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Patterns Of Limitations In Activities Of Daily Living, Sleep, And Pain In The Early Postoperative Period Following Total Shoulder Arthroplasty: A Prospective Study

Running Title: Limitation of ADL following Total Shoulder Arthroplasty

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1 **BACKGROUND:** The aim of this study is to investigate the pattern of changes in activities of
2 daily living (ADLs), sleep disturbance, and pain in the early postoperative period following a
3 total shoulder arthroplasty (TSA).

4 **METHODS:** Prospective data on patterns of limitation in ADLs, sleep disturbance, and pain
5 were collected from patients undergoing elective TSA preoperatively and at specific time points
6 postoperatively (2, 6, and 12 weeks). At each time point, patients were asked regarding the major
7 limitation affecting their shoulder. Limitations in ADLs and sleep disturbances were scored on a
8 3-point scale (0 = unable to do, 3 = no difficulty) modeled after the ADLER score and VAS
9 scores were used for pain. Patient responses were analyzed with respect to patient factors
10 (demographics, arm dominance, function of opposite arm, and ambulation status), and living
11 situation (alone, or with caregiver).

12 **RESULTS:** Shoulder pain (43%), and inability to perform ADLs (38%) were the two
13 most common reported limitations prior to undergoing total shoulder arthroplasty. Patient's
14 noticed progressive improvements in pain with 37% reductions in VAS scores at 2 weeks and
15 67% reduction at 3 months. At 2 weeks after TSA, sleep disturbances were the most disabling
16 issue in 33% of the cohort, with considerable improvements (104%) in sleep scores at 3 months
17 compared to preop. The ADLs involving forward elevation and working at the waist level
18 improved considerably between 6 weeks and 3 months but activities involving rotation including
19 reaching behind the back, across the chest and use of strength showed mild improvements by 3
20 months.

21 **DISCUSSION/CONCLUSION:** This prospective study demonstrates the chronology of
22 improvements in pattern of limitations experienced by patients with respect to pain, sleep and
23 ADLs in the early postoperative period after TSA. Majority of patients can expect to have 2/3

24 resolution of pain, improved sleep and improvement in ADLs involving forward elevation and
25 waist level function by 3 months.

26 **Keywords** Activities of Daily Living ;total shoulder arthroplasty; reverse shoulder arthroplasty;
27 shoulder pain; sleep disturbances; Visual Analogue Scale

28 **Level of Evidence: Level IV; Case Series; Treatment Study**

29 Total shoulder arthroplasty (TSA) is a successful surgical treatment for end stage primary
30 and secondary shoulder arthritis. The primary objectives of shoulder arthroplasty are to reduce
31 pain, restore function, and improve the quality of life. Numerous studies have demonstrated
32 long-term improvements in these parameters compared to baseline (preoperative) after total
33 shoulder arthroplasty^{3,6}.

34 Although short, mid and long-term outcomes of TSA have been extensively published, there is
35 limited literature on the chronological pattern and extent of limitations incurred with respect to
36 postoperative pain, sleep disturbances and ADL limitations in first few months after total
37 shoulder arthroplasty. There are substantial dynamic improvements and changes that occur
38 during the first several weeks after TSA with respect to pain relief, sleep cycle changes, and
39 ability to perform activities of daily living (ADLs). During this time patient's interaction with the
40 surgeon are more frequent and questions regarding recovery are more common. Although
41 improvements in outcomes scores and pain scores during the early postoperative period are
42 helpful for patients to understand the big picture of their recovery, it has been our observation
43 that information about chronology of improvements in pain and function are lacking. Prior
44 studies have focused on characterizing improvements in shoulder specific outcomes after TSA
45 but these outcome scores do not take into consideration important limitations specific to ADLs,
46 sleep disturbances and extent of pain relief in the first several weeks after shoulder

47 arthroplasty^{1,5,11,12}. Therefore, the purpose of this study is to prospectively examine the pattern of
48 self-reported improvements (chronological, and objective) with respect to activities of daily
49 living (ADL), sleep changes, and pain in the early postoperative period (first 3 months) after
50 TSA.

51 **METHODS:**

52 In this prospective study from September 2018 to May 2019, consecutive patients who
53 underwent total shoulder arthroplasty (anatomic or reverse) by one of three fellowship trained
54 orthopedic surgeons were included in the study. Patients were included in the study if they were
55 over 18 years of age, undergo either anatomic or reverse total shoulder arthroplasty, and have
56 follow-up visits at the 2 weeks, 6 weeks, and 3 months. Patients were excluded if the arthroplasty
57 indication was acute fracture or if they were unable or unwilling to complete the study
58 questionnaire.

59 Each patient gave informed consent and completed a questionnaire preoperatively and at
60 the 2-week, 6-week, and 3-month postoperative time points assessing the level of daily and
61 athletic activity, sleep disturbances, and level of pain following shoulder arthroplasty. The
62 questionnaire included demographics (gender, marital status, race, ethnicity, employment status,
63 occupation, yearly income, and living situation), pain scores, operative information, and
64 questions regarding activities of daily living (ADLs). These included clothing related activities
65 (5 questions), personal hygiene activities (5 questions), food preparation (4 questions), household
66 activities (4 questions), general mobility (4 questions), and general activities (3 questions).
67 Patient responses to the ADLs questions were scored on a 3-point scale ranging from a lower
68 functioning (0 = unable to do) to a higher functioning (3 = no difficulty) level modeled after the
69 ADLER score^{2,4}. A total of 25 different activities were assessed, leading to a maximum possible

70 score of 75 points. Sleep disturbances were grouped into one or more of the following: difficulty
71 in falling sleep, interrupted sleep and reduced sleep time and scored on a 3-point scale ranging
72 from a 0 (unable to do) to a 3 (no difficulty) level. The patients also self-identified the most
73 significant limitation at each time point starting from preoperatively and postoperatively at 2
74 weeks, 6 weeks, and 3 months. All data from the questionnaires was collected and stored
75 securely using REDCap (Vanderbilt University; Nashville, TN, USA).

76 Response data were tabulated for the entire study group including both numerical data
77 and respondent written answers. Data was divided into subgroups based on time of follow-up at
78 2 weeks, 6 weeks, or 3 months. The data was further subdivided categorically based both on the
79 aforementioned activity groups in the ADLs as well as by primary motion required (forward
80 flexion, abduction, extension, external rotation, internal rotation). Additional subdivisions were
81 made dependent on whether the patient underwent an anatomic total shoulder arthroplasty or a
82 reverse total shoulder arthroplasty.

83 **Surgical details**

84 During the defined study period patients with primary or secondary arthritis that were indicated
85 for TSA (anatomic or reverse) were included in the study. All patients underwent TSA via a
86 deltopectoral approach. In the anatomic TSA (aTSA), subscapularis tenotomy was performed in
87 all cases and repaired at the end of the procedure. Three different anatomic implant types (DJO
88 Inc, Vista, CA, USA; Exactech Inc. Gainesville, FL, USA; and Tornier Inc., Bloomington, MN,
89 USA) were used by the surgeons. For reverse total shoulder arthroplasty, subscapularis tenotomy
90 was performed when subscapularis was intact or partially torn. The tenotomy was repaired at the
91 end of procedure unless it was not reparable. Both inlay (DJO Inc.) and onlay (Exactech Inc. and
92 Tornier Inc.) designs implants were used by the surgeons.

93 **Postoperative immobilization and rehabilitation**

94 The arm was placed in a sling for 4-6 weeks in patients that underwent aTSA. For rTSA the
95 sling use varied as per surgeon's preference (2 weeks versus 6 weeks). Physical therapy was
96 started on all TSAs on day 1 after surgery. Total shoulder arthroplasty precautions were followed
97 in a similar fashion for all shoulder arthroplasties for at least 6 weeks

98 In this study the primary outcome of interest is the pattern of restoration of the ability to
99 complete activities of daily living (ADLs) following total shoulder arthroplasty. This was
100 represented using two novel clinical outcome indexes, the Total ADLs Score (TADLS) and the
101 Percentage Adjusted ADLs Score (PAADLS). Subgroup analysis was performed to assess
102 patient's ability to perform a subset of activity type, giving insight on when patient can return to
103 normal function. The statistical analysis was performed using R studio (R Studio; Boston, MA,
104 USA).

105 **RESULTS:**

106 *Patient characteristics:*

107 This study included a total of 154 patients, all of whom met the aforementioned inclusion
108 and exclusion criteria. Of these patients, 154 completed the preoperative survey, 105 completed
109 the 2-week survey, 105 completed the 6-week survey, and 101 completed the 3-month survey.
110 The cohort was split almost evenly by gender (51% female, 49% male), and 60% were retired
111 (**Table 1**). The patients' mean age was 67 years (Standard Deviation [SD], 10.0 years; Range,
112 38-88 years).

113 The preoperative questionnaire was completed by 154 patients prior undergoing either
114 anatomic or reverse total shoulder arthroplasty. Of the 105 patients that completed the 2 week
115 postoperative questionnaire underwent 81 aTSA and 24 rTSA. There were no significant

116 differences in preoperative ADL scores with respect to gender, (males [51.8] and females [43.8])
117 race, marital status, arm dominance, and ethnicity. Employment, was one factor that showed to
118 affect ADL scores. Patients who were retired and unemployed had a significantly lower ADL
119 scores compared to patients who were employed either full time or part time or self-employed.
120 Patients in the lowest income bracket of less than 25,000 of annual income were shown to have
121 statistical impactful lower ADL scores compared to patients with higher annual income ($p=0.03$).
122 Patients who were operated on their right arm ($p=0.05$) and had higher preoperative VAS pain
123 scores had significantly lower preoperative ADL scores ($p=0.03$).

124 Pattern of Limitations of shoulder pain

125 Preoperatively pain was the most common complaint with 43.5% of patients reporting
126 pain as the sole reason to undergo total shoulder arthroplasty. At the 2-week postoperative period
127 there was 37 % reduction in pain from preoperative baseline pain with only 16% patients
128 reporting pain as most disabling symptoms. The VAS scores demonstrated 59 % reduction at 6-
129 week and 67 % reduction at 3-month time point (**Figure 1**)

130 Pattern of Limitations of Sleep

131 Preoperatively, 13% of the cohort complained of sleep disturbances as primary
132 complaint, and this number actually peaked postoperatively to 33% at 2 weeks and subsequently
133 decreased to 26 % at 6 weeks and 21 % of the cohort at 3 months. The sleep score demonstrated
134 gradual improvement postoperatively compared to preoperative score with 72% improvement at
135 6-week time point and 104% improvement at 3-month time point (**Figure 2**)

136 Pattern of Limitations of ADL

137 Prior to surgery, approximately 39% of the patients reported inability to perform
138 activities of daily living as the major complaint secondary to shoulder arthritis and this

139 proportion of cohort did not show any appreciable change at 2-week (5% reduction) and 6-week
140 (3% reduction) after shoulder arthroplasty. However, there was a considerable improvement (34
141 % reduction) in these limitations at 3 months after TSA. The mean ADL score improved to 61 at
142 3 months from a preoperative score of 47 (**Figure 4**).

143 The mean functional score improved from 1.59 preoperatively to 2.23 (70% increase) at 3
144 months, with specifically a 19 % and 23% improvement in activities performed at work and
145 while taking part in hobbies, respectively (**Figure 3**).

146 The ADL scores related to clothing tasks showed a similar trend with gradual
147 improvement by 10% and 19% at 6 weeks and 3 months respectively. The subgroup analysis
148 demonstrated that most difficult task reported by the cohort was putting on a shirt with an
149 average score of 1.70, which improved to 1.84 and 2.27 at 6 weeks and 3 months, respectively
150 (**Figure 4**).

151 The ADL scores related to personal hygiene showed a decrease at 2-week time point but
152 there was considerable improvement in this score at the 6 weeks (18.7% improvement) and 3
153 months (41.2% improvement) time points. However, patients consistently demonstrated
154 difficulty reaching the opposite shoulder/arm pit, and reaching behind the back during activities
155 of personal hygiene at 3 months (**Figure 4**).

156 The ADL scores related to the food preparation demonstrated a 36% reduction at 2 weeks
157 after surgery compared to preoperative scores. At the 6-week time point, the majority of patients
158 reported restoration to preoperative function and at 3 months there was 16.8% further
159 improvement compared to preoperative scores. Opening a tight jar was the most difficult task
160 reported by the cohort preoperatively and at 3 months (**Figure 4**). The ADL scores focused on
161 the ability of patients to complete household tasks demonstrated a 41% improvement at 3

162 months. Reaching up to a high shelf was reported as the task with most limitation in the forward
163 plane of the shoulder preoperatively with moderate overall improvement in this task at 3 months
164 (**Figure 4**). With respect to the ADLs related to general mobility, getting out of bed or chair and
165 going up and down the stairs showed minimal limitations preoperatively and postoperatively
166 (**Figure 4**).

167 **DISCUSSION:**

168 In this prospective cohort study, we describe the chronology of improvements that occur
169 with regards to pain, sleep disturbances, and performing ADLs in the first three months
170 following a total shoulder arthroplasty. We found that pain with or without limitations in ADLs
171 was the most common preoperative reason to undergo shoulder arthroplasty. Postoperatively,
172 patients can expect a 2/3 reduction in their pain in first 3 months of recovery with some residual
173 sleep disturbances at 3 months. The ADLs involving forward elevation (reaching shoulder level
174 shelf in the forward plane), general mobility and working at the waist level (food preparation)
175 improves considerably at 3 months but activities involving rotation including reaching behind the
176 back, and across the chest and activities involving use of strength show mild improvements by 3
177 months.

178 Total shoulder arthroplasty has shown good-excellent short and long-term outcomes for
179 treatment of shoulder arthritis with considerable improvements in pain and functional outcome
180 scores. There are considerable improvements that occur during the first several weeks after total
181 shoulder arthroplasty with respect to pain relief, sleep cycle changes, and ability to perform
182 activities of daily living (ADLs) but chronology and frequency of these limitation and
183 improvements are less well described in literature. In this prospective study, we investigated the

184 challenges experienced by patients during first 12 weeks after TSA. We believe that this data
185 will serve as a resource for counseling patients, as to what to expect in first 3 months after TSA.

186 It is important to note that chronology and extent of pattern of limitations after shoulder
187 arthroplasty are not identical compared to after rotator cuff repair or instability repair even
188 though the sling time may be similar. Postoperative pain levels after arthroscopic instability
189 repair are less than those undergoing shoulder arthroplasty. Although patients with arthroplasty
190 have early onset of ROM exercises, the pattern of limitations and its recovery with respect to
191 ROM and ADLs are likely to be different between post arthroplasty and rotator cuff repair or
192 instability repair. A more objective insight into the aforementioned differences will require
193 additional study including postsurgical patients with different surgical procedures

194 Shoulder pain was reported as the most common reason and limited function as the
195 second most common reason to undergo shoulder arthroplasty by our study cohort. Previous
196 studies have demonstrated that TSA is a predictable operation for pain relief. Tashjian et al
197 reported a 5.9-fold decrease in pre- and postoperative Visual Analog Scale (VAS) scores
198 following total shoulder arthroplasty that was statistically significant¹⁵. In this study they showed
199 that the Mean Clinically Important Difference (MCID) showcasing significant improvements in
200 pain (MCID VAS of 1.4) occur as early as 2 weeks. Similarly, Simovitch et al corroborated that
201 following shoulder arthroplasty patients had significant reduction in pain at latest follow-up of 2
202 years following shoulder arthroplasty¹⁴. Unlike these other studies, they did not follow
203 progression of pain relief, which allows physician to guide patient's expectations follow shoulder
204 arthroplasty. These other studies also do not discuss the pattern of pain relief in the acute
205 postoperative period, which provides better guidance for physicians to manage immediate
206 postoperative shoulder arthroplasty patients. Based on the data from our study, it is reasonable to

207 tell the patients that pain levels will considerably decrease 63% in our study in first two weeks
208 after surgery.

209 Shoulder pathology has been correlated to have significant impact on sleep quality, sleep
210 duration, and habitual sleep efficiency¹⁰. Although TSA has shown to lead to resolution of sleep
211 disturbances and improved quality of life, sleep disturbances are common within the first several
212 weeks after TSA. Sleep disturbances have been attributed to a positional requirement inability to
213 sleep in the preferred position and temperature changes^{7,8}. Weinberg et al showed a progressive
214 improvement of sleep quality after TSA, which returned to normal limits at 12 months after
215 surgery¹⁶. In this study, we demonstrate that sleep disturbances peak before 6 weeks and are
216 much less thereafter, which could reflect the association of sleep disturbances with sling use and
217 restrictions related to positioning of the arm.

218 Limitations in range of motion following shoulder arthroplasty is a reasonable concern of
219 patients after TSA. Although patients with shoulder arthritis have limited function prior to
220 surgery, sling use in first 4-6 weeks after surgery makes the patient one handed for most part.
221 Our study demonstrates that function involving forward elevation improve much faster than
222 ADLs that required internal rotation behind the back or reaching across the body. ADLs
223 involving rotation behind the back remain quite limited for a longer period of time due to the
224 pattern of recovery of range of motion after shoulder surgery and also in part due to restrictions
225 imposed by the surgeons. Razmjou et al showcased statistically significant improvement of range
226 of motion at the 6-month postoperative mark, which continued to the 2-year postoperative
227 follow-up compared to preoperative baseline¹³. Kasten et al findings also corroborated
228 improvement in completing ADLs at the 6-month postoperative follow-up following shoulder
229 arthroplasty and showed a limitation the reconstitution of some planes of shoulder motion⁹.

230 Kasten et al and Razmjou et al did not comment on improvements in early postoperative phase,
231 which is provided in our study^{9,13}. This is important information that can be shared with the
232 patients in the postoperative period.

233 The construct of this study has several strengths and limitations. In this study we focused on the
234 chronological sequence of presentation of three most important limitations (as determined by the
235 patients) and were able to determine the frequency and progression of the extent of improvement
236 of these limitations at three time points (2 weeks/6 weeks/3 months). Study strengths include a
237 large cohort, prospective standardized data collection, and *a priori* categorization of primary
238 outcomes, and presentation of important clinical improvements with regards to ADLs, sleep, and
239 pain management. In addition, there was limited recall bias because the data collection was on
240 regular scheduled basis. However, there are also several important limitations. First, the sleep
241 disturbances were subjectively determined and not objectively assessed. Second, the study
242 duration was short (3 months) but because prior studies have reported on one-year outcomes, we
243 wanted the focus of this study on first 3 months. Third, we did not have enough numbers to
244 evaluate the differences in pattern of recovery in patients undergoing anatomic or reverse total
245 shoulder arthroplasty. Finally, we did not have adequate control groups with respect to shoulder
246 pathology (inflammatory arthritis, cuff tear arthropathy, primary osteoarthritis) to determine
247 differences in pattern of recovery in early phases after TSA.

248 **CONCLUSION:**

249 This prospective study demonstrates the chronology of improvements in pattern of
250 limitations experienced by patients with respect to pain, sleep and ADLs in the early
251 postoperative period after TSA. The majority of patients can expect to have 2/3 resolution of

252 pain, improved sleep and improvement in ADLs involving forward elevation and waist level
253 function by 3 months.

254 **Figure Legend:**

255 Figure 1: Bar graph demonstrating VAS scores of patients at preoperatively and at each follow-
256 up after total shoulder arthroplasty

257 Figure 2: Line graph showing progression of sleep score of patients preoperatively and at each
258 follow-up after total shoulder arthroplasty

259 Figure 3: Line graph showing progression of the mean total ADL score of patients preoperatively
260 and at each follow-up after total shoulder arthroplasty

261 Figure 4: Bar graph showing progression of ADL Subset scores of patients and at each follow-up
262 after total shoulder arthroplasty

263 **Table Legend:** Table 1: Patient Demographic Characteristics

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Table 1: Patient Demographic Characteristics (total cohort, n=154)

Parameter	Value
Gender	
Male	49%
Female	51%
Arm Operated On	
Dominant	54%
Non-dominant	46%
Age	
<30	0%
31-40	1%
41-50	5%
51-60	10%
61-70	45%
71-80	30%
>80	9%
Race	
White	91%
Black/African American	5%
Asian/Pacific Islander	0%
Native American	1%
More than one Race	1%

Unknown/Not Reported	2%
Ethnicity	
Hispanic or Latino	9%
Not Hispanic or Latino	83%
Unknown/Not Reported	8%
Marital Status	
Single or Never Married	19%
Married	58%
Divorced/Separated	11%
Widowed	10%
Separated	2%
Employment Status	
Full-time Employment	25%
Part-time Employment	4%
Unemployed	6%
Self-employed	7%
Homemaker	1%
Student	0%
Retired	57%
Current Living Situation	
No Caregiver	77%
One or more Caregivers	23%

Help Required for Daily Activities	
Need for most/all activities	3%
Need for some activities	17%
Need for few activities	5%
Need for no activities	75%

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