Activity following reverse total shoulder arthroplasty: What should surgeons be advising?

Scott J MacInnes¹, Katherine E Mackie², Andrew Titchener¹,
Rebekah Gibbons² and Allan W Wang^{1,3}

Abstract

Background: Reverse total shoulder arthroplasty (RTSA) is now the most frequently performed form of shoulder arthroplasty. There is currently no consensus on recommended levels of activity and sport following RTSA. The aim of this review is to outline the current evidence and provide a guide for surgeons on what to advise their patients regarding activity level following RTSA.

Methods: A systematic review of the literature was performed using the Preferred Reporting for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The search was performed using the electronic databases PubMed and Medline. Included studies were of level 1 to 4 evidence in the English language evaluating complications and return to sport after RTSA.

Results: Eleven studies were selected and included a total of 621 patients (67% female) with a mean age of 73 years (range 22–92). All of the included patients participated in sports prior to RTSA. The rate of return to sport ranged from 60 to 86% and varied with the level of sport activity. Mean time to return to sport after surgery varied greatly between studies.

Conclusions: Return to sport is tolerated following RTSA; however, studies are short to medium term only and although the reported complication rate is low, the studies did not include radiographic evaluation. Longer term studies with subgroup analysis evaluating common recreational activities after RTSA are required, particularly in the younger population, in order to establish clear post-operative guidelines.

Keywords

reverse shoulder arthroplasty, activity, sports participation, recommendations

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Introduction

Reverse total shoulder arthroplasty (RTSA) was introduced by Grammont and Lelaurain in 1987 for the treatment of rotator cuff arthropathy.¹ The ‘reversed’ design distalizes and medializes the centre of rotation of the gleno-humeral joint, increasing the deltoid moment arm improving its efficiency. Inferiorization of the humerus re-tensions the deltoid and together with a semi-constrained articulation improves stability.² Although gleno-humeral arthropathy in the presence of rotator cuff deficiency remains the primary indication for RTSA, its application has expanded to include revision shoulder arthroplasty,

pseudoparalysis due to rotator cuff tear, proximal humeral fracture, osteoarthritis with glenoid deformity, inflammatory arthropathy and following tumour resection.^{3–10} Increasing surgeon confidence, favourable revision rates and expanding indications have

¹Sir Charles Gairdner Hospital, Nedlands, Australia

²St John of God Murdoch Hospital, Murdoch, Australia

³Department of Surgery, University of Western Australia, Nedlands, Australia

Corresponding author:

Allan W Wang, Department of Orthopaedics, Sir Charles Gairdner Hospital, Nedlands, WA, Australia.
Email: allanwang@aapt.net.au

led to a surge in the number of RTSA performed. RTSA now accounts for 69% of all total shoulder arthroplasty (TSA) in Australia and 51% in the United Kingdom.^{11,12}

RTSA is now being performed in younger patients with higher functional expectations and many wish to continue shoulder active sports which involve impact loading.^{13–16} Additionally, as life expectancy increases, many older patients are continuing to participate in sport and higher demand recreational activities.¹⁷ The Australian Bureau of statistics reported that 47% of the population over the age of 65 participated in sport or physical recreation.¹⁸ Patient satisfaction following arthroplasty has been found to associate with the ability to return to their chosen sporting activity.¹⁹ Surgeons are regularly asked whether a post-operative return to sporting or recreational activity will be possible. Whilst a number of studies have answered these questions with regard to hip and knee arthroplasty there is a paucity of evidence evaluating activity following shoulder arthroplasty and in particular RTSA.^{6,20–28}

There is no current consensus on the recommended level of activity following RTSA. In this article, we present a systematic review of the literature to provide a guide for surgeons on what to advise their patients regarding activity post-operatively.

Methods

A comprehensive systematic review in adherence to the Preferred Reporting for Systematic Reviews and Meta-Analyses (PRISMA) guidelines was conducted.²⁹ Included studies were those reporting on return to sport or activity and complications after RTSA.

Article searches were performed in PubMed (1980 to May 2018) and Medline (1966 to May 2018) using the search terms for the intervention (reverse, shoulder, arthroplasty), for patients (athletes, recreational activity, wheelchair, paraplegic) and for the outcomes (return to sport, complications) with search algorithms designed for each database. We included level 1 to 4 evidence studies. Only studies published in the English language were reviewed and no restrictions were placed on publication status. No restrictions were placed on date of publication. The reference lists of all retrieved articles were also screened for potential inclusions. Duplicate publications were deleted. Reviews and expert opinions were excluded. All titles, abstracts and then full texts were screened by authors with surgical and methodological expertise. The final list of included publications was made by consensus from all authors.

Two assessors independently extracted data according to a predefined protocol. The epidemiological characteristics (age, gender, sport) and assessment of results

(return to sport, level of activity after surgery, complications) were extracted.

Results

Characteristics of studies

A total of 176 studies were retrieved, from which 11 studies were selected for meta-analysis (Figure 1).^{16,17,30–38} The included studies consisted of a total of 621 patients (mean 67% female) with a mean age of 73 years (range 22–92) and were published between 2008 and 2018 (Table 1). The primary indications for RTSA were rotator cuff arthropathy and massive cuff tear.

All studies used either a deltopectoral or superolateral surgical approach. The humeral component implant position varied between neutral version to 30° retroversion. Repair of the subscapularis tendon was not routinely performed. RTSA in the selected studies was performed with both cemented and uncemented implants.

The post-operative rehabilitation protocol varied between studies. Use of a shoulder immobiliser sling ranged from use only at night for four weeks to full time use for six weeks. The sling could then be discontinued immediately or gradually weaned for up to 12 weeks following surgery. Passive range of movement (ROM) or pendular exercises were commenced either immediately post-operatively or within the first six weeks. This was progressed to active or active-assisted ROM between four and 12 weeks, then to strengthening between two and three months. Return to work, previous recreational activities or sports were permitted between three and four months post-operatively for all but one study which permitted sport specific exercises starting six weeks post-operatively.¹⁶

Two additional studies were selected as they reported the results of surveys that asked surgeons for activity recommendations following RTSA.^{39,40} These are included separately in Table 2.

Post-operative complications

Five studies reported complications.^{17,30,31,39,40} Twenty-three complications were reported in a total of 203 patients (11.3%). The reported complications included dislocation, aseptic loosening and infection. None of the complications were reported to be a result of sports activities.

Patient expectations and satisfaction

One of the selected studies reported patient expectations for return to sport after RTSA, with no expectation to return to sport being noted in 27.5% of

Figure 1. PRISMA flowchart.

patients.³⁶ Kolling et al. reported that patient's rating of fulfilment of their expectation to practice sports after surgery was an average of 8.7 points (range 6–10 points).³³ Satisfaction with sports outcome following RTSA was rated high (86.3% and 88.2%) in two studies.^{32,34} Garcia et al. reported lower satisfaction with ability to return to sports in revision surgery patients.³²

Sports participation after RTSA

Return to sport rates ranged from 60% to 86%.^{16,17,30,32,34} Patients reported a reduced level of participation in 3–24% of cases in three of the included studies.^{17,30,32} Labriola and Edwards reported on 'senior athletes' where 100% ($n=4$) reported a decreased level of participation.¹⁶ Patients reported inability to return to sports such as swimming, tennis and skiing in 14–60% of cases.^{30–32}

Following RTSA, patients reported involvement in high demand activities/sports in 23–47% of cases and moderate activities in 24–49% of cases.^{31,35,36} The mean time to return to full sports was reported

to be 5.3 months in two studies^{32,34} and ranged from 7% to 86% of cases by 12 months in two studies.^{30,33}

Sport participation in older patients

All of the included studies looked at senior athletic or recreationally active populations.

Labriola and Edwards were the first to evaluate RTSA in the senior athlete.¹⁶ This was a small series of only four patients with over two years' follow-up. They found that three of the four returned to sport which included golf, tennis and weight lifting. All patients reported being unable to perform at their pre-operative level and half reported frequent limitations following RTSA.

Simovitch et al. reviewed 67 patients (mean age 73 years) who indicated that they played high or low impact sport before RTSA.¹⁷ The return to sport rate was 60% at mean follow-up of 43 months, with the most commonly undertaken activities being golf (75%) and swimming (29%).¹⁷ In contrast to Labriola and Edwards' findings, 45% of patients were

Table 1. Studies reporting sports and recreational activities after reverse shoulder arthroplasty.

Study	Population characteristics (<i>n</i> , mean age, gender)	Primary diagnosis	Activity level after surgery	Mean time to return to sport after surgery	Complications
Bulhoff et al. ³⁰	<i>n</i> = 21, 76.2 (65–85) years, 90% female	Gleno-humeral osteoarthritis and rotator cuff deficiencies	67% were able to return to the same sporting activity after surgery (no high impact sports), however 24% reduced frequency and 10% reduced level. 14% were unable to return to sport due to their shoulder (swimming, tennis and skiing).	Only 7% returned fully to sport by 12 months, which increased to 57% at more than 2 years. 29% were partially returned by 12 months.	3 complications including aseptic loosening and dislocation.
Fink Barnes et al. ³¹	<i>n</i> = 78, 75.3 (SD 7.5) years, 75% female	Cuff tear arthroplasty or revision procedure	23% high 49% moderate 28% low Additionally 21% reported being unable to return to activities of tennis, swimming, basketball and kayaking. 19% reported activities were limited by shoulder.	Not reported	10 complications including dislocation, aseptic loosening, dissociated glenosphere baseplate, deep and superficial infection.
Garcia et al. ³²	<70 years <i>n</i> = 18 ≥70 years <i>n</i> = 58, 74.8 (49–92), 66% female	Cuff tear arthroplasty, osteoarthritis or proximal humerus fracture, included revision procedure	85% restarted at least 1 sport, 60% reported discontinuation of 1 or more sports. Fitness sports had the highest rate of return 82%. Lower rates were seen in higher demanding sports (skiing, tennis). 48% returned to a higher intensity and longer duration post-op, 43% same duration and intensity, and 11% had to lower their duration and intensity. Patients <70 years had a higher rate of return to sports.	Average time to return was 5.3 months (range 1–36 months).	Not reported

(continued)

Table 1. Continued

Study	Population characteristics (n, mean age, gender)	Primary diagnosis	Activity level after surgery	Mean time to return to sport after surgery	Complications
Kolling et al. ³³	n = 166, 76.5 years, 60% female	Rotator cuff deficiency with osteoarthritis, including massive cuff tears and cuff tear arthropathy	Post-operatively the number of reported sport types declined. 9% of reported sport types could only be performed with limitations.	The majority (81%) of sporting activities were started within 6 months post-operatively. By 1 year, 86% were performing sports activities without limitations.	Not reported
Labriola and Edwards ¹⁶	n = 4 'senior athletes'	Gleno-humeral arthritis associated with massive cuff tear	3 of the 4 senior athletes were able to return to their preinjury sports.	Not reported	None
Liu et al. ³⁴	n = 75, 72.3 years, 68% female	Arthritis and rotator cuff dysfunction, proximal humeral fractures and rheumatoid arthritis	86% returned to sports post-operatively. Patients younger than 70 and surgery on the dominant limb had a higher return to sport rate. Fitness sports, swimming and cycling were the top sports patients returned to post-operatively. 86% reported a good to excellent sports outcome.	Average time to full return to sports was 5.3 months.	Not reported
Simovitch et al. ¹⁷	n = 67, 73 (61–88), 62% female	Osteoarthritis/rotator cuff tear, massive cuff tear and cuff tear arthropathy, includes revision	60% reported return to sport after surgery. 18% were able to perform sports at a higher level, 3% were worse, and 39% reported no change in ability.	Not reported	3 complications and 2 reoperations including stress fracture, infection and dislocation

(continued)

Table 1. Continued

Study	Population characteristics (n, mean age, gender)	Primary diagnosis	Activity level after surgery	Mean time to return to sport after surgery	Complications
Walters et al. ³⁵	n = 46, 68.5 (range 22–85) years, 63% female	Rotator cuff tear arthropathy or massive rotator cuff tear	<65 years (n = 17): 47% high 24% medium 29% low >65 years (n = 29): 44% high37% medium 19% low	Not reported	10 patients <65 were still requiring analgesic medication at mean 2.2 (1–3.7) years follow-up. 53% of <65 reported disability, whilst 0% >65 reported disability.
Wang et al. ³⁶	n = 51, 74.1 years, 52% female	Rotator cuff arthropathy or massive cuff tear	35% high 43% moderate 22% low demand	Not reported	Not reported
Wheelchair-dependent patients					
Alentorn-Gel et al. ³⁷	n = 18 (19 shoulders), 68 years, 50% female	Cuff tear arthropathy, osteoarthritis, previous cuff failure in TSA, or septic arthropathy (n = 1)	Patient satisfaction was rated excellent in 16%, satisfactory in 63% and unsatisfactory in 21% of patients.	N/A	3 complications including intrao- perative greater tuberosity fracture, post-operative ulnar neuropathy, and infection.
Kemp et al. ³⁸	n = 19 with follow-up only in 10 patients (12 shoulders), 71.9 (range 59–84) years, 80% female	Rotator cuff arthropathy or gleno-humeral osteoarthritis	Three patients excluded from follow-up due to early complica- tions. Of the remaining patients, 50% reported improvement in 'toileting', 70% reported normal function and one patient 'unable' to function. 75% reported that their shoulder was 'much better', 8% were 'better' and 17% were 'worse'.	N/A	3 patients failed RTSA with early disloca- tion; 1 patient had humeral stem loosening and periprosthetic frac- ture due to infec- tion; scapular notching was observed in 5/11 (45%) shoulders.

Table 2. Studies of surgeon recommendations following reverse shoulder arthroplasty.

Reference	Response rate, number of surgeons	Region	Allowed without limitations	Allowed with experience / limitations	Not allowed	Undecided	Time until maximum activity permitted
Golant et al. ³⁹	30%, 94	North America	Low impact sports (26%) High impact sports (4%) Contact sports (1%) Non-upper extremity sports (9%)	Low impact sports (46%) High impact sports (33%) Contact sports (17%) Non-upper extremity sports (42%)	Low impact sports (26%) High impact sports (63%) Contact sports (79%) Non-upper extremity sports (48%)	Low impact sports (2%) High impact sports (1%) Contact sports (3%) Non-upper extremity sports (1%)	Not reported
Magnussen et al. ⁴⁰	18%, 99	North America, Europe	Non-impact activities: jogging, running, walking, stationary bicycling, ballroom dancing	Light upper extremity involvement: low impact aerobics, golf, swimming, table tennis, hiking, road cycling, pilates	Sports with fall potential or high impact sports: tennis, basketball, football, soccer, ice skating, baseball, snowboarding, weightlifting, water skiing, volleyball, aerobics, martial arts, lacrosse, handball	Doubles tennis, downhill skiing, rollerblading, rowing, fencing, bowling	20% required >8 months 56% allowed after 5–7 months 22% allowed after 2–4 months

unable to return to sport or reported performing at a lower level post-operatively.¹⁷

Garcia et al. retrospectively reviewed 76 patients following RTSA, with 58 of these patients aged 70 years or older.³² In patients of all ages, 86% returned to at least one sport post-operatively at an average of 5.3 months. In the older subgroup, fitness sports had the highest return rate (82%), whilst lower rates of return were reported in higher demand sports such as singles tennis (62%) and golf (50%).

Bulhoff et al. retrospectively reviewed 38 patients who underwent RTSA for cuff tear arthropathy with a mean follow-up of 4.8 years.²⁰ Sixty-seven per cent of patients who participated in sports prior to surgery (mean age 76.2 years) were able to continue their usual sporting activities. Twenty-four per cent had to reduce their frequency of sporting activity and 10% had to reduce their level of intensity. The majority of patients required one year to fully return to sports. The most common sport undertaken was swimming (100%) with 57% returning to tennis and 50% returning to skiing and bowling.

Walters et al. reported on sports involvement after RTSA in patients aged over 65 years ($n=29$).³⁵ Sports were classified as high, medium or low demand activities as classified by Zarkadas et al.⁴¹ A low demand activity does not impose a repetitive stress on the shoulder and does not involve heavy lifting (i.e. stationary bike); a medium demand activity has a potential for repetitive stress and may involve lifting up to 20 lbs and occasional overhead activity (i.e. swimming and golf); and high demand activities involve repetitive stress, heavy loads (>20 lbs) and regular overhead movements (i.e. free weights and singles tennis). Walters reported that 44% participated in high demand activities, 37% in medium demand and 19% in low demand activities. None of the patients aged over 65 years reported any disability of their shoulder.

Wang et al. has retrospectively studied 51 RTSA patients (mean age 74.1 years) at mean follow-up of 29.5 months.³⁶ Mean Oxford Shoulder Score was 39.6 with 72% reporting good or excellent satisfaction levels. Thirty-five per cent of patients returned to high demand sporting activity and 43% returned to moderate demand activities. No sports related complications were reported. The association between isokinetic strength and activity level was also studied. Patients with greater strength in forward flexion and internal rotation were found to participate in higher demand sporting and recreational activity.

Sports participation in younger patients

Walters et al. reported on sports involvement after RTSA in patients aged younger than 65 years ($n=17$). Forty-seven per cent participated in high demand

activities, 24% in medium demand and 29% in low demand activities as classified by Zarkadas et al.⁴¹ Nine (53%) of the patients aged under 65 years reported a disability of their shoulder. It is noteworthy that 10 (59%) of these younger patients were still requiring analgesic medication at a mean 2.2 year follow-up.

Garcia et al. included younger patients in their study; however, they did not report overall rate of return to sport in this subgroup. Fitness sports participation increased following RTSA with seven patients participating post-operatively, compared to only five pre-operatively. Swimming had a return rate of 78%, singles tennis 75%, and golf 50%.

RTSA in wheelchair-dependent patients

Kemp et al. studied 19 wheelchair-dependent RTSA patients, with follow-up performed on 10 patients (12 shoulders) with a mean follow-up of 40 months and a diagnosis of rotator cuff arthropathy or gleno-humeral osteoarthritis.³⁸ Patients were advised to temporarily restrict activity and weight-bearing for a period of 12 weeks after surgery. Patient satisfaction following surgery was 83%. However, complications were common with dislocation and glenoid baseplate failure occurring in 21% (4/19) of cases, and scapular notching noted to occur in 42% (5/11) of patients.

Alentorn-Geli et al. performed RTSA in 18 wheelchair-dependent patients (19 shoulders).³⁷ The mean age was 68 years and mean follow-up was 36 months. Cuff tear arthropathy was the predominant diagnosis. The rate of mortality and morbidity was high during the post-operative follow-up period. Three complications were related to the shoulder and included intraoperative greater tuberosity fracture, post-operative ulnar neuropathy, and infection. X-ray revealed scapular notching in three cases. Patient satisfaction was rated excellent in 16%, satisfactory in 63% and unsatisfactory in 21%; however, all rated their shoulder as improved compared to the pre-operative level.

Discussion

There is a lack of consensus regarding recommendations to give patients about resuming sports after RTSA with scapular notching, accelerated polyethylene wear and premature implant loosening being of concern. This systematic review is focused on what we can learn from the currently available literature.

A unique prosthesis with unique problems

RTSA is associated with a unique set of post-operative complications which have raised concerns in patients returning to high levels of activity. A limitation of the

studies included in this systematic review is that few report complications, and only three of the included studies (including both wheelchair-dependent patient studies) performed radiographic evaluation.¹⁷

Particulate wear debris generated at the bearing surfaces can lead to periprosthetic osteolysis and aseptic implant loosening.⁴² RTSA has been shown to have a five-fold increase in volumetric wear rates when compared with anatomical TSA.⁴³ Patients undertaking a higher level of activity are more likely to develop prosthesis loosening in the midterm from accelerated polyethylene wear.^{44,45} These factors have potentially contributed to conservative return to sport recommendations.

Stress fractures of the acromion and scapular spine are uncommon following RTSA. Simovitch et al. reported one case of stress fracture.¹⁷ The incidence of scapular fracture following RTSA ranges between 3.1% and 10.2% of patients.^{46,47} They have been reported to occur between 2 and 62 months.^{46,47} These fractures are thought to be due to greater stress on the acromion from increased deltoid tensioning and loading from sporting activity. This complication is more of a concern with high activity levels in older patients with concomitant osteoporosis.

Few of the selected studies in our review reported scapular notching.^{37,38} First described by Sirveaux in 1997, notching is an osseous defect in the inferior scapular neck caused by impingement of the humeral component on the scapula during adduction of the arm, and may also be associated with osteolysis from polyethylene wear debris.^{48,49} The incidence of scapular notching has improved with newer prosthesis design and inferior placement of the glenoid baseplate.^{50,51} Levigne et al. found that notch incidence was higher in more active patients (74% compared with 64% for inactive patients).⁴⁹ Notching has also been shown to correlate with inferior clinical outcome and can lead to glenoid component loosening.^{4,52,53} This evidence suggests that patients with scapular notching should be advised to limit activities that involve adduction of the operated limb (i.e. racquet sports).

Surgeon opinions on post-operative activity

Golant et al. carried out a survey of 310 members of the American Shoulder and Elbow Society (ASES).³⁹ Seventy-four per cent of responders allowed some participation in sport following TSA. However, recommendations were dependent on the type of implanted prosthesis, with only 45.2% allowing return to sport after RTSA.

Magnussen et al. undertook an online survey of 99 North American and European surgeons' recommendations about type of sport after TSA.⁴⁰ The majority

of surgeons surveyed allowed low impact activities after RTSA. Higher demand upper extremity activities or those with a falls risk such as tennis, basketball and soccer were not allowed following RTSA by the majority of respondents.

Activity levels in the senior athlete following RTSA

Studies included in this review indicate that the return to sports rate in the older population following RTSA ranged from 60% to 86%.^{16,17,30,32,34} Return to non-contact and low demand sports is safe in this age group as already recommended by surgeons.⁴⁰ Recent evidence would now suggest that in the midterm, return to higher demand upper limb loading sporting activities such as tennis are also safe in this age group.^{32,34-36}

RTSA in the younger patient

There are currently few studies looking specifically at return to sporting activity in younger patients following RTSA.^{32,35} Younger patients can and do return to sports after surgery with Walters et al. reporting a higher rate of return to sports in patients aged less than 70 years compared to patients 70 years or over.³⁵ However, midterm data from the Australian Orthopaedic Association (AOA) National Joint Replacement Registry have reported higher rates of revision of RTSA in the 55-64 year age group compared to older patients (Figure 2).¹¹ Male patients are identified as a higher risk of revision in the midterm compared to female patients (Figure 3).¹¹ Longer term studies of younger patients playing sport are necessary with particular emphasis on radiographic evaluation of scapular scotching, osteolysis and implant loosening. Currently, we advise caution in recommending return to high demand sports following RTSA in the younger population.

Other considerations

Shoulder function in wheelchair or ambulatory aid users is essential to maintain independence and quality of life. These patients rely on their upper limbs for transferring, ambulation, and their shoulders becoming weight bearing joints, resulting in a high incidence of rotator cuff disease and arthropathy.⁵⁴ Studies by Alentorn-Geli et al. and Kemp et al. have found high levels of patient satisfaction in wheelchair users after RTSA.^{37,38} Scapular notching, accelerated polyethylene wear and premature implant loosening are concerns in wheelchair or ambulatory aid users. As with younger patients undergoing RTSA, we would recommend careful counselling outlining complication rates and

Figure 2. Australian Orthopaedic Association National Joint Replacement Registry data demonstrate higher RTSA revision rates in patients younger than 65 years irrespective of primary diagnosis. (a) Primary diagnosis OA, (b) primary diagnosis cuff arthropathy, (c) primary diagnosis fracture.¹¹

Figure 3. Australian Orthopaedic Association National Joint Replacement Registry data demonstrate higher RTSA revision rates in male patients irrespective of primary diagnosis. (a) Primary diagnosis OA, (b) primary diagnosis cuff arthropathy, (c) primary diagnosis fracture.¹¹

potential implant failure particularly with high demand sporting activities.

Conclusions

Reverse shoulder arthroplasty has been a reliable procedure that relieves pain and improves function. There are an increasing number of studies that evaluate the capability and safety for sport and recreational activity following RTSA. The majority of patients undergoing RTSA can return to sporting activity and can expect to do so within six months of surgery.

Low complication rates and encouraging prosthesis survival would suggest that it is safe for older athletes to return to medium and higher level sport in the mid-term, most likely due to a less competitive nature of sporting activity and self-regulation of activity in the older population.

In view of current evidence, we recommend caution in return to moderate and high demand sporting activity following RTSA in the younger population.

Patient expectations with regard to post-operative functional limitations and risk of re-operation must be addressed pre-operatively.

Longer term studies with subgroup analysis evaluating common recreational activities after RTSA are required, particularly in the younger population, in order to establish clear post-operative guidelines.

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