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Immediate versus delayed passive range of motion following total shoulder arthroplasty

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Background: The goal of this study was to compare immediate with delayed range of motion (ROM) following total shoulder arthroplasty (TSA). The hypothesis was that ROM gains would occur earlier with immediate motion but that there would be no difference in ultimate ROM or functional outcome.
Methods: Sixty patients were randomized to immediate motion (IM) or delayed motion (DM) following TSA. A lesser tuberosity osteotomy was performed in all cases. ROM and functional outcome were compared at 4 weeks, 8 weeks, 3 months, 6 months, and 1 year postoperatively.
Results: Compared with preoperative values, in the IM group, forward flexion improved from 106° to 141° at 1 year postoperatively, external rotation improved from 21° to 65°, and internal rotation improved by 2 spinal levels ($P < .05$). In the DM group, forward flexion improved from 104° to 144°, external rotation improved from 20° to 53°, and internal rotation improved by 4 spinal levels ($P < .05$). The 2 groups regained motion differently, but there were no significant differences in final ROM or functional outcome scores between the 2 groups. The IM group had higher functional outcome scores initially, but by 3 months postoperatively, there was no difference. The rate of osteotomy healing was 81% in the IM group compared with 96% in the DM group ($P = .101$).
Conclusion: Immediate ROM provides a more rapid return of function compared with a delayed ROM protocol following TSA. However, there are no differences in ultimate ROM or functional outcome between the 2 groups. Moreover, immediate ROM may lower the healing rate of a lesser tuberosity osteotomy.
Level of evidence: Level I; Randomized Controlled Trial; Treatment Study

Keywords: Shoulder arthroplasty; rehabilitation; lesser tuberosity osteotomy; delayed motion; passive motion; functional outcome

Total shoulder arthroplasty (TSA) is commonly used to treat primary glenohumeral arthritis and in most cases leads to substantial improvement in pain and function.[9] The number of shoulder arthroplasties is rapidly growing and expected to continue to increase in the years to come.[3] It is therefore important to optimize factors that contribute to a successful outcome.

Although there is consensus that rehabilitation is important following TSA, the ideal rehabilitation protocol has not been established. Many authors recommend immediate passive range of motion (ROM).[16] This protocol is typically based on the belief that immediate motion will decrease the chance

Institutional Review Board approval was obtained prior to initiation of the study.

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of postoperative stiffness. However, there is little evidence to support this protocol. Moreover, there may be downsides to early passive ROM such as subscapularis failure. To date, only one study has evaluated different rehabilitation protocols following TSA.[7] In this retrospective evaluation, patients who were immobilized in a sling for 6 weeks achieved higher forward flexion and abduction than patients who participated in immediate passive ROM.

The goal of our study was to evaluate 2 different rehabilitation protocols following TSA. The hypothesis was that ROM gains would occur earlier with immediate ROM but that there would be no difference in ultimate ROM or functional outcome.

Methods

Study design

A prospective, randomized controlled trial of patients undergoing anatomic (unconstrained) TSA was performed. The study was conducted by 2 surgeons (P.J.D. and A.L.). The inclusion criteria included primary glenohumeral arthritis treated with an anatomic TSA, age 40 to 85 years, and minimum follow-up of 1 year. The exclusion criteria included a full-thickness rotator cuff tear, a type C glenoid, concomitant glenoid bone grafting, previous surgery on the affected shoulder, and incomplete follow-up. Patients were prospectively randomized by a random number generator.

A power analysis was performed prior to enrollment and determined that a total of 34 patients were necessary to detect a 10° difference in ROM based on an SD of 10°. In addition, a total of 52 patients were necessary to detect a minimal clinically important difference of 6.4 points in the American Shoulder and Elbow Surgeons (ASES) score based on an SD of 8.[15] On the basis of this analysis, we enrolled 60 patients. Patients scheduled for a TSA who met the study criteria were invited to participate. Four patients refused to participate. Three patients in the immediate motion (IM) group and 2 in the delayed motion (DM) group were lost to follow-up, leaving 27 patients and 28 patients, respectively, available for analysis. Baseline characteristics of the patients are presented in Table I. There were no differences between the groups at baseline ($P > .05$).

Surgical technique

TSAs were performed by 2 surgeons using a consistent technique. A deltopectoral approach was used to expose the shoulder. The biceps underwent tenodesis to the pectoralis major tendon. A lesser tuberosity osteotomy was used to access the glenohumeral joint. The osteotomy was initiated at the bicipital groove with a saw blade and then completed with a curved osteotome. A 5-mm fleck of lesser tuberosity was taken such that the osteotomy entered the joint medially without violating the humeral head.[10,13] A complete release of the subscapularis tendon was performed, and then the humeral head was resected with a free-handed anatomic cut respecting native humeral head version and inclination. The humerus was prepared for placement of a short-stem press-fit component. The glenoid was then exposed, and an all-polyethylene glenoid was cemented into place (50 pegged components and 10 keeled components). Prior to placement of the humeral component, a 2-mm drill was used to create 3 holes in the bicipital groove and 2 holes at the medial aspect of the lesser tuberosity. Three No. 2 FiberWire sutures (Arthrex, Naples, FL, USA) were then passed through these holes; the superior suture passed only through the superior hole in the bicipital groove, whereas the middle and inferior sutures passed through both a medial hole and a hole in the bicipital groove. The humeral prosthesis was then impacted with the sutures passing posterior to the stem so as to encircle the prosthesis.[10] The osteotomy was repaired to native bone with these sutures. The repair was augmented with 1 to 2 sutures passing through the superolateral corner of the subscapularis tendon and the anterior supraspinatus, and the rotator interval was closed with 2 to 3 simple sutures.

Rehabilitation protocol

Postoperatively, patients were randomized to an immediate or delayed ROM protocol as follows: In the immediate ROM group (IM), a sling was worn for 4 weeks following surgery. On the first postoperative day, patients began passive forward flexion as tolerated with an overhead rope and pulley and passive external rotation to 30°

Table I Baseline characteristics

	Immediate ROM (n = 27)	Delayed ROM (n = 28)	*P* value
Mean age, y	69.1 (range, 52-85)	66.9 (range, 42-82)	.361
Sex, n			.227
M	12 (44%)	17 (61%)	
F	15 (56%)	11 (39%)	
Dominant arm, n	16 (59%)	15 (54%)	.671
Mean forward flexion (SD), °	106 (± 34)	104 (± 28)	.728
Mean external rotation (SD), °	21 (± 16)	20 (± 16)	.824
Mean internal rotation (SD)	L5	L5	.713
Mean VAS pain score (SD)	6.5 (± 1.5)	6.4 (± 2.2)	.679
Mean ASES score (SD)	34.0 (± 11.3)	39.4 (± 18.2)	.183
Mean SST (SD)	3.1 (± 2.2)	3.7 (± 2.6)	.518
Mean SANE score (SD)	32.7 (± 23.5)	38.2 (± 24.9)	.532

ASES, American Shoulder and Elbow Surgeons; *F*, female; *M*, male; *ROM*, range of motion; *SANE*, Single Assessment Numeric Evaluation; *SST*, Simple Shoulder Test; *VAS*, visual analog scale.