0.05$).

The mean values of ASES, DASH, and SF-12 scores for each indication are summarized in Table 1.

The functional scores improved over the study period with a significant difference between operations performed after 2013 compared to those performed before 2012 (ASES 68.6 vs. 54.2, respectively; DASH 37.2 vs. 48.8, respectively, $P < 0.05$) [Table 1, Figure 1].

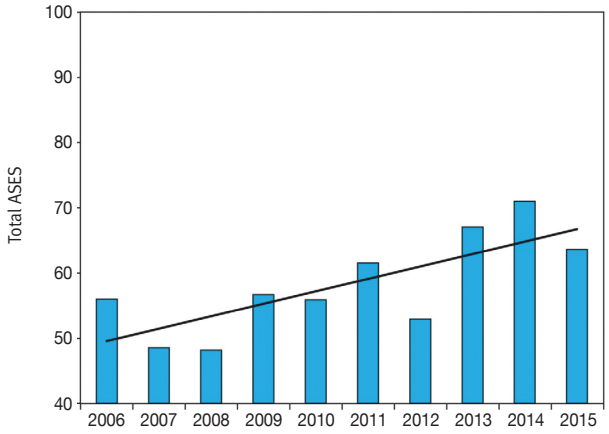
Patients in the osteoarthritis group underwent anatomic TSA in 49% of cases, RTSA in 23%, and hemiarthroplasty or resurfac-

Table 1. Mean values of functional and subjective scores by indication

Indication	ASES	DASH	SF-12 physical	SF-12 mental
Osteoarthritis	66.8	33.3	70.4	75.9
Fracture	59.2	45.3	68.6	68.4
Rotator cuff arthropathy	54.9	49.5	64.4	64.2
Other	60.2	47.6	81.6	72.5
All indications until 2012	54.2	48.8		
All indications from 2013	68.6	37.2		

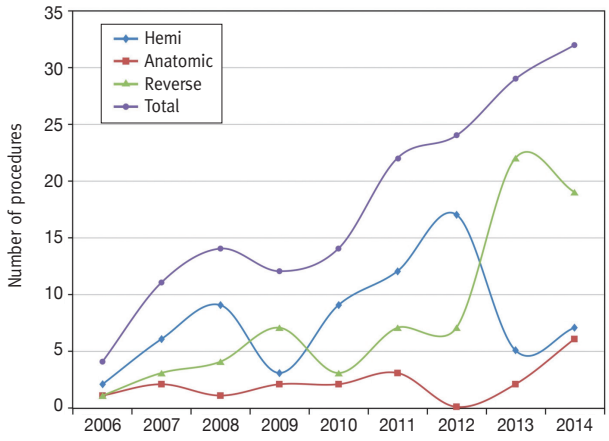
ASES = American Shoulder and Elbow Surgeons Shoulder Score, DASH = Disabilities of the Arm, Shoulder and Hand outcome measure, SF-12 = Short Form Health Survey

Figure 1. Mean ASES values from 2006 to 2015



ASES = American Shoulder and Elbow Surgeons Shoulder Score

Figure 2. Types of shoulder arthroplasty procedures from 2006 to 2014



ATSA = anatomic total shoulder arthroplasty, hemi = hemiarthroplasty, reverse = rotator cuff arthropathy

ing in 28%. Patients with proximal humerus fracture underwent hemiarthroplasty in 61% of cases and RTSA in 37%. The rate of RTSA for this indication increased over the study period. RTSA surgeries have been performed in the majority of the cases for this indication since 2013. Patients with RCA underwent RTSA in 97% of the cases. The trends of shoulder arthroplasties illustrate a decreasing number of hemiarthroplasties and an increasing number of RTSA from 2006 to 2015 [Figure 2].

Seventeen patients (9%) experienced complications that included stiffness treated with arthroscopic release surgery (n=4), infections treated surgically with removal of the prosthesis and debridement (n=3), transient nerve palsy (ulnar and radial) that was treated conservatively (n=2), dislocation (hemiarthroplasty) that was surgically revised to RTSA (n=1), deltoid dysfunction that was treated with re-operation (n=1), implant

Table 2. Major and minor complications by prosthesis procedure

Complication	ATSR	Hemi	Resurfacing	RTSA	Total
Stiffness		3		1	4 (2%)
Deltoid injury				1	1 (< 1%)
Dislocation		1			1 (< 1%)
Infection		2		1	3 (1.5%)
Nerve injury		2			2 (1%)
Periprosthetic fracture	2			2	4 (2%)
Prosthesis disassembly		1		1	2 (1%)
Total	2	9		6	17 (9%)

ATSA = anatomic total shoulder arthroplasty, Hemi = hemiarthroplasty, RTSA = reverse total shoulder arthroplasty

disassembly treated with re-operation (n=2), and periprosthetic fractures treated conservatively (n=4). One intra-operative acromion fracture was fixated [Table 2]. Six other cases (hemiarthroplasty and resurfacing) with poor functional outcomes were successfully revised to RTSA.

DISCUSSION

Shoulder arthroplasty is the third most common joint arthroplasty. The number of shoulder arthroplasties has increased worldwide, and various registries report that they range from 13 to 21 per 100,000 persons per year [3,4,12]. These numbers represent an increase of up to 100% since 2008. In Israel, the number of shoulder arthroplasties performed in 2016 was estimated by shoulder prosthesis distributors to be approximately 4 per 100,000 persons, of which 110 were performed in our institution. Many factors contribute to the growth in the number of shoulder replacement surgeries, including confidence in the shoulder specialist, awareness of other medical professionals (e.g., orthopedic surgeons, general practitioners, physiotherapists, and nurses), advanced prosthesis design, published studies that present promising results, increased survivorship, and decreased number of complications.

One of the new prosthesis designs that contributed significantly to the increased numbers of shoulder replacement during the last decade is the RTSA. This revolutionary prosthesis can be used for different indications and has shown satisfactory and predictive functional results. As it has evolved, fewer complications have been noted [13,14].

While indications for shoulder replacement in cases of osteoarthritis or RCA are relatively clear, the best management for proximal humerus fractures remains controversial. That pathology is common in the elderly population and represents up to 33% of the fractures in patients older than 60 years of age [15]. The appropriate treatment is influenced by many variables, including patient age, medical condition, fracture pattern, tendon and muscle quality, and surgeon preference. Unlike hemiarthroplasty for fracture cases, the RTSA provides a reli-

able outcome for these complicated cases, leading to a worldwide increase in shoulder replacement for proximal humerus fracture. The increased use of RTSA was accompanied with a reciprocal decrease in the use of hemiarthroplasty [3,12,16].

The results of our study reveal similar findings in Israel with regard to the transition from hemiarthroplasty to RTSA, with a turning point in 2012 [Figure 2]. Our findings were based on selected parameters that included patient outcome with various prostheses for different indications.

Whether the indication for the surgery was osteoarthritis, fracture, or RCA, our later results were comparable to those reported by others [17]. Similar to previous studies [18], anatomic TSA, which was mainly used for osteoarthritis (the classic indication for shoulder arthroplasty), yielded the best functional outcome. The use of RTSA for the diverse indications yields different results. Many studies have concluded that all indications show a statistically significant improvement in preoperative to postoperative ASES scores [17].

Our study supported the findings of several other studies that had demonstrated improved functional results over the years [16,19]. This improvement in patient outcome may be attributed to a learning curve by the surgeons, improved surgical skills, and increased volume of shoulder replacement procedures over time. Nolan et al. [20] and Walch et al. [21] concluded that patients who have shoulder arthroplasty performed by a high-volume surgeon or at a high-volume center are more likely to have better outcomes, lower mortality rates, and fewer complications. In line with those results, a recent systematic review by Weinheimer and co-authors [19] demonstrated increased complications, longer length of stay, increased surgical time, and higher surgical cost in shoulder arthroplasty when performed by a low-volume shoulder surgeon.

The effects of a learning curve on surgical outcomes were demonstrated by Walch and team [21]. They divided their study population into two groups, the second of which included patients who were operated later than those in the first group. There was a decrease in the number of complications (infection, dislocations, and glenoid loosening) in the second group, which was attributed to increased surgeon experience and decreased operative time. Another report [22] demonstrated a marked decrease in the number of complications after TSA with improved surgeon experience.

Our study has several limitations. First, it is retrospective by design, and preoperative functional shoulder scores were not available. Another limitation was that surgeries were performed using various types of shoulder replacement prostheses and by a number of surgeons with different levels of experience and different surgical techniques.

CONCLUSIONS

Shoulder arthroplasty provided our patients with an effective treatment modality and satisfactory functional outcomes. Those outcomes were directly and positively affected by surgeon experience and volume of surgeries. There is a need for better understanding and awareness on the part of the general medical staff regarding this effective and reliable surgical solution for numerous shoulder pathologies.

Correspondence
Dr. O. Dolkart
Division of Orthopedic Surgery, Tel Aviv Sourasky Medical Center, Tel Aviv 64239, Israel
Phone: (972-3) 697-3920, **email:** dolkarto@gmail.com

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