



## SHOULDER ARTHROPLASTY

# Home-based physical therapy results in similar outcomes to formal outpatient physical therapy after reverse total shoulder arthroplasty: a randomized controlled trial

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**Background:** Outcomes following reverse total shoulder arthroplasty (RTSA) are influenced by surgical indications, surgical technique, implant design, and patient variables. The role of self-directed postoperative physical therapy after RTSA is poorly understood. The purpose of this study was to compare the functional and patient-reported outcomes (PROs) of a formal physical therapy (F-PT) program vs. a home therapy program after RTSA.

**Methods:** One hundred patients were prospectively randomized into 2 groups: F-PT and home-based physical therapy (H-PT). Patient demographic variables, range of motion (ROM) and strength measurements, and outcomes (Simple Shoulder Test, American Shoulder and Elbow Surgeons, Single Assessment Numeric Evaluation, visual analog scale, and Patient Health Questionnaire-2 scores) were collected preoperatively and at 6 weeks, 3 months, 6 months, 1 year, and 2 years postoperatively. Patient perceptions regarding their group assignment, F-PT vs. H-PT, were also assessed.

**Results:** Seventy patients were included for analysis, with 37 in the H-PT group and 33 in the F-PT group. Thirty patients in both groups had a minimum of 6 months' follow-up. The average length of follow-up was 20.8 months. Forward flexion, abduction, internal rotation, and external rotation ROM did not differ between groups at final follow-up. Strength did not differ between groups with the exception of external rotation, which was greater by 0.8 kilograms-force (kgf) with F-PT ( $P = .04$ ). PROs at final follow-up did not differ between therapy groups. Patients receiving home-based therapy appreciated the convenience and cost savings, and the majority believed home therapy was less burdensome.

**Conclusion:** Formal physical therapy and home-based physical therapy programs after RTSA result in similar improvements in ROM, strength, and PRO scores.

**Level of evidence:** Level I; Randomized Controlled Trial; Treatment Study

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Since US Food and Drug Administration approval of reverse total shoulder arthroplasty (RTSA) in November 2003, the population-adjusted incidence has grown to 9.3 cases/100,000 (62,705 procedures).<sup>2</sup> RTSA outcomes demonstrate substantial improvements in function and pain relief, with a survival rate >90% at 10 years.<sup>8</sup> Outcomes and survivorship are frequently influenced by surgical indications, surgical technique, implant design, and patient variables.<sup>8</sup> One area that may impact outcomes but has generally been overlooked is postoperative rehabilitation with physical therapy.

Physical therapy has long been considered important for optimal patient outcomes, often achieved through a progressive and graduated program that consists of range of motion (ROM) and strengthening exercises.<sup>7,16</sup> Restoration of shoulder ROM and strength has been shown to be essential for good functional outcomes and patient satisfaction following anatomic total shoulder arthroplasty (ATSA).<sup>13</sup> Physical therapy guidelines for RTSA have been derived from those applied to patients undergoing rotator cuff repair and ATSA.<sup>15</sup> However, the concerns postoperatively for ATSA and RTSA may be different given the implant designs and function, as well as operative soft-tissue management.<sup>12</sup> Given that RTSA changes the biomechanics of the shoulder joint by shifting the moment arms and changing the muscular length-tension relationship to the deltoid, postoperative rehabilitation goals and limitations differ for ATSA and RTSA.<sup>5</sup> Likewise, RTSA has an inherent concern of early-stage dislocation owing to prosthesis design that may prevent the accelerated mobilization noted in some total shoulder arthroplasty rehabilitation protocols.<sup>9</sup>

With increasing focus on maximizing value in health care, it is important to assess the utility of a home-based physical therapy program compared with formal physical therapy after RTSA. Numerous studies have attempted to provide a consensus on rehabilitation guidelines following RTSA.<sup>3,5,7,10,15</sup> However, no study has evaluated the necessity of formal in-person physical therapy.

The purpose of this study was to compare patient-reported outcome (PRO) scores and functional scores (ROM and strength) of a formal physical therapy–led rehabilitation program vs. a patient-led home therapy program after RTSA. Our hypothesis was that formalized therapy by a trained physical therapist would result in superior PROs and functional scores compared with home-based, patient-directed therapy.

## Methods

Patients undergoing primary RTSA performed by 2 surgeons (E.W.B. and B.A.P.) were recruited from January 2018 to January 2021. All patients received the Ascend Flex prosthesis by Tornier (Edina, MN, USA) and underwent subscapularis repair. As no prior studies have assessed the role of therapy in

RTSA outcomes, we selected a minimal clinically important difference in the American Shoulder and Elbow Surgeons (ASES) score of 15 points as the anticipated difference between the groups.<sup>14</sup> Power analysis calculations required 30 patients in each group to detect a difference with 80% power and  $\alpha = 0.05$ . The inclusion criteria were adults undergoing primary RTSA performed by one of the participating surgeons (E.W.B. or B.A.P.). Non-English-language speakers, minors (age <18 years), pregnant women, members of prison populations, patients with acute shoulder fractures, and patients unable to provide informed consent were excluded.

Patients undergoing RTSA and meeting the inclusion and exclusion criteria who agreed to participate in the study were randomized into 2 groups based on a randomized sequence generated prior to trial initiation: The formal physical therapy (F-PT) group received formal physical therapy, whereas the home-based physical therapy (H-PT) group was given a list of activities that were allowed for self-rehabilitation. Preoperative assessment included completion of the following PRO surveys: Simple Shoulder Test (SST), ASES Shoulder Score, Single Assessment Numeric Evaluation (SANE), visual analog scale (VAS), and Patient Health Questionnaire-2. Additionally, preoperative ROM and strength testing was performed with a goniometer.

At the treating academic institution, F-PT participants received formal physical therapy based on the protocol described by Boudreau et al<sup>3</sup> involving 4 phases and totaling 26 weeks (Table 1). The patients randomized to H-PT were allowed to complete the same rehabilitation regimen at home without the guidance of a physical therapist. Following surgery, physical therapy was initiated within 1 week, with advancement in phases through strength and ROM exercises.

Postoperatively, patients were seen at standard intervals: 2 weeks, 6 weeks, 3 months, 6 months, and 1 year. ROM and strength testing was repeated at the 6-week, 3-month, 6-month, and 1-year follow-up visits. Similarly, at each of these time intervals, patients repeated the PRO assessments (SST, ASES Shoulder Score, SANE, VAS, and Patient Health Questionnaire-2 [PHQ-2]). At the completion of patients' physical therapy or final follow-up, patients were given a physical therapy survey to assess their satisfaction with physical therapy. Data on the number of visits attended, ease of completing or attending therapy, time frame to pain improvement, need for family assistance, and overall benefits were collected by researchers blinded to treatment allocation.

## Results

A total of 100 patients were enrolled in the study, and 70 were included for analysis, with 37 in the H-PT group and 33 in the F-PT group (Fig. 1). The average follow-up time was 20.8 months. In total, 30 patients were excluded (19 cancelled surgery, 8 were lost to follow-up, and 3 required RTSA for acute fractures) (Fig. 1).

### Demographic characteristics

Most patients were women (76.5%). The average age was 67.1 years. Patient demographic characteristics, including

**Table I** Physical therapy regimen for F-PT and H-PT

	Activity	Restrictions
Phase 1		
1-4 weeks	Limited shoulder ROM Pendulum exercises	Sling worn at all times Avoidance of excessive forward flexion, abduction, internal and external rotation
5-6 weeks	Passive ROM exercises Rhythmic stabilization	Sling use as needed Avoidance of external rotation in extension
Phase 2		
7-12 weeks	Mild resistive exercises (water resistance)	Sling use discontinued Avoidance of pain generating activity
Phase 3		
13-16 weeks	Continued strength exercises ROM activities as tolerated	Avoidance of ballistic motions (boxing, jackhammer, chopping wood, and so on)
Phase 4		
17-26 weeks	Shoulder strengthening exercises Full functional activity exercises	
≥27 weeks	Overhead lifting up to 11.3 kg (25 lb)	

*F-PT*, formal physical therapy; *H-PT*, home-based physical therapy; *ROM*, range of motion.

Phase 1 (weeks 1-6) consists of early healing of the capsule while decreasing shoulder pain and inflammation. The patient should only move the shoulder without causing any pain. He or she should not lift any weights or perform any resistance exercises. The patient should avoid shoulder motion behind the back, lifting the arm straight to the side or to the front, and lifting the hand to the back of the head or neck. In weeks 1-4, we advise use of a sling at all times and no shoulder ROM; in particular, extension and external rotation should be avoided. Therapy focuses on elbow and wrist ROM and gripping and pendulum exercises. Ice can be used for pain, and when lying down, the patient uses a pillow under his or her arm to support the shoulder. In weeks 5-6, rope-and-pulley, rhythmic stabilization, and passive ROM exercises are initiated. Phase 2 (weeks 7-12) includes the previous goals along with gradually increasing functional activity. The shoulder should be moved as tolerated, and mild resistance exercises (water resistance) may be performed. The patient should not be wearing a sling. In weeks 7-8, the exercises of phase 1 are continued and the patient adds active assisted ROM exercises focusing on supine external and internal rotation in the scapular plane and isometrics. Weights and resistive exercises should still be avoided. In weeks 9-12, there is a progression of passive and active assisted ROM exercises, with the addition of active ROM, gentle deltoid strengthening, and pool exercises. Phase 3 (weeks 13-16) consists of continued improvement in strength and ROM and increased functional activities with decreasing pain. It includes the aforementioned exercises with the initiation of a fundamental shoulder program. The shoulder should be moved as tolerated, and resistance exercises can be performed as tolerated. Phase 4 includes weeks 17-26 and has the goal of improving strength of the shoulder musculature, increasing functional activities, and initiating an independent home exercise program. The patient continues fundamental shoulder exercises, may continue pool exercises, and may initiate an interval sport program with the approval of the physician. Permanent restrictions of not lifting >11.3 kg (25 lb) overhead and not performing any ballistic motions (boxing, jackhammer, chopping wood, and so on) are followed.

body mass index, dominant arm, operative arm, and American Society of Anesthesiologists classification, were similar between the H-PT and F-PT groups. Additionally, time to final evaluation was similar between groups (Table II).

### ROM and strength

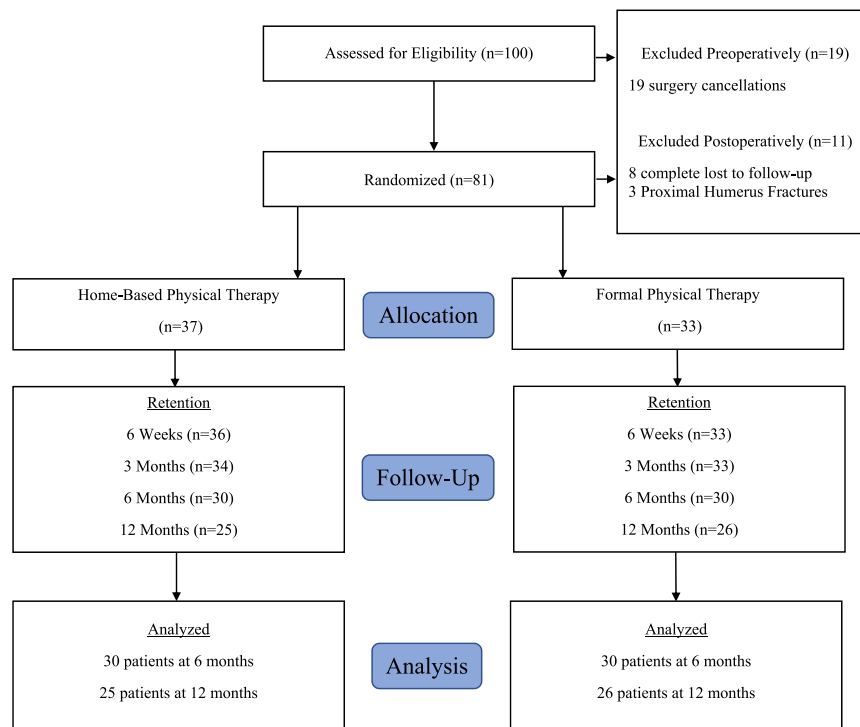
Baseline ROM and strength measurements were similar between groups at baseline assessment. Forward flexion, abduction, and external rotation ROM increased in both groups by latest follow-up ( $P = .01$ ) but did not differ between groups at the final time point (Table III). At latest follow-up, forward flexion strength, abduction strength, and internal rotation strength did not significantly differ between groups (Table III). The only exception was external rotation strength, which was 0.8 kilograms-force (kgf) greater in the F-PT group ( $P = .04$ ) (Table III).

### PRO measures

All baseline PROs (SST, ASES, SANE, and VAS scores) were similar between groups and significantly improved at the final assessment in both groups ( $P < .001$ ). Final PROs did not significantly differ between treatment groups (Table IV).

### Free-response surveys

In both groups, patients were satisfied with the therapy they received. The large majority of F-PT patients (92.5%) and H-PT patients (82%) stated that they would choose their respective physical therapy modalities again if given the option. However, F-PT patients less frequently reported family assistance with therapy (28.4%) than did H-PT patients (51.5%) ( $P = .003$ ). Despite this, most H-PT patients (93%) believed that home therapy would be less burdensome on their families than formal physical therapy.



**Figure 1** PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) flowchart.

**Table II** Patient demographic characteristics

	F-PT	H-PT	P value
Patients, n (preoperatively)	31	37	
Sex			
Male	8 (25.8)	8 (21.6)	.630
Female	23 (74.2)	29 (78.4)	
Age, yr	67.8 ± 9.8	66.5 ± 10.2	.458
Operative arm			.818
Right	17 (54.8)	22 (60.5)	
Left	14 (45.2)	15 (39.5)	
Dominant arm			.794
Right	29 (93.5)	34 (91.9)	
Left	2 (6.5)	3 (8.1)	
BMI	32.7 ± 7.3	31.4 ± 6.4	.323
ASA classification			.506
2	6 (19.4)	11 (29.7)	
3	25 (80.6)	26 (70.3)	
4	0 (0)	0 (0)	
Follow-up, d	305 ± 145	296 ± 155	.815

F-PT, formal physical therapy; H-PT, home-based physical therapy; BMI, body mass index; ASA, American Society of Anesthesiologists; SD, standard deviation.

Data are presented as number (percentage) or mean ± standard deviation.

When patients were asked about the benefits of their respective group, the most common responses of F-PT patients were physical therapists' expertise and advice (33%), program structure and oversight (16%), and

therapist motivation (10%). Patients in the H-PT group appreciated the convenience of performing home therapy (64%) and the cost savings from travel (22%) and formal therapy (5%).

**Table III** Postoperative ROM and strength

	Preoperative	Latest follow-up	Change from preoperative to latest follow-up	<i>P</i> value
<b>ROM</b>				
Forward flexion, °				
F-PT	76 ± 34	107 ± 34	31.9	.001*
H-PT	86 ± 36	113 ± 25	26.3	.004*
<i>P</i> value	.313	.779		
Abduction, °				
F-PT	69 ± 23	101 ± 28	31.9	<.001*
H-PT	82 ± 31	104 ± 24	21.7	<.001*
<i>P</i> value	.092	.759		
External rotation, °				
F-PT	26 ± 16	40 ± 17	13.8	.003*
H-PT	23 ± 13	42 ± 24	18.8	<.001*
<i>P</i> value	.279	.864		
Internal rotation				
F-PT	L4/L5	L4/L5		.236
H-PT	L4/L5	L4/L5		.771
<i>P</i> value	.734	.306		
<b>Strength, kgf</b>				
Forward flexion				
F-PT	1.9 ± 2	3.2 ± 1.8	1.3	.003*
H-PT	2.0 ± 1.6	2.5 ± 1.3	0.5	.064
<i>P</i> value	.712	.216		
Abduction				
F-PT	1.7 ± 1.7	2.5 ± 1.4	0.8	.004*
H-PT	2.0 ± 1.6	2.2 ± 1.1	0.2	.106
<i>P</i> value	.701	.402		
External rotation				
F-PT	2.1 ± 1.1	3.3 ± 1.6	1.2	.002*
H-PT	2.1 ± 1.3	2.5 ± 1.6	0.4	.399
<i>P</i> value	.892	.037*		
Internal rotation				
F-PT	3.4 ± 1.9	3.8 ± 2.4	0.4	.689
H-PT	3.5 ± 2.1	3.1 ± 1.4	-0.4	.738
<i>P</i> value	.868	.259		

ROM, range of motion; F-PT, formal physical therapy; H-PT, home-based physical therapy; kgf, kilograms-force.

\* Statistically significant ( $P < .05$ ).

## Discussion

Formal therapy and home-based therapy after RTSA resulted in similar postoperative improvements in the ASES score at 1 year. Additionally, other PRO scores, as well as strength, ROM, and pain, were similar between home-based therapy and formal physical therapy. Home-based physical therapy may result in greater convenience for the patient in addition to cost savings.

Physical therapy remains important to recovery following shoulder surgery. Numerous studies have demonstrated that physical therapy aids in guiding patients through the recovery period and improving functional outcomes, highlighting the importance of access to therapy following surgical intervention. Home-based physical therapy and traditional physical therapy in hip<sup>1</sup> and knee<sup>4</sup>

arthroplasty have demonstrated comparable outcomes. In shoulder arthroplasty, previous retrospective studies have found that improvements in PRO measures, ROM, and patient satisfaction were statistically similar between formal physical therapy and home-based physical therapy after ATSA.<sup>6,11</sup> No study has evaluated PRO measures after RTSA in a prospective randomized trial. Our study evaluated such outcomes prospectively after RTSA in a randomized fashion and similarly found that the 2 groups had similar ROM, strength, and PROs.

Free-response feedback from each group allowed insight into the patients' thoughts and perspective on the benefits of home-based vs. formal physical therapy regimens. F-PT patients appreciated the motivation and expert guidance of formal in-person physical therapy. H-PT patients unanimously mentioned the convenience and cost savings of

**Table IV** Improvements in postoperative patient-reported outcomes

	Preoperative	Latest follow-up	Change from preoperative to latest follow-up	<i>P</i> value
<b>SST score</b>				
F-PT	4.3 ± 2.8	8.6 ± 2.6	4.3	<.001*
H-PT	3.8 ± 3.3	8.3 ± 3.1	4.5	<.001*
<i>P</i> value	.305	.794		
<b>ASES score</b>				
F-PT	31.3 ± 17.0	70.4 ± 20.9	39.1	<.001*
H-PT	32.2 ± 16.1	65.0 ± 24.8	32.8	<.001*
<i>P</i> value	.995	.445		
<b>SANE score</b>				
F-PT	43.1 ± 23.6	74.2 ± 18.4	31.1	<.001*
H-PT	41.8 ± 22.5	71.7 ± 25.1	29.9	<.001*
<i>P</i> value	.884	.879		
<b>VAS score</b>				
F-PT	7.1 ± 2.5	2.7 ± 2.8	−4.4	<.001*
H-PT	7.2 ± 2.3	3.5 ± 2.9	−3.7	<.001*
<i>P</i> value	.924	.169		

SST, Simple Shoulder Test; F-PT, formal physical therapy; H-PT, home-based physical therapy; ASES, American Shoulder and Elbow Surgeons; SANE, Single Assessment Numeric Evaluation; VAS, visual analog scale.

\* Statistically significant ( $P < .05$ ).

home therapy. Free-response feedback also indicated that both groups had high levels of satisfaction with the assigned physical therapy modality. Shared decision making should focus on patient preference for cost savings vs. increased guidance because both modalities are well tolerated and produce similar outcomes.

Health care institutions, health care providers, and insurers must weigh the reduction of financial expenditures against the potential for negative patient outcomes. In patients undergoing ATSA and RTSA, Wagner et al<sup>17</sup> found that privately insured patients utilized physical therapy more than Medicare patients. The cost of physical therapy following rotator cuff repair for Medicare patients was \$1221, with only 37% of physical therapy-related expenses covered by Medicare. Given the potential financial impact of formal physical therapy on patients and health care institutions, patient insurance status plays a critical role in postoperative decision making and physical therapy standardization. Our study demonstrates that a home-based physical therapy program does not lead to poorer outcomes.

This study is not without limitations. Physical therapy protocols following RTSA are numerous, and the results of this study may not be applicable to other protocols at home and in person. Our study exclusively used 1 prosthesis in addition to subscapularis repair, which may limit generalizability to other RTSA implant designs and surgical techniques. The PRO measurements during the initial 6 weeks should be understood within the context of the postoperative constraints. Although our study reports ROM, strength, and PROs, it should be noted that our study was not specifically powered to detect differences in ROM or

strength between groups and it may be underpowered to detect differences related to these endpoints. There was a high rate of loss to follow-up and a small sample size. However, the study did take place during the COVID-19 pandemic. Post hoc statistical analysis found that our study's 6- and 12-month follow-up was moderately underpowered for strength and ROM outcomes. Additionally, this study excluded RTSA for acute shoulder fracture and revision surgery; thus, our findings should not be extrapolated to such populations.<sup>14,18</sup> The strengths of this study include the randomized and prospective nature of the study and the inclusion of patients treated at a single institution.

## Conclusion

Formal physical therapy and home-based physical therapy programs after RTSA result in similar improvements in ROM, strength, and PRO scores.

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## Supplementary Data

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