10 Reverse Total Shoulder Arthroplasty

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Pearls and Pitfalls

Pearls

- Clarify preoperatively whether the issue is pain, lack of elevation, or lack of strength and whether severe external rotation weakness (hornblower's sign) might warrant addition of a latissimus transfer.
- Obtain a CT scan with or without three-dimensional reconstruction to evaluate available glenoid bone and pattern of bone loss. Occasionally a custom glenoid baseplate or bone grafting may be needed if there is no adequate bone for a standard glenosphere.
- At the time of surgery, especially in the presence of poor cuff tissue, residual cuff can be excised, but try to save the teres minor for some external rotation. Once the subscapularis is divided, it may or may not be able to be repaired.
- Particularly if the humeral head has been high-riding for a long period of time, a more generous humeral head osteotomy may need to be taken to seat the implant appropriately under glenosphere.
- The baseplate should have some inferior tilt and, if possible, be inferiorly seated to minimize potential for notching.
- Ideally, at least 80 % of the base plate should be seated and secured to satisfactory glenoid bone.
- Once the humeral bearing surface is inserted, proper tension in the system may be difficult to define—but, in general, should be secure when reduced and be stable throughout the full range of motion. The senior author uses "a little hard to reduce, a little hard to dislocate" as a guide or "Three Bears" analogy—not too loose, not too tight, but just right.
- It does not seem critical to repair the subscapularis, and repair may not be possible if there is poor tissue quality.
- Immobilize in a sling postoperatively—but the period of immobilization is shorter than in an anatomic total shoulder

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replacement in which subscapularis healing is so critical.

- If performed for fracture, repair the tuberosities for optimal functional result.

Pitfalls

- Protect the axillary nerve—loss of deltoid function is a major problem if RTSA is being performed.
- Confirm baseplate security and taper of parts are engaged fully.
- When the shoulder is reduced, make certain the arm can be brought to the side and there is no inferior impingement of the humerus on the inferior glenoid—inferior impingement can lead to prosthetic instability and scapula notching.

Rehabilitation

- Formal rehabilitation is rarely necessary after RTSA because there is frequently little cuff tissue needing postoperative protection. Postoperatively, the shoulder is immobilized in a simple sling to hold the arm in internal rotation for a few weeks. Passive range of motion is begun immediately. Afterward, the patient can remove the sling for hygiene and use the hand for simple activities of daily living. Sling use is gradually weaned after a month and activity as tolerated is permitted.

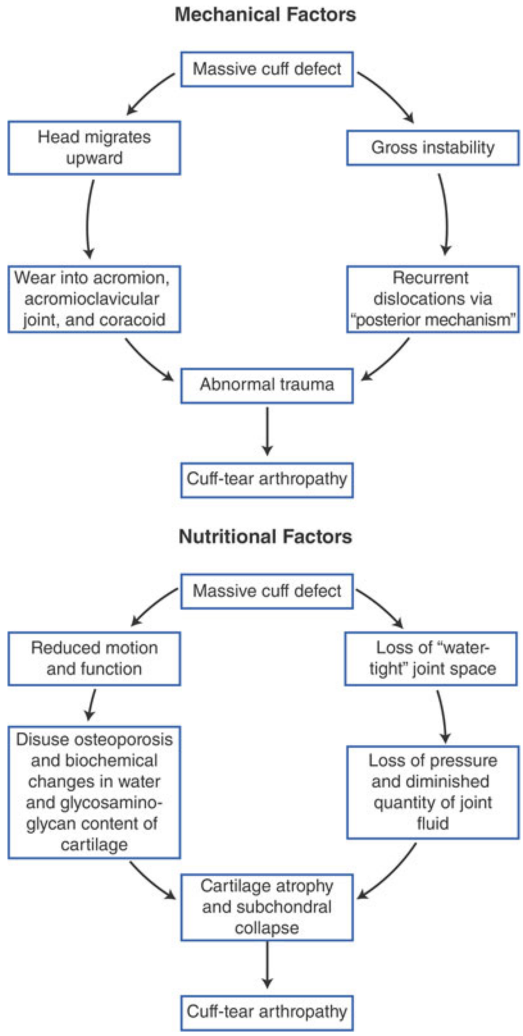

Fig. 10.1 Both mechanical factors (*top*) and nutritional factors (*bottom*) contribute to joint destruction in rotator cuff tear arthropathy (Modified from Neer et al. [7])

Background

The first introduction of reverse total shoulder arthroplasty (RTSA) in the 1970s was met with little clinical success. It had a constrained design and lateralized glenohumeral center of rotation that led to excessive shear forces and failure of the glenoid component [1, 2]. In the subsequent years, implant design modifications focused on a larger radius of curvature of the glenoid component and movement of the center of shoulder rotation medially and distally to decrease shear forces at the glenoid bone interface and to create a more stable and efficient deltoid fulcrum [3, 4]. Paul Grammont and colleagues modernized the reverse shoulder arthroplasty implant in 1987 to treat "cuff tear arthropathy," a clinical entity first labeled by Neer et al. [5].

Cuff tear arthropathy is shoulder arthritis in the setting of a massive, irreparable rotator cuff tear. The authors of the original Neer paper that first described the process theorized that both mechanical and nutritional factors might play a role in its development [6, 7] (Fig. 10.1).

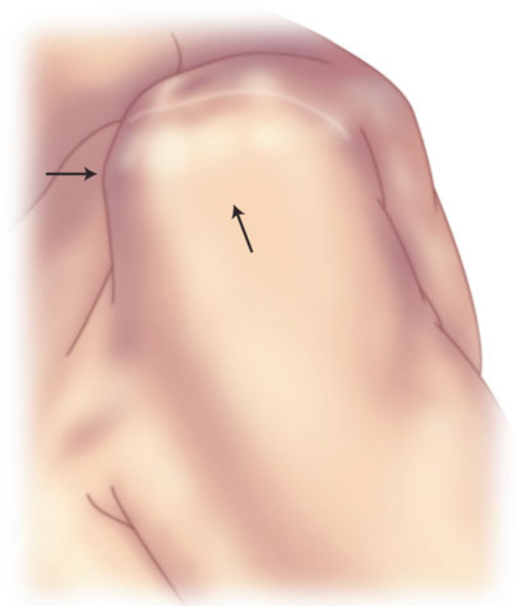

Fig. 10.2 Clinical picture of the left shoulder in a patient with rotator cuff tear arthropathy, demonstrating anterior (*left arrow*) and superior (*right arrow*) escape of the humeral head resulting from loss of the subscapularis with a grossly deficient rotator cuff (Modified from Nam et al. [8])

Mechanical factors arise from disruption of the force coupling effect, as attempts at elevation or rotation of the humerus cause instability. A deficient cuff may also allow excessive upward migration of the humeral head, resulting in abnormal pressure and degenerative changes in the acromion, acromioclavicular joint, and coracoid. In severe cases, loss of the subscapularis muscle and a grossly deficient rotator cuff lead to anterior and superior escape of the humeral head [8] (Fig. 10.2). Moreover, with attempted shoulder abduction and loss of the inferior and compressive action of the rotator cuff, the unopposed contraction of the deltoid creates a force vector that displaces the humeral head superiorly, leading to pseudoparalysis of shoulder elevation (defined as "an inability to actively elevate the arm in the presence of free passive range of motion, and in the absence of a neurologic lesion") [4]. At about the same time cuff tear arthropathy was described, the rheumatology literature reported an entity named "Milwaukee Shoulder", which was essentially the same process, and theorized

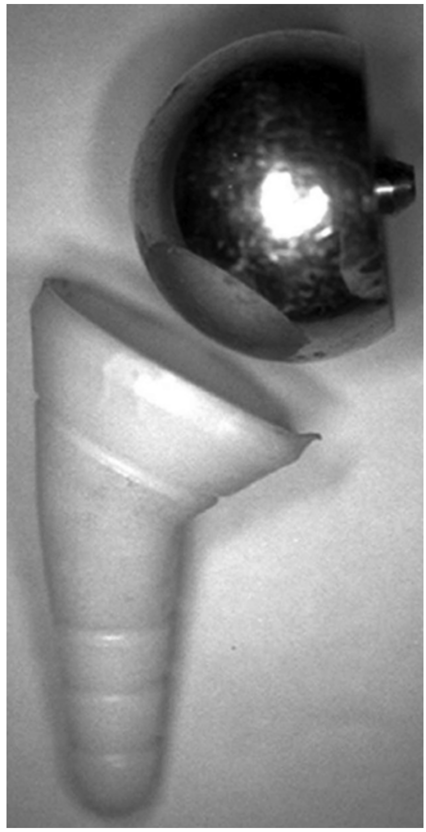

Fig. 10.3 Grammont's original reverse total shoulder arthroplasty (Reproduced with permission from Boileau et al. [12])

that crystalline deposits had a destructive effect on both joint and soft tissue [6].

Cuff tear arthropathy treatment has ranged from nonoperative management, glenohumeral arthrodesis, resection arthroplasty, and constrained or conventional total shoulder arthroplasty to hemiarthroplasty alone [9–11]. However, these interventions resulted in poor functional outcomes and high long-term complication rates [8]. Eventually, RTSA received renewed interest once improved implant designs were able to provide glenohumeral stability and optimize shoulder biomechanics. Paul Grammont is credited with describing the modern reverse total shoulder prosthesis [12] (Fig. 10.3). Earlier reverse ball-and-socket designs included a small glenoid component and a lateralized center of rotation within the prosthesis, instead of within

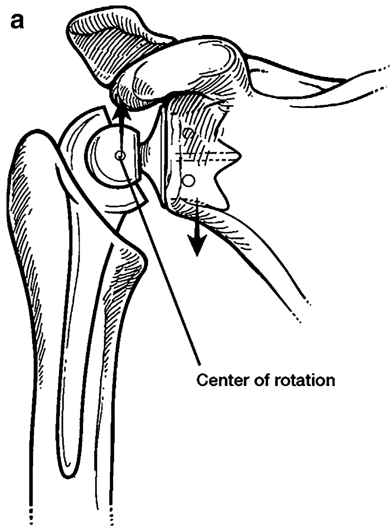

Fig. 10.4 (**a**, **b**) Diagrams demonstrating an earlier reverse total shoulder prosthesis design, with a small glenosphere component and a lateralized center of rotation (**a**), versus the modern design, with a large glenosphere, a nonanatomic valgus angle of the humeral implant, and medial and distal positioning of the center of rotation (**b**) (Reproduced with permission from Gartsman and Edwards [13])

the glenoid. As a consequence, these designs increased stresses at the glenosphere-bone interface and led to early component failure [13] (Fig. 10.4a). The modern RTSA employs the following concepts: (1) a large glenoid component with no neck to facilitate medialization of the center of rotation and reduced torque; (2) a humeral implant with a nonanatomic valgus angle, which moves the center of joint rotation distally, thereby maximizing the length and tension of the deltoid to make it a more efficient humerus abductor, as well as increasing stability; and (3) a greater impingement-free shoulder range of motion [12, 13] (Figs. 10.4b and 10.5).

Fig. 10.5 AP radiograph of a modern reverse total shoulder arthroplasty

Indications

When the RTSA received US Food and Drug Administration approval in 2003, it was initially recommended only for those patients with the combination of disabling glenohumeral arthritis and cuff insufficiency. However, clinical success in restoration of stability, balance, and function has given rise to expanded indications such as the cuff deficient shoulder without arthritis. While the indications continue to evolve, concerns exist over its complication rate, longevity, and paucity of long-term functional outcome data [2]. Despite these concerns, the RTSA is now an important surgical option in the treatment of a variety conditions including: (1) cuff tear arthropathy, (2) irreparable cuff tears without arthritis and

Table 10.1 Indications

Cuff tear arthropathy
Pseudoparalysis
Failed cuff surgery
Anterior-superior escape
Tuberosity malunion
Acute shoulder fracture in elderly

clinical "pseudoparalysis," (3) instability directly attributable to cuff insufficiency (anterior-superior escape), (4) the "cuff insufficiency equivalent"—nonunion or malunion of the tuberosity following trauma or prior arthroplasty, (5) acute shoulder fractures in the elderly patient in which the greater tuberosity has poor potential for healing and poor bone for primary fixation, and (6) revision arthroplasty surgery. Some have recently begun to suggest its use in osteoarthritis with posterior subluxation and glenoid bone loss, a condition which has been associated on occasion with troubling posterior instability in anatomic unconstrained arthroplasty, though its use in this capacity is controversial (Table 10.1).

Cuff tear arthropathy is the single most common indication for RTSA [14]. Total shoulder replacement in the absence of a functioning rotator cuff is unpredictable in restoration of a balanced, centered shoulder, and glenoid longevity can be compromised because of the inability of the cuff to center the humeral head (rocking horse glenoid). Hemiarthroplasty with or without soft tissue interposition has had mixed results, does little to re-center the head, with few reports of improvement in active motion and functional scores [10, 15–20]. Its clinical symptoms include severe shoulder pain, shoulder or arm weakness, and progressive disability [7, 21, 22]. On exam, patients may have glenohumeral or acromiohumeral crepitus with stiffness. Rotator cuff testing will reveal specific deficiencies of the posterosuperior rotator cuff, anterosuperior, or both. Additionally, the long head of the biceps is often diseased or ruptured [7, 13, 23]. Plain radiography displays loss of glenohumeral joint space with or without humeral head osteophytes. Anterosuperior cuff failure can be appreciated on the axillary radiograph as static anterior subluxation (Fig. 10.6). If the posterosuperior

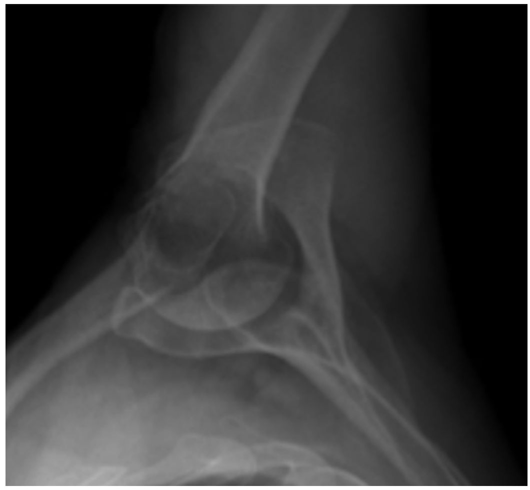

Fig. 10.6 Compromise of the anterosuperior rotator cuff results in static anterior subluxation (anterior escape) that is apparent on the axillary radiograph (Reproduced with permission from Gartsman and Edwards [13], pp 219–221)

cuff is involved, superior subluxation may be seen (Fig. 10.7). A number of studies have shown that the reverse shoulder arthroplasty can predictably restore function including overhead elevation, improve pain (as reflected in Constant score), and increase external rotation, particularly if there is a functioning teres minor [3, 24–26]. Additionally, some studies have suggested that external rotation may be reestablished with incorporation of a latissimus transfer to the reverse shoulder prosthesis [27–29].

Patients may present with massive irreparable cuff tears without glenohumeral arthritis. Despite their cuff dysfunction, some are able to compensate and maintain surprisingly good function. Thus, in the absence of arthritis, particularly if pseudoparalysis is not present, it is reasonable to attempt to build muscle through rehabilitation, allowing potential recruitment of accessory muscles. In the presence of a massive cuff tear, poor function, and pain, options other than a reverse prosthesis may include partial or complete repair, arthroscopic debridement, and biceps tenotomy. However, patients may present with pseudoparalysis: full passive forward elevation but a loss of active elevation as a result of the inability of the rotator cuff to provide a fulcrum for the deltoid during elevation.

Fig. 10.7 Compromise of the posterosuperior rotator cuff results in static superior subluxation that is apparent on the anteroposterior radiograph (Reproduced with permission from Gartsman and Edwards [17], pp 219–221)

Contraindications

Infection, a nonfunctioning deltoid, and insufficient glenoid bone stock and glenoid bone quality are absolute contraindications for a RTSA. However, loss of anterior deltoid alone is not a contraindication if the middle and posterior deltoid are working effectively [30] (Table 10.2).

Arthritis and a small cuff tear with a well-centered head is a relative contraindication. In this situation a traditional anatomic arthroplasty with a cuff repair is a better alternative. Patients with massive cuff tears without arthritis and nearly full active elevation usually have a balanced shoulder with stability provided by the deltoid and residual cuff are not ideal candidates for RTSA.

RTSA cannot treat isolated external rotation deficits. The loss of active external rotation can be severely disabling and is caused from posterior extension of the rotator cuff tear to the teres minor, whereas isolated infraspinatus rupture is generally well-tolerated [31–33]. RTSA does not restore active external rotation when the posterior rotator cuff muscles are absent or deficient. Inferior outcomes have resulted from RTSA in the presence of a nonfunctioning teres minor [3, 12, 34]. Patients who regain active elevation from a RTSA but have an atrophied or absent teres minor may complain of the inability to spatially position their arm due to the tendency of their forearm to swing toward the trunk upon attempted elevation, abduction, or trying to lift an object [29]; this has clinically been termed a "hornblower's sign. A combined RTSA and latissimus dorsi and teres major transfer can restore both active elevation and external rotation in this subgroup of patients with cuff deficiency and absent or atrophied infraspinatus and teres minor [29] (Fig. 10.8).

Table 10.2 Contraindications

Infection
Nonfunctioning deltoid
Insufficient glenoid bone stock/bone quality
Arthritis with a small cuff tear (relative contraindication)
Isolated external rotation pseudoparalysis (relative contraindication)

Techniques

RTSA can be performed via a deltopectoral or a superolateral approach. There are distinct advantages and disadvantages of each approach. The argument for superolateral is that it may better ensure and provide better postoperative stability and may more effectively prevent fractures of the scapular spine and acromion [35]. A deltopectoral approach provides better preservation of active external rotation, better glenoid positioning, and easier access to the inferior glenoid, is more extensile, and may be associated with fewer incidents of inferior notching. Additionally, most surgeons are more familiar with this approach. Ultimately, the selection of approach should be based on surgeon experience and patient-specific needs. Proper implantation of a RTSA is technically demanding and should therefore be utilized

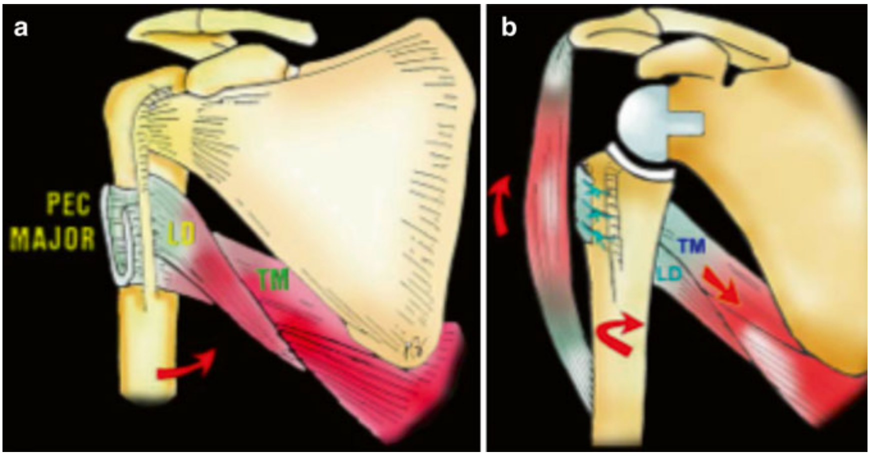

Fig. 10.8 (**a**, **b**) Principles of the surgical procedure are shown. The reverse prosthesis restores active elevation and the latissimus dorsi and teres major (LD/TM) transfer improves active external rotation. The two tendons that are located at the medial border of the humerus are harvested after partial section of the pectoralis major tendon (**a**). Because of the lowered, medialized position of the humerus in front of the glenosphere, the course of the rerouted tendons is short and horizontal, facilitating reattachment to the posterior aspect of the humerus (**b**) (Reproduced with permission from Boileau et al. [29])

only by experienced shoulder surgeons to minimize complications [2].

The deltopectoral approach is performed in many institutions, and it is our current preference. The key aspects will be emphasized here. The approach gives excellent humeral shaft and glenoid exposure while allowing identification and protection of the axillary nerve. The subscapularis is transected through the tendinous portion, approximately 1.5 cm medial to the insertion, in line with the anatomic neck of the humerus. It is tagged, and after prosthesis implantation, repaired with the goal of both improving humeral internal rotation and creating an anterior soft tissue restraint against instability. However, if the subscapularis is diminutive or if it cannot be repaired in a tension-free fashion with arm in 30° of external rotation, then it is not repaired. A recent retrospective case-control study found subscapularis repair conferred no appreciable effect on complication rate, dislocation events, or range of motion gains and pain relief [36]. A generous capsular release is performed along the inferior neck of the humeral head, back to the insertion of the teres minor. This will help mobilize the humerus so that better glenoid visualization can be achieved.

The specifics of humeral and glenoid preparation depend on the implant used. What follows is a general guideline for proper placement of the prosthesis. To prepare the humerus, the humeral head is typically osteotomized in anywhere between 0° and 30° of retroversion. Cutting the humerus in more retroversion is gaining favor because it may improve postoperative external rotation [37]. The long head of the biceps is tenotomized. The humerus is then reamed and broached similarly to the methods used in conventional total shoulder arthroplasty. Conveniently, many prosthesis systems are platform systems; that is, they allow the same humeral stem to be used for a hemiarthroplasty, conventional total shoulder arthroplasty, or RTSA. Such versatility affords many intraoperative options to be applied as conditions warrant and permit conversion from an anatomic arthroplasty to a reverse without the need for stem extraction (Fig. 10.9).

Once the glenoid is well-exposed, the labrum is excised and the capsule is released circumferentially. Meticulous preoperative planning with careful attention to glenoid bone stock and version is a prerequisite for proper glenoid preparation. Accurate central guidewire placement is dictated by availability of the best bone stock for

Fig. 10.9 Biomet Comprehensive® reverse shoulder system

baseplate screw fixation and placement of the baseplate as inferiorly as possible, with an inferior tilt, since this positioning has been shown to decrease the rate of implant loosening and scapular notching [32, 38, 39]. The method of baseplate fixation is system specific. An appropriate-size glenosphere is then mounted on the baseplate. Larger glenospheres may be associated with less pain and better strength [35, 40]

Once the final prosthesis is implanted and a stable range of motion is demonstrated, the subscapularis tendon is repaired and one or two suction drains are inserted. A sling is used postoperatively and the patient is allowed to use the arm for light activities of daily living such as brushing teeth and eating. Sling use is discontinued at 3 weeks in shoulders in which the subscapularis is not repaired and at 6 weeks in shoulders in which it is repaired (see Pearls and Pitfalls).

Outcomes

Results of RTSA correlate with the original indication for surgery, and functional outcome and complication rates are distinctly different in primary versus revision cases [14, 24, 25, 40]. In cuff tear arthropathy, a number of studies have shown that RTSA can predictably restore function including overhead elevation, improve pain (as reflected in Constant score), and increase external rotation, particularly if there is a functioning teres minor [3, 24–26]. Additionally, some studies have suggested that external rotation may be reestablished with incorporation of a latissimus transfer to the reverse shoulder prosthesis when the posterior cuff and teres minor are absent or deficient [28, 29, 41]. A recent comparison of RTSA and hemiarthroplasty for the treatment of cuff tear arthropathy found superior functional outcomes for RTSA patients [42].In a large multicenter study, the Constant score increased from 24 points preoperatively to 62 points postoperatively, pain scores increased from 3.7 to 12.6 point (where 15 points represents absence of pain), and elevation increased from 71° to 130° [35]. Normalized postoperative Constant scores reflect improvement generally within the same range. Sersohn et al. [43] reported a mean of 54.3, which was similar to Ek et al. [44] (mean, 57) and Boileau et al. [45] (mean, 55.8). Improvement in active forward flexion also occurred across studies: Wall et al. [14] (from 86° to 137°), Sersohn et al. [43] (from 56° to 121°), Boileau et al. [3] (from 82° to 123°), Muilieri et al. [46] (from 53° to 134°), and Levy et al. [47] (from 38° to 72°). A long-term study by Molé and Favard with at least 10 years follow-up [35] demonstrated that 89 % of prostheses were still in place, and 72 % of the patients had a Constant score greater than 30 points. Radiographic deterioration, however, started to appear after 5–6 years, and clinical deterioration appeared after approximately 8 years.

Patients with rheumatoid arthritis and adequate glenoid bone stock have encouraging short-term results, showing good pain relief and significant improvement in Constant score [48–50]. Studies with follow-up between 5 and 10 years suggest faster radiographic deterioration than in rotator cuff disease [51]. However, a higher rate of infection is found in this group [48, 49].

Acute three- and four-part proximal humerus fractures in the elderly have been successfully treated by RTSA [52, 53]. Hemiarthroplasty has long been the “gold standard” in these fractures in which the risk of nonunion, malunion, implant failure, or osteonecrosis precludes fragment fixation [54–56]. The repair and healing of the greater and lesser tuberosities have the greatest impact on clinical outcomes in hemiarthroplasty [57–60]. In contrast, RTSA relies less on a functioning rotator cuff and/or tuberosity healing than hemiarthroplasty does. In the first systematic review to date comparing hemiarthroplasty and RTSA for the treatment of acute fractures, Namdari [61] found similar functional outcomes and physical examination parameters between the groups. Clinical complications differed substantially, however, with a four times greater odds of complication after RTSA. Less optimal results than those achieved in the treatment of cuff tear arthropathy may be expected. Postoperative abduction between 90° and 100° has been reported, with significant variation in external rotation and poor internal rotation [42, 62–64].

Revision surgery with RTSA can be plagued by complications and results are inferior to those obtained for other indications [14, 65]. Furthermore, studies have shown limited gains in range of movement and pain relief and minimal gain or even worsening of rotation [3, 14, 47, 63, 66]. Revising failed hemiarthroplasty to RTSA has resulted in a complication rate between 32 and 50 % depending on the study [14, 65]. Failed total shoulder arthroplasty revision surgery can yield acceptable functional results, but primary total shoulder arthroplasty results are consistently better [67]. Wall et al. [14] found that patients who received primary RTSA for failed arthroplasty or posttraumatic arthritis had worse results and more complications than patients who received RTSA for cuff tear arthropathy, osteoarthritis with cuff tear, and massive cuff tear. A thorough risk-benefit analysis must be assessed for patients after failed proximal humerus fractures because RTSA is the only surgical procedure that will restore overhead function [4].

There are few studies of revisions of failed RTSA. Boileau et al. [68] recently examined a series of revisions and found that, similar to previous reports instability, humeral complications (aseptic loosening, implant derotation, and fractures), and infection were the most common complications requiring surgical reintervention [14, 25, 40, 66, 69–72]. Outcomes were encouraging, with preservation of shoulder function, a mean Constant score of 47 points compared with 58 points in a previous series of primary RSA [45], and 89 % of the patients were satisfied. It is clear that revision surgery of a failed or complicated RTSA is a high-risk surgery since 30 % of the patients in this series had complications that required further surgical interventions.

Although the majority of RTSA are performed in the older patient population, it is becoming more commonplace in individuals younger than 60. There are few studies on this younger demographic population, however. Findings from a recent retrospective study of 41 patients aged younger than 65 by Ek et al. [44] show that RTSA in younger patients provides subjective improvement of overall shoulder function maintained up to 10 years after treatment. There was a high complication rate of 37.5 % and implant survivorship was only 75 %. Dillon et al. [73] recently completed a multicenter retrospective cohort study on shoulder arthroplasty in 504 patients aged 59 years or younger versus 2,477 patients aged 60 years or older, with a mean follow-up of 2.2 years. There was a two times higher risk of revision arthroplasty in the younger cohort at early follow-up. In their study of patients aged <60 years with RTSA, Sershon et al. [43] reported a Constant score of 54.3, complication rate of 13.9 %, and implant survivorship of 91 % at a mean follow-up of 2.8 years. In a study of RTSA patients with a mean age of 52.2 years and mean follow-up of 36.5 months, Muh et al. [74] reported excellent improvement in active forward elevation (from 54.6° to 134.0°); however, overall satisfaction was 81 %, which is substantially lower than rates for older patients reported in the literature (90–96 %) [35, 40].

As RTSAs are performed on younger patients, long-term implant survivorship becomes particularly crucial. Unfortunately, there is a paucity of literature on this long-term data. A recent multicenter analysis of 489 patients with massive cuff tears with or without glenohumeral arthropathy who underwent RTSA by Favard et al. [75] determined complication rates, functional scores over time, survivorship, and whether radiographs would develop signs of loosening. There was a complication rate of 22 %. Survivorship free of revision was 89 % at 10 years with a marked break occurring at 2 and 9 years. Survivorship to a Constant score of less than 30 was 72 % at 10 years with a noticeable break at 8 years. Progressive radiographic changes were apparent after 5 years, and there was an increasing frequency of large notches with long-term follow-up. Based on these findings, the authors concluded that on average, there is a progressive decline in patient function after the eighth year the authors urge caution when indicating RTSA, especially in younger patients.

Complications

Drawing definitive conclusions regarding complications in RTSA is sometimes difficult because of heterogeneity in reporting studies, but salient trends exist in the literature. In general, previous surgery is a risk factor for increased complications [14], reoperations [25], and lower implant survival rates [24].

Scapular notching, erosion of the scapular neck related to impingement by the medial rim of the humeral cup during adduction, is one of the most common complications in many reports [12, 25, 40, 76–79] (Fig. 10.10). In a large multicenter trial comprised of 461 shoulders, Lévigne et al. [80] found an incidence of 68 % at a mean follow-up of 51 months. Furthermore, they demonstrated that notching was accompanied by decreases in strength and anterior elevation as well as an increased incidence in humeral and glenoid radiolucent lines. Inferior placement of the baseplate on the glenoid plate has been shown by Nyffeler et al. [32] to prevent the occurrence of notching and also improve range of motion. Glenospheres with a lateral center of rotation have been shown to produce lower rates of scapular notching [81–83].

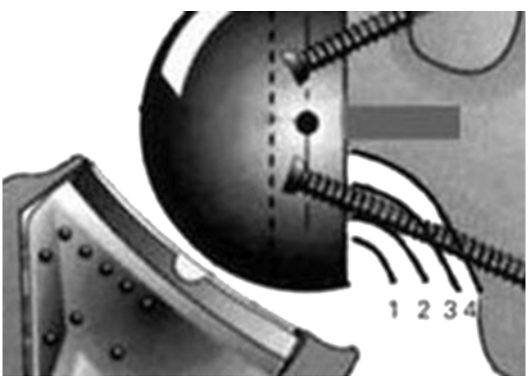

Fig. 10.10 A drawing shows classification of scapular notching according to Sirveaux et al. [39]. Grade *1* shows a notch limited to the scapular pillar, Grade *2* shows a notch reaching the inferior screw of the base plate, Grade *3* shows a notch extending beyond the inferior screw, and Grade *4* shows a notch reaching the base plate's central peg

In cuff tear arthropathy, the dislocation rate has been reported to be between 2 and 3.4 % [35, 50, 84]. Instability is almost always anterior, but the reasons are not well known. Correct deltoid tension and correct component version are necessary for stability [53]. Dislocation within the first 3 months is most likely due to technical error, and closed reduction is usually not successful. On the other hand, a late dislocation (>1 year postoperatively) has a higher likelihood of a successful closed reduction [35].

The incidence of deep infection in primary RTSA was 4 and 5.4 % in two studies [35, 50], compared with 1.1 % for anatomic replacement [85]. Infection rates are even higher with revision surgery [3, 25]. RTSA may be susceptible to infection because of the large subacromial dead space created by the inverse prosthesis [4]. The two most common organisms responsible for infections after shoulder surgery are *Propionibacterium acnes* and *Staphylococci*, which are mainly coagulase-negative [86]. Since component removal after RTSA can cause significant bone loss, some authors have advocated that patients with a deep infection should be managed with an initial irrigation and debridement, culture-driven intravenous antibiotics, and component retention [87].

Intraoperative glenoid complications are rare but they can occur because there is often erosion and medialization of the glenoid, leaving little bone stock for fixation. Glenoid loosening has been reported in 4.1 % of prostheses followed for longer than 2 years [35]. Treatment involves a staged procedure to fill the glenoid cavity with

Table 10.3 Complications

Scapular notching
Dislocation
Infection
Glenoid loosening
Acromion fracture
Humeral disassembly
Humeral fracture
Neuropraxia

autogenous bone and await incorporation with a hemiarthroplasty prior to reimplantation of the glenosphere.

Acromion fracture or even scapula spine fracture is another postoperative complication. Insufficiency fractures are characteristic and may result from overtensioning the deltoid [12], but the exact mechanism is poorly understood [25, 81, 88]. Postoperative fractures have been observed in 1.4–4 % of patients [50, 84]. The fracture usually occurs either through the acromion or at the base of the spine of the scapula [89, 90]. Despite causing minimal pain, the functional score and subjective satisfaction are reduced in patients who sustain acromial fractures [84, 91]. Treatment options are limited because there is little remaining bone for fixation. Preoperative acromial fragmentation due to cuff tear arthropathy or os acromiale, however, is not a contraindication to RTSA because no adverse effects on outcome have been observed [89] (Table 10.3).

Conclusions

Prior to the advent of RTSA, cuff tear arthropathy was a severely debilitating condition with few options. While imperfections still exist, modern RTSA has proven to be an extremely successful innovation in the treatment of this disease. Although sophisticated implants and advanced surgical techniques have expanded indications for RTSA, validation from well-designed long-term studies will help guide its future implementation in cuff tear arthropathy and other pathological conditions of the shoulder.

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