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Variability in physical therapy protocols following total shoulder arthroplasty

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Background: Physical therapy (PT) plays an important role in the recovery of function following anatomic total shoulder arthroplasty (aTSA). While several PT protocols have been published for these patients, there is no standardized protocol for aTSA rehabilitation. This lack of standardization may lead to confusion between patients and physicians, possibly resulting in suboptimal outcomes. This study examines how PT protocols provided by academic orthopedic surgery programs vary regarding therapeutic goals and activities following aTSA.

Methods: PT protocols for aTSA available online from the Accreditation Council for Graduate Medical Education accredited orthopedic surgery programs were included for review. Each protocol was analyzed to evaluate it for differences in recommendation of length of immobilization, range of motion (ROM) goals, start time for and progression of therapeutic exercises, and timing for return to functional activity.

Results: Of 175 accredited programs, 25 (14.2%) had protocols publicly available, programs (92%) recommended sling immobilization outside of therapy for an average of 4.4±2.0 weeks. Most protocols gave recommendations on starting active forward flexion (24 protocols, range 1–7 weeks), external rotation (22 protocols, range 1–7 weeks), and internal rotation (18 protocols, range 4–7 weeks). Full passive ROM was recommended at 10.8±5.7 weeks, and active ROM was 13.3±3.9 weeks, on average. ROM goals were inconsistent among protocols, with significant variations in recommended ROM and resistance exercise start times. Only 13 protocols (52%) gave recommendations on resuming recreational activities (mean, 17.4±4.4 weeks).

Conclusions: Publicly available PT protocols for aTSA rehabilitation are highly variable.

Level of evidence: IV.

Keywords: Arthroplasty; Physical therapy; Shoulder; Rehabilitation

INTRODUCTION

Total shoulder arthroplasty can help provide function and pain relief to those with arthritis of the shoulder that has failed to respond to conservative treatment. Anatomic total shoulder arthroplasty (aTSA) usage rose 17% between 2011 and 2014 [1,2]. While the popularity of reverse TSA has outpaced aTSA, estimates of 2012–2017 census data indicate that aTSA still accounts for just over a third of all shoulder arthroplasty in the United States [3]. Primary indications for aTSA include degenerative joint disease (92% of cases) followed by rheumatoid arthritis (4.1%), and aseptic necrosis of the humerus (2.2%) [3]. Out-

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comes of aTSA depend on many variables including patient anatomy, prosthesis type, stem length, surgical technique, rotator-cuff integrity, and bone deficiency, and subscapularis management (e.g., osteotomy, peel-off, tenotomy) can also play a role in planning postoperative management [4]. There is a consensus in the orthopedic community with regard to the importance and effectiveness of postoperative physical therapy (PT) following aTSA. The exact protocol that patients follow often depends on the quality of the soft tissue, age, expectations of the patient, and physician preference [5]. While there are several PT protocols published for patients undergoing aTSA, there is no standardized protocol for aTSA rehabilitation [5-8].

This lack of standardization may prove to be problematic because it may lead to confusion between patients and their physicians and less than ideal functional outcomes for patients. Our purpose in this study was to evaluate the degree of variability in the PT protocols published by Accreditation Council for Graduate Medical Education (ACGME) accredited orthopedic programs. We hypothesized that the protocols will vary among programs, specifically regarding the timing of various exercises and functional milestones.

METHODS

The requirements for Institutional Review Board approval and informed consent were waived since this does not involve human subjects research. A list of academic orthopedic surgery institutions was obtained from the ACGME website. A web-based search was performed using an internet search engine (https://www.Google.com) using the search phrase "[program/hospital/medical school] total shoulder arthroplasty rehabilitation protocol" to identify publicly available PT protocols. Protocols for reverse total shoulder arthroplasty were excluded. Out of 175 accredited orthopedic surgery programs included in the search, 24 institutions (13.7%) had protocols publicly available with 25 total protocols included for review.

A single researcher (KDP) reviewed each rehabilitation protocol to ensure consistency in the data-collection process. Each protocol was analyzed to assess recommendations of length of immobilization, range of motion (ROM) goals, start times and progression of therapeutic and resistance exercises, and timing for a return to functional activity. Start times and milestones for specific exercises within each category were recorded. Data were collected and analyzed using descriptive statistics in Microsoft Excel (Microsoft Corp.).

RESULTS

Postoperative Adjunctive Therapy and Restrictions

Out of 175 accredited programs, 25 (14.2%) had protocols publicly available for review (Fig. 1). Of the 25 programs, 23 (92%) recommended sling immobilization outside of therapy for an average of 4.4 ± 2.0 weeks. Only one protocol (4%) specified the use of an abduction pillow. Thirteen protocols (52%) recommended avoiding active shoulder extension for an average of 5.0 ± 1.4 weeks. Similarly, 10 protocols (40%) set restrictions on active internal rotation for an average of 6.4 ± 2.0 weeks. In addition, two protocols (8%) gave recommendations to avoid active external rotation for an average of 4.3 ± 2.8 weeks.

ROM Progression and Goals

ROM recommendations varied considerably among different protocols. Goals and start times for various planes of motion varied between protocols (Figs. 2 and 3). Average start times for passive forward flexion, passive external rotation, and passive abduction were 1 ± 0.5, 1 ± 0.7, 1 ± 0.5 weeks postoperatively, respectively. The recommended start time for passive IR was more inconsistent with a mean start time of 2 ± 3.1 weeks. The average postoperative week recommended to begin active forward flexion, external rotation, abduction, and internal rotation was 5 ± 1.7, 5 ± 1.4, 5 ± 1.6, 6 ± 2.1, respectively.

Recommendations for achieving different passive ROM goals varied among protocols (Fig. 3). The goal of 90° of passive forward flexion was reported by 40% of the programs and averaged 2.9 ± 1.3 weeks postoperatively. Similarly, the mean goal for reaching 20° of passive external rotation was 3 ± 2.5 weeks, and the mean goal for reaching 30° was 3.2 ± 1.6 weeks. Goals for internal rotation were more inconsistently reported. Only one pro-

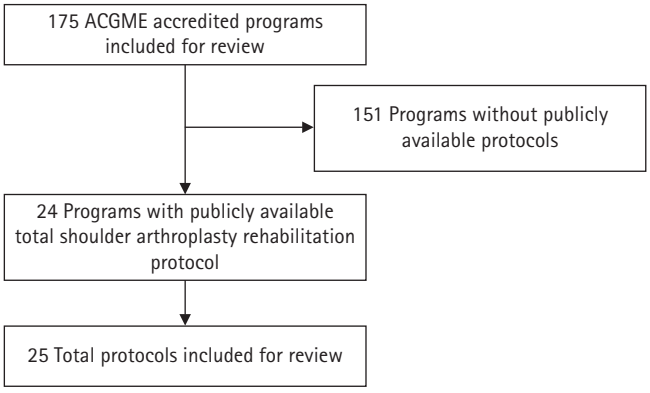

Fig. 1. Physical therapy protocol identification and collection algorithm. ACGME: Accreditation Council for Graduate Medical Education.

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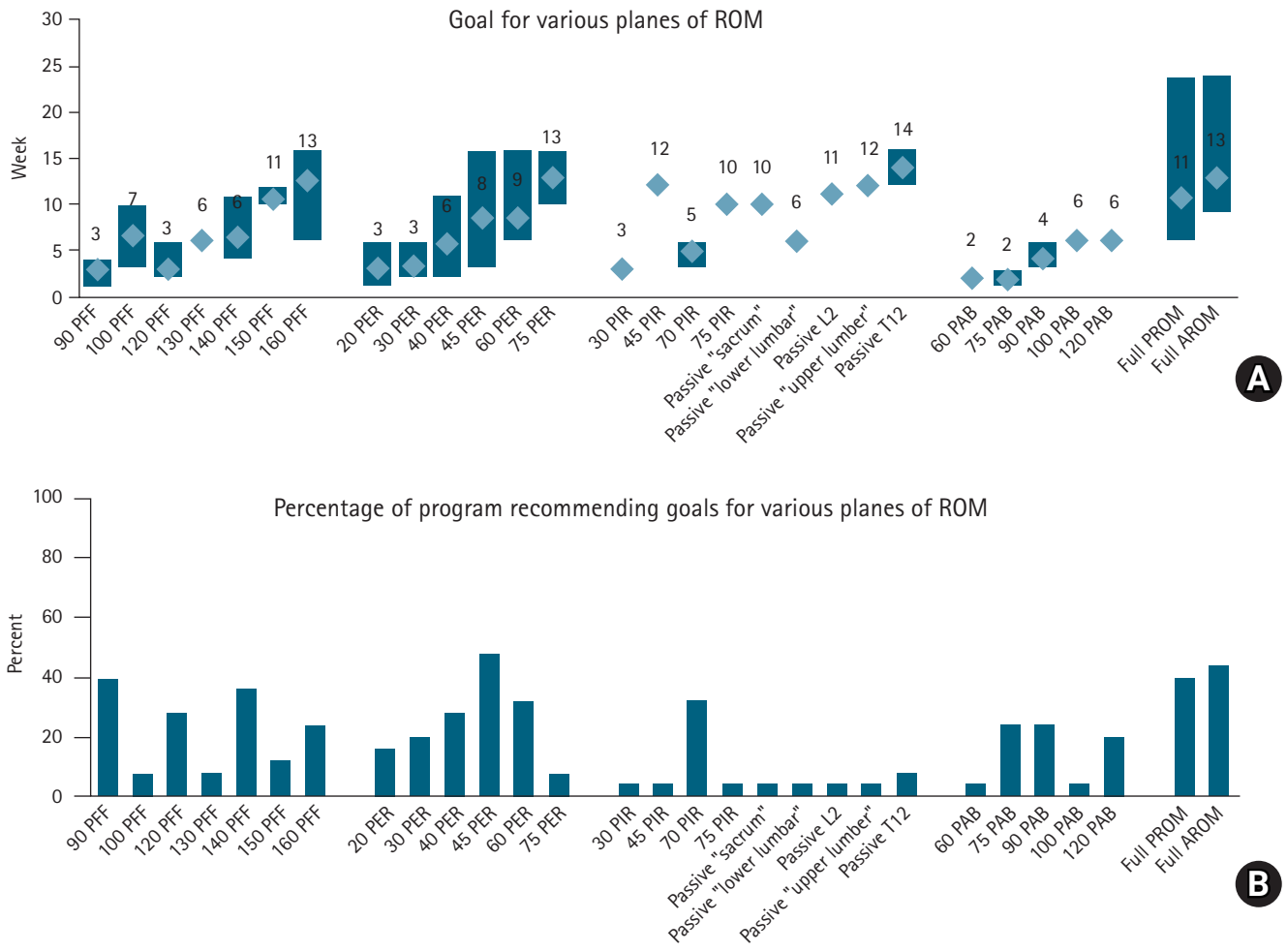

Fig. 2. Goals for various planes of range of motion (ROM) (A). Mean (diamond) and range (bar) of goals and (B) percentage of programs that stated each goal for achieving ROM in various planes of shoulder movement. The numbered diamond represents the mean time in weeks. PFF: passive forward flexion, PER: passive external rotation, PIR: passive internal rotation, PAB: passive abduction, PROM: passive ROM, AROM: active ROM.

gram set goals for 30°, 45°, and 75° for passive internal rotation, whereas eight programs set a goal for 70° of passive internal rotation. Additionally, one program each set goals of the patient's being able to reach lower lumbar, upper lumbar, sacrum, and L2, whereas two programs set goals for reaching T12. Goals for reaching full passive ROM were set by 40% of the programs and averaged 11 ± 5.7 postoperative weeks. Furthermore, the mean goal of reaching full active ROM was 24 ± 3.9 weeks postoperatively and was recommended by 44% of programs.

Therapeutic Exercises

There were many recommended rehabilitation exercises, and start times for initiating various activities varied greatly (Fig. 4). The most commonly recommended exercises were elbow, hand, and wrist motion (92% of programs) and Codman pendulums (88% of programs). These two exercises were the initial exercises postoperatively in most programs and had the least variation in recommended start times at 1.1 ± 0.2 weeks and 1.1 ± 0.2. Other recommended exercises by more than half of the programs included pulleys (80%), isometric external rotation (72%), deltoid isometrics (64%), isometric internal rotation (60%), and rhythmic stabilization (56%). The exercises with the latest recommended start times included capsule stretching (7.6 ± 3.1 weeks), isotonic resistance (8.0 ± 3.6 weeks), and behind-the-back towel stretching (8.7 ± 2.3 weeks). The goal for normal scapulothoracic motion was recommended to be achieved by an average of 12.9 ± 4.0 weeks by 44% of the programs.

Resistance Exercises

There was considerable variation in the start times for various recommended resistance exercises (Fig. 5). The most commonly recommended exercise was external rotation band training

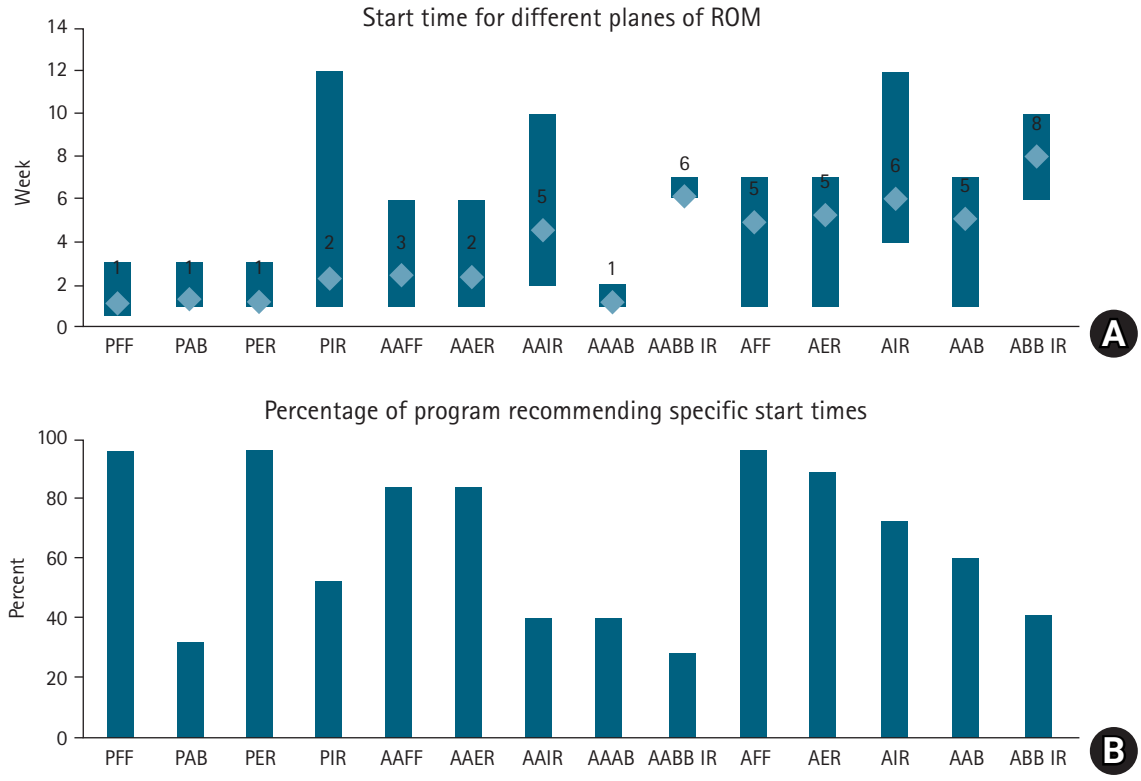

Fig. 3. Start times for range of motion (ROM). (A) Mean (diamond) and range (bar) of goals and (B) percentage of programs that stated times for starting passive, active-assisted, and active ROM in various planes of shoulder movement. The numbered diamond represents the mean time in weeks. PFF: passive forward flexion, PAB: passive abduction, PER: passive external rotation, PIR: passive internal rotation, AAFF: active assisted forward flexion, AAER: active assisted external rotation, AAIR: active assisted internal rotation, AAAB: active assisted abduction, AABB IR: active assisted behind back internal rotation, AFF: active forward flexion, AER: active external rotation, AIR: active internal rotation, AAB: active abduction, ABB IR: active behind back internal rotation.

(96%). Other exercises recommended by more than half of the programs included internal rotation bands (76%), scapular strengthening (76%), flexion bands (72%), light distal extremity training (64%), and light resistance training (64%). More demanding exercises such as push-ups (10.0±2.0 weeks), chest presses (10.5±1.0 weeks), and dumbbell training (13.6±3.3 weeks) had later average starting times than exercises such as scapular strengthening (6.4±3.2 weeks), light distal extremity training (5.1±3.3 weeks), and external rotation band training (8.1±3.2 weeks).

Functional Exercise and Return to Sports

Recommendations for a return to functional exercise and regular daily activities varied widely among protocols (Fig. 6). Only 52% of protocols recommended a time for returning to light functional activity; 36% made recommendations for returning to moderate functional activity; and 48% made recommendations for returning to recreational activities such as gardening, golf, and doubles tennis (Fig. 6). Additionally, only a minority of programs (<20%) made recommendations for aerobic exercises during the rehabilitation period. Lower impact exercises such as stationary bike (1.5±0.7 weeks), aquatic therapy (3.5±1.9 weeks), and upper body ergometer (6.5±0.7 weeks) were started earlier in the program than high-impact exercises such as stair climbing (10.0±2.8 weeks), jogging (12.0±0.0 weeks), and running (12±0.0 weeks) (Fig. 6).

DISCUSSION

Our study found that a significant amount of variability is present in publicly available rehabilitation protocols for aTSA with regard to the duration of immobilization, length of movement restriction, timing of range-of-motion milestones, and inclusion and recommended start times of various therapeutic exercises. The most consistent components of the different protocols appear to be a recommendation of at least some period of sling immobilization, beginning distal extremity motion, and Codman pendulums immediately postoperatively. The variation in components of these protocols indicates a lack of consensus on the standard of care for PT protocol following aTSA. This is consistent with trends seen in rehabilitation protocols for other ortho-

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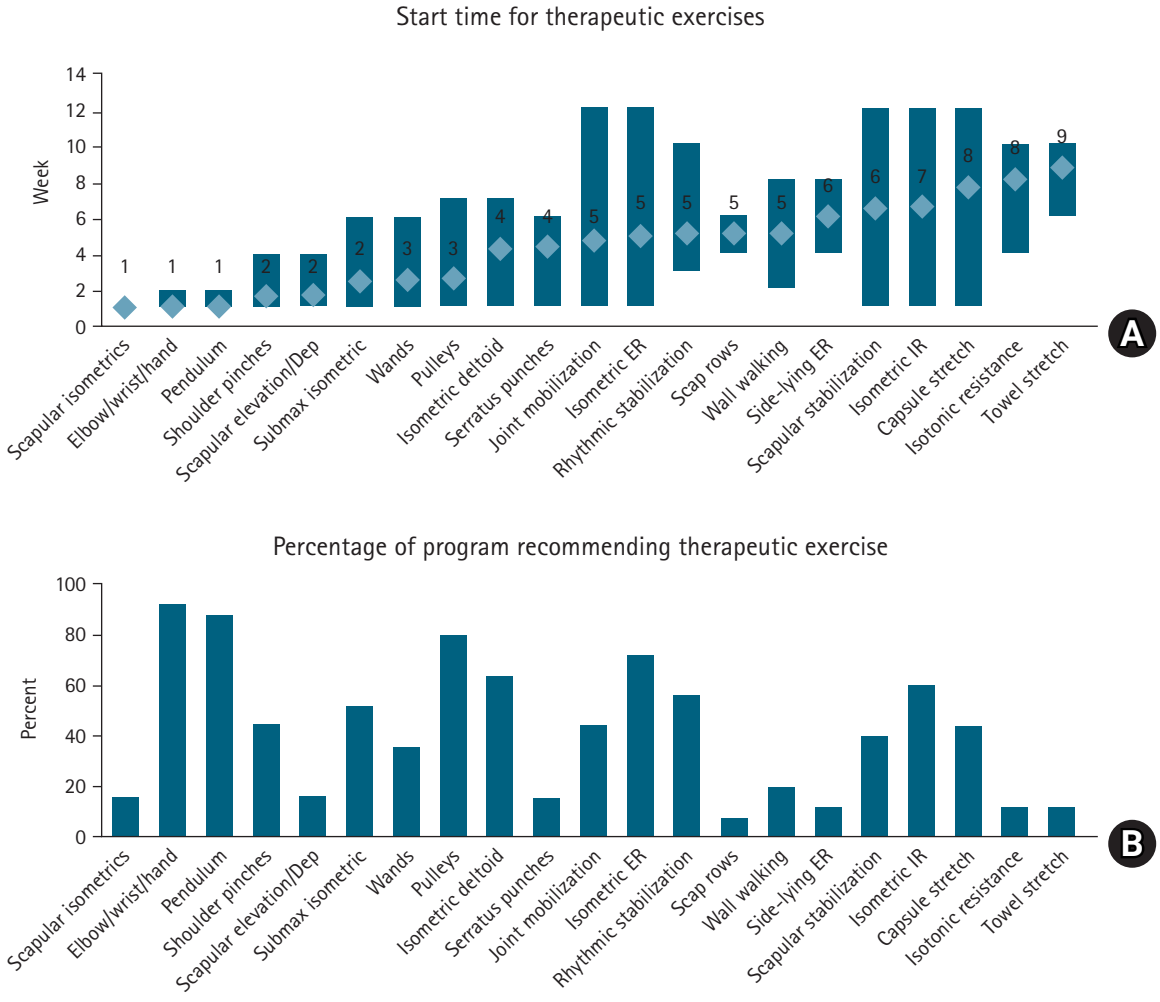

Fig. 4. Start times for therapeutic exercise. (A) Mean (diamond) and range (bar) of goals and (B) percentage of programs that stated times for starting various therapeutic exercises for shoulder rehabilitation. The numbered diamond represents the mean time in weeks. Dep: depression, ER: external rotation, IR: internal rotation.

pedic operations [9-12].

Although early ROM is important in the early recovery phase to prevent stiffness, care must be taken to protect the subscapularis repair. The rate of subscapularis re-tear following aTSA ranges from 3% to 46%, and failure may result in anterior shoulder instability and weakness with internal rotation [13-16]. In general, excessive passive external rotation and active internal rotation are avoided to prevent stress on the subscapularis. Unfortunately, there is a paucity of evidence regarding precautions for protecting the subscapularis repair [5]. In a systematic review of proposed rehabilitation guidelines for shoulder arthroplasty, Bullock et al. [17] found no consensus among protocols with regard to internal rotation recommendations. Additionally, multiple studies in the review did not mention external rotation precautions [17]. Our study demonstrated similar results with approximately half of the available protocols having recommended restricted internal rotation and only 8% initial restriction of external rotation.

Despite the consensus that postoperative PT plays a critical role in return of function after aTSA, there exists no standardized guideline for rehabilitation for patients who have undergone aTSA [17]. There is a paucity of prospective literature comparing outcomes of different protocols and a paucity of prospective evidence as to how the components of PT protocols impact outcomes. In a prospective trial, Denard and Lädermann [18] found that immediate passive ROM following aTSA results in a more rapid return of function compared to delayed passive ROM; however, there was no significant difference in the ultimate ROM or functional outcomes between the two groups. Our study further demonstrates that while general concepts of protocols used by various programs are the same, there is minimal standardization of protocols for aTSA rehabilitation.

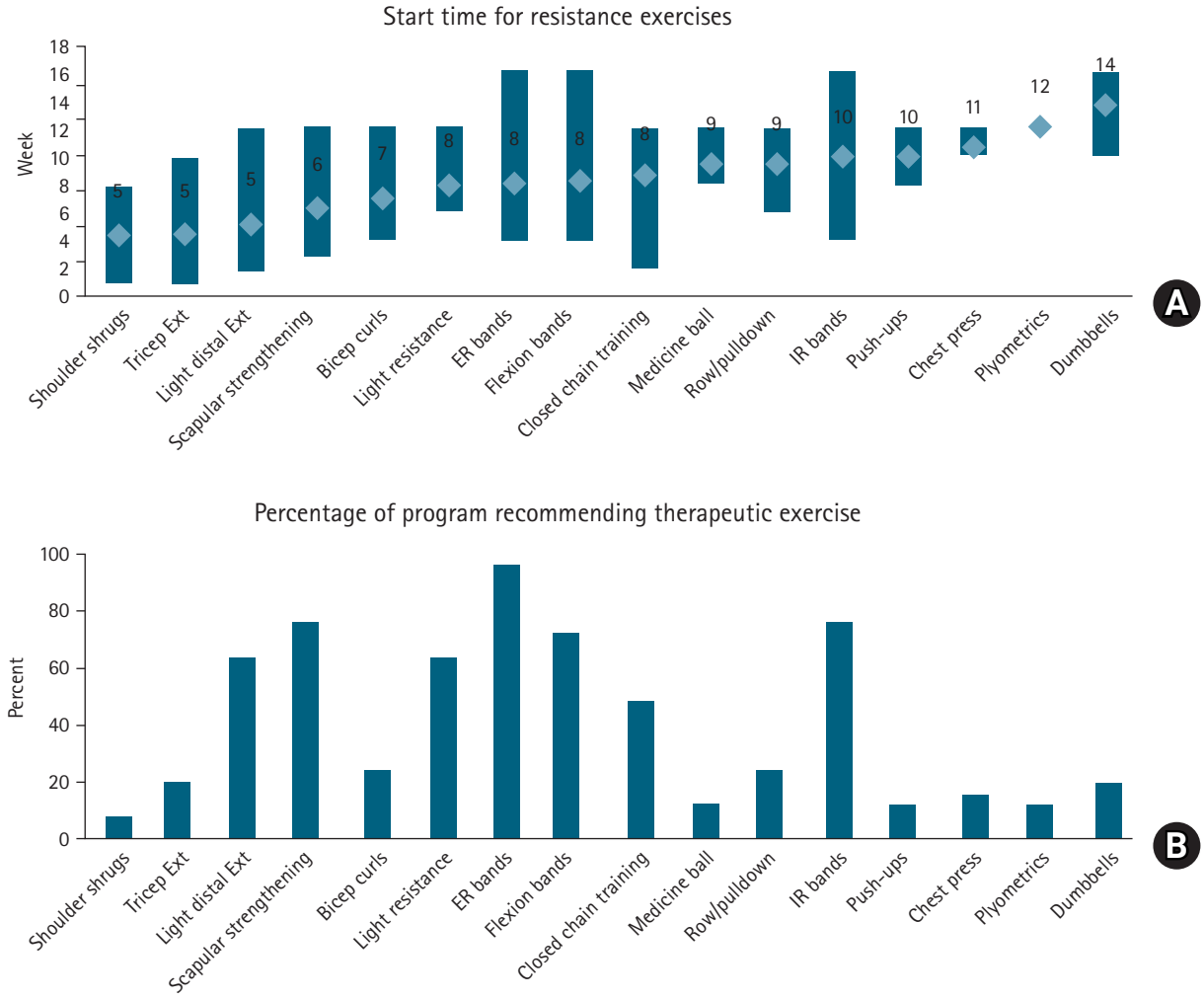

Fig. 5. Start times for resistance exercise. (A) Mean (diamond) and range (bar) of goals and (B) percentage of programs that stated times for starting various resistance exercises for shoulder strengthening. The numbered diamond represents the mean time in weeks. Ext: extension, ER: external rotation, IR: internal rotation.

Even though standardization may lead to increased therapy efficacy and less confusion among patients, postoperative therapy targets and pacing must be tailored to the individual patient based on age, education, joint laxity, and ability to pay for rehabilitation as a recovery trajectory following aTSA. It depends on a multitude of factors such as underlying pathology, soft tissue quality, patient age, and patient expectations [5]. Therefore, it is recommended that PT protocols should not be based on strict timelines, but rather specified clinical criteria [5,19]. Time frames should still be used as approximate time frames to inform the patient and physician that the patient is progressing appropriately [5,19]. However, our study found that there is limited clinical criteria to guide progression, and the suggested time frames are highly variable. Standardization and clarification of these details among protocols will decrease confusion among patients and lead to higher chances of successful rehabilitation and return of function.

With the current economic stress on the healthcare system in the United States, there has been a shift in emphasis from volume to value-based care systems that focus on producing high-quality care that maximizes outcomes while minimizing the cost associated with treatment [20-23]. One component of the total cost of aTSA is formal physical therapist-supervised rehabilitation. As such, there have been studies seeking to determine if formal PT is necessary to ensure good outcomes following aTSA. Mulieri et al. [24] compared outcomes of a standard PT with a physician-guided home-based program and found that there were no significant differences in outcomes scored between the two groups at a final follow-up. Additionally, it has been shown that the use of formal PT following aTSA is higher in privately ensured patients [25]. As cost concerns become increasingly important, there is likely to be an increase in patients that choose to undergo home-based PT. As

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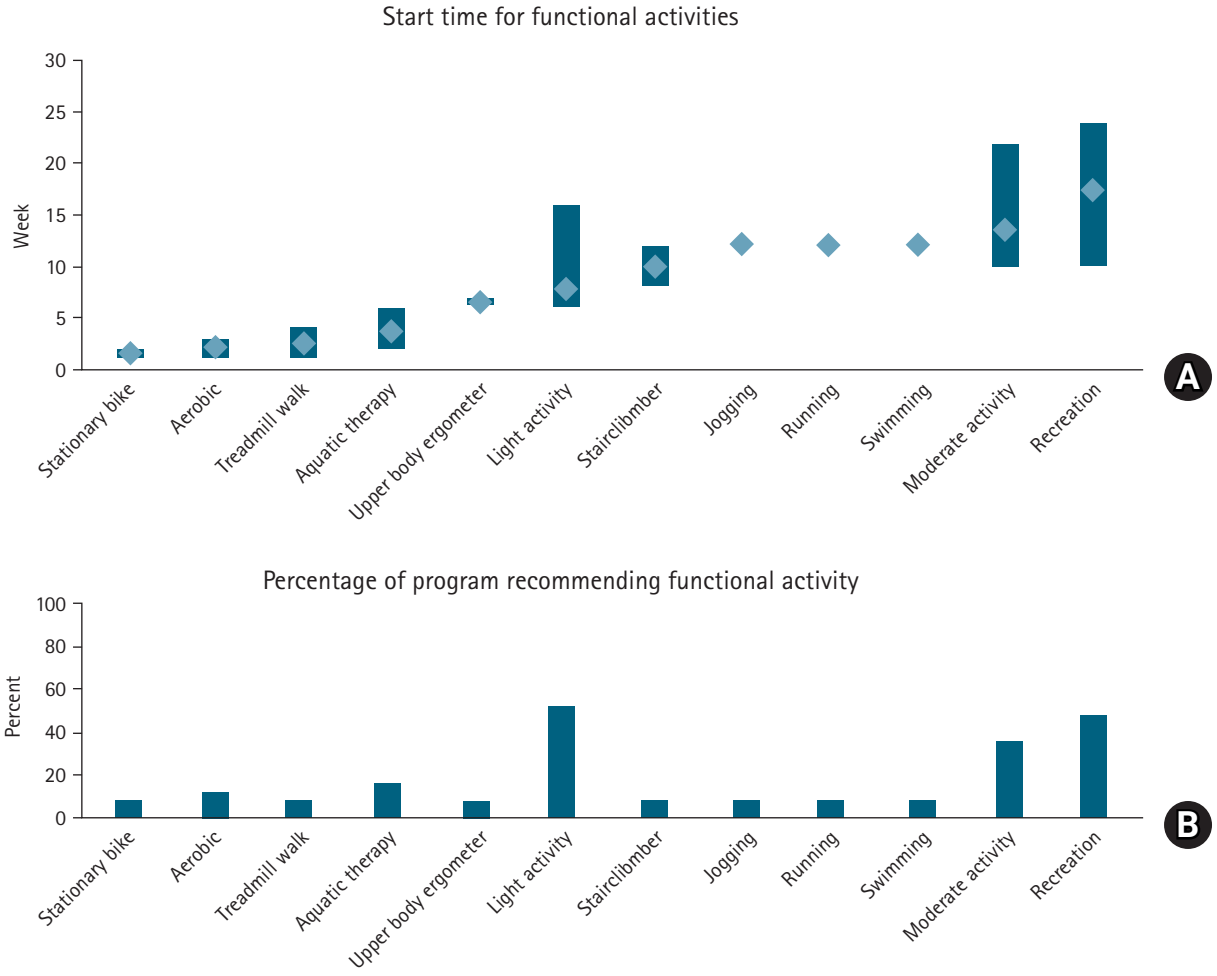

Fig. 6. Start times for functional activities. (A) Mean (diamond) and range (bar) of goals and (B) percentage of programs that stated times for initiating functional exercises or resuming activity. The numbered diamond represents the mean time in weeks.

patients are given a more independent role in the recovery process, they are likely to consult online resources, and the current variability of results may lead to confusion that could impede progress. Furthermore, protocols that are made publicly available should be based on evidence and contain clear details on performing exercises to ensure patient success.

This study has limitations. This review was conducted by a single researcher who may have held observer bias or made measurement errors. Although there are 175 accredited programs, only 24 had publicly available aTSA rehabilitation protocols. This accounts for only a minority of programs and may not be representative of all PT protocols available to patients. This study may thus be subject to availability bias and nonresponse bias. Additionally, this study does not account for protocols provided by private practice physicians. Furthermore, this study is unable to assess how protocols vary based on the surgical technique used.

CONCLUSIONS

Significant variability exists among publicly available aTSA rehabilitation protocols with regard to range-of-motion goals, recommended exercises, and timing for the initiation of various exercises with the initiation of an active and passive internal rotation and external rotation among the most varied across protocols examined. More work is needed to identify which PT factors impact outcomes of aTSA to maximize patient outcomes.

NOTES

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Conflict of interest

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Data availability

Contact the corresponding author for data availability.

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