Systematic Review

Return to sport criteria following upper extremity surgery in athletes—part 4: shoulder arthroplasty procedures: a scoping review


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A R T I C L E I N F O

Keywords:
Shoulder arthroplasty
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Criteria
Athletes
Shoulder replacement
Shoulder reconstruction

A B S T R A C T

Purpose: To describe the reported return to sports (RTS) criteria following all types of shoulder arthroplasty procedures in athletes.

Methods: This scoping review was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses–Scoping Review (PRISMA-ScR) as a guide. A comprehensive search was conducted in four electronic databases (Scopus, Pubmed/MEDLINE, Web of Science, and Google Scholar Advanced Search) in the English Language that reported a minimum of 1 RTS criterion in athletes after shoulder arthroplasty. The data were aggregated and summarized as frequencies, means, and standard deviations.

Results: Thirteen studies were included, with a total of 942 athletes with a mean age of 68.7 years. The most commonly used RTS criterion was time from surgery (range 3–6 months), reported by 7/13 (54%) of all studies, followed by restrictions on contact sports (36%). Other reported RTS criteria included no lifting/limited lifting (3/13, 23%), physician clearance based on assessment (3/13, 23%), return per patient tolerance (2/13, 15%), and upon return to full range of motion (ROM) and strength in the operated shoulder (1/13, 8%). Three studies (3/13, 23%) allowed for an unrestricted RTS postoperatively.

Conclusion: Thirteen studies reported one or more RTS criteria following shoulder arthroplasty, with time after surgery being the most common RTS criterion used. These results emphasise the need for interprofessional discussions and communication amongst surgeons, physical therapists, and athletic trainers to establish evidence-based RTS criteria following arthroplasty and promote a safe and effective return to sport.

1. Introduction

Shoulder arthroplasty, also known as shoulder replacement, is an effective form of end-stage surgical management for a variety of upper extremity pathologies, including osteoarthritis, rheumatoid arthritis, fractures, and osteonecrosis [1,2]. Anatomical total shoulder arthroplasty (TSA), reverse total shoulder arthroplasty (rTSA), and hemiarthroplasty (HA) are the most commonly performed techniques. Over the past three decades, the total number of shoulder arthroplasty procedures performed has been rising, increasing at 6% to 13% annually from 1993 to 2007 [1,3,4].

While pain relief and improved function will always be the primary goals of most shoulder arthroplasty procedures, returning to sport is also an important motivator for undergoing shoulder surgery in older athletes. Although multiple previous studies have reported on the rate of

What is already known:
- Return to sport is an important motivator for older athletes undergoing shoulder arthroplasty.

What are the new findings:
- Time after surgery was the most frequently reported return to sport criteria.
- Discussion amongst surgeons, physical therapists, and athletic trainers is needed to establish evidence-based return-to-sport criteria following shoulder arthroplasty.

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return to sport after shoulder arthroplasty procedures, these investigations seldom report on the specific criteria used to clear an athlete for return to sports (RTS) after surgery. Furthermore, the reasons why shoulder arthroplasty patients fail to return to sport have rarely been described in the literature [5-18]. Given that return to sport is often a primary incentive for older athletes undergoing shoulder arthroplasty, it is imperative to establish standardized guidelines and timing for clearing athletes for RTS postoperatively. This scoping review intends to describe the reported RTS criteria in the literature following shoulder arthroplasty procedures (TSA, rTSA, and HA).

2. Methods

A scoping review was chosen over a systematic review due to the significant degree of heterogeneity among studies reporting RTS criteria upon a preliminary search. Adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-ScR) guidelines, we conducted a scoping review of the literature for publications reporting criteria used to clear patients to RTS after shoulder arthroplasty [19].

2.1. Study identification and criteria

Articles published through March 2021 were collected across four electronic databases (Google Scholar Advanced Search, MEDLINE/PubMed, Scopus, and Web of Science). The following search terms were used, either by “AND” or “OR”: shoulder replacement; total shoulder arthroplasty; reverse total shoulder arthroplasty; humeral prosthesis; return to sport; return to sport criteria; sport; functional outcomes; sports participation; return to activity; athlete return; return to play; rehabilitation; golf; swim. The literature search included clinical studies that report on at least 1 RTS criterion following shoulder arthroplasty procedures, including TSA, rTSA, and HA, in patients classified as athletes. The search was further restricted to include only peer-reviewed articles published in the English language, with no limits placed with regard to the year of publication.

2.2. Study criteria and definitions

Studies were included in this scoping review based on the following criteria:

- **Study Design**: We included (1) prospective and retrospective studies with at least six patients classified as athletes (at any level of competition or intensity) who underwent any type of shoulder arthroplasty procedure (TSA, rTSA, HA) that reported at least one criterion that was used to clear athletes for return to sport; (2) peer-reviewed articles published in the English language. Exclusion criteria were as follows: (1) studies on RTS in athletes after shoulder arthroplasty that did not clearly mention criteria used in clearing an athlete; (2) studies reporting on non-athletes; (3) non-peer-reviewed articles, or those not available in the English language; case studies and case series with less than six athletes, or those where shoulder arthroplasty was not the primary surgical procedure.

- **Participants**: We included any study where patients were characterised as “athletes,” regardless of level of play, age, or intensity of sport. Studies including a mixed population of athletes and non-athletes were only included if the results were clearly stratified between athletes and non-athletes. Studies that did not specifically label or characterise patients as athletes were excluded from the analysis.

- **Procedures**: All studies that reported on any type of shoulder arthroplasty procedure (TSA, rTSA, and HA) were included. Studies were excluded in the event that additional procedures were performed at the time of shoulder arthroplasty in cases where shoulder arthroplasty was not reported as the primary surgical procedure.

- **RTS Rate**: Defined as the percentage of athletes or shoulders that returned to sport (regardless of level of play or intensity) based on the definition provided by each of the included studies.

- **Outcomes**: Studies that reported on at least one RTS criterion

2.3. Study screening

All potentially eligible studies were aggregated in EndNote X9.1 software (Clarivate Analytics; London, United Kingdom). Articles were screened by title and abstract for the predetermined inclusion/exclusion criteria by two independent authors (I.K.B. and B.D.). A full-text review was completed by two independent authors (B.D. and A.H.). Any disagreements in this process were resolved by the senior author (S.C.G.). The study screening and selection process is outlined in the PRISMA flowchart in Fig. 1.

2.4. Data extraction

All data was collected and tabulated in Microsoft Excel (Microsoft Corporation; Redmond WA, USA). Data aggregated for each study included authors, year of publication, number of athletes or shoulders analysed, type of arthroplasty performed, age, number of athletes who returned to sport, RTS rate, mean RTS time, and reported RTS criteria. All data elements were discussed between two authors (B.D. and A.H.) with disagreements resolved by a third senior author (S.C.G.).

3. Results

3.1. Study identification

Results from the study search and screening process are presented in the PRISMA flowchart (Fig. 1). Thirteen studies were eligible and included in this scoping review. Four studies 4/13 (31%) included athletes that underwent TSA, 5/13 (38%) included athletes that underwent rTSA, and 1/13 (8%) included athletes that underwent HA. Additionally, 3/13 (23%) studies reported on more than one type of shoulder arthroplasty technique. A summary of the studies included is provided in Table 1.

3.2. Study population

A total of 1273 patients were identified across the 13 studies included. Among all patients included, a total of 942/1273 (74.0%) were definitively classified as athletes, with a mean age of 68.7 reported in 9/13 studies (69.2%). Among the athletes, the specific procedure performed was readily identifiable in 918 patients, with 285/918 (31.0%) undergoing TSA, 522/918 (56.9%) rTSA, and 112/918 (12.1%) HA. The rate of RTS was reported by 11 studies and was calculated to be 665/826 (80.5%). The mean time to return to sport was 6.0 months (range: 4.5–7), reported in 6/13 studies (46.2%).

3.3. Return to sport criteria

We identified seven criteria used to clear athletes to return to sport following shoulder arthroplasty, and these are described below as well as in Table 1. The number of RTS criteria used in each of the included articles ranged from 1 to 3. Postoperative time was the most frequently reported criterion overall, and it was used in 7/13 (54%) studies. Other return to sport criteria reported included avoidance of contact sports or sport-specific restrictions (5/13, 38%), no lifting/limited lifting (3/13, 23%), physician clearance based on assessment (3/13, 23%), return per patient tolerance (2/13, 15%), and upon return to full range of motion (ROM) and strength in the operated shoulder (1/13, 8%). Three studies (3/13, 23%) allowed for an unrestricted RTS postoperatively. Fig. 2 presents the frequency of each RTS criteria among the included studies.
Time was the most frequently reported RTS criterion reported by 7/13 studies (54%). Among these, 5/7 (71%) mandated a minimum time postoperatively before patients were able to return to sports, 1/8 provided patients with a time range, and 1/8 reported on the average minimum time recommended based on suggestions for an ideal RTS time postoperatively from a group of surgeons (Fig. 3). The most commonly reported postoperative time for clearance to RTS was 3 months postoperatively.

- **Physician clearance based on Exam and Assessment**

  Of all included studies, 3/13 (23%) noted that patients were cleared for return to sports based on their individual physician's assessment and recommendation. However, further specifications as to what factors constituted a clearance for return to sport by the physician were not given by any of the studies.

- **Activity Restriction – Avoidance of Contact Sports/Sports-Specific Restrictions**

  Five studies (5/13, 38%) included either recommendations for avoidance of contact sports or specified restrictions on certain types of sports. In 4/5 studies, patients were barred from participating in any type of physical activity categorised as a “contact sport”. In 1/5 studies, the restrictions given were sport-specific and prohibited patients from resuming activities including “volleyball and handball”.

- **Activity Restriction – No Lifting/Limited Lifting**
Patients were given restrictions for weight bearing on the operated extremity in 3/13 studies. In one such study involving patients undergoing rTSA, this restriction was set at a maximum of 20 lbs permanently. In another study for patients undergoing TSA, the restriction was noted to be in effect for only the first six months postoperatively.

- **Recovery of Full Range of Motion and Strength**

  One study established that patients were cleared for return to sports after obtaining full range of motion and upper extremity strength; however, this clearance was also contingent on time, with the recommendation to RTS at 4–6 months postoperatively.

- **Unrestricted Return to Sports**

  Overall, 3/13 (23%) studies cleared patients for an unrestricted return to sports without any additional restrictions. In 1/3 of the studies, physician clearance was also required. In the other two studies, patients also had to meet a specified amount of postoperative time before clearance was given, with one study also specifying successful restoration of full range of motion and muscle strength prior to full unrestricted clearance.

- **Return Per Patient Tolerance**

  Two studies (2/13, 15%) noted that patients were allowed to resume sports according to their own tolerances. However, in both studies, patients were restricted from participating in contact sports, with one study also recommending the avoidance of heavy weightlifting.

### 4. Discussion

This scoping review identified seven criteria used to clear athletes for returning to sports after undergoing shoulder arthroplasty. Among the criteria identified, time was by far the most frequently cited (54%) for determining when an athlete could safely resume sports, followed by restrictions on contact sports (38%). Interestingly, 23% of studies noted that athletes were permitted to return to sports without any restrictions on the type of activity performed. Less frequently, patient readiness or tolerance (15%), return to full ROM, and shoulder muscle strength (8%) were cited as criteria for athlete clearance for RTS. It is important to note that for studies reporting more than one criteria used in the clearance of athletes, there was no consensus established on whether certain criteria were weighted more heavily than others in deciding clearance for return to sports.

Postoperative time was the most commonly used criteria to clear athletes for returning to sports after undergoing shoulder arthroplasty. Among the criteria identified, time was by far the most frequently cited (54%) for determining when an athlete could safely resume sports, followed by restrictions on contact sports (38%). Interestingly, 23% of studies noted that athletes were permitted to return to sports without any restrictions on the type of activity performed. Less frequently, patient readiness or tolerance (15%), return to full ROM, and shoulder muscle strength (8%) were cited as criteria for athlete clearance for RTS. It is important to note that for studies reporting more than one criteria used in the clearance of athletes, there was no consensus established on whether certain criteria were weighted more heavily than others in deciding clearance for return to sports.

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### Table 1

Studies reporting at least one return to sport criterion following TSA, rTSA, and HA surgery in athletes.

<table>
<thead>
<tr>
<th>Study year</th>
<th>Athlete age (mean)</th>
<th>Procedure</th>
<th># of athletes analysed</th>
<th>Athletes RTS N (%)</th>
<th>Mean time to return to sport (months)</th>
<th>Return to Sport Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulhoff et al., 2018</td>
<td>58.6</td>
<td>Humeral head resurfacing</td>
<td>42</td>
<td>21 (50%)</td>
<td>NR</td>
<td>1 Avoidance of handball/volleyball</td>
</tr>
<tr>
<td>Endell et al., 2021</td>
<td>72</td>
<td>Reverse total shoulder arthroplasty</td>
<td>70</td>
<td>NR</td>
<td>1 Time (3 months)</td>
<td>2 Avoidance of contact sports</td>
</tr>
<tr>
<td>Garcia et al., 2019</td>
<td>NR</td>
<td>Hemiarthroplasty and Total shoulder arthroplasty</td>
<td>40 (18 HA, 22 TSA)</td>
<td>HA – 17 (94%)</td>
<td>1 Time (6 months)</td>
<td>2 Avoidance of lifting</td>
</tr>
<tr>
<td>Garcia et al., 2017</td>
<td>NR</td>
<td>Total shoulder arthroplasty</td>
<td>57</td>
<td>55 (96%)</td>
<td>6.7</td>
<td>1 Avoidance of contact sports</td>
</tr>
<tr>
<td>Garcia et al., 2015</td>
<td>74.8</td>
<td>Reverse total shoulder arthroplasty</td>
<td>76</td>
<td>65 (86%)</td>
<td>5.3</td>
<td>3 Return as tolerated by patient</td>
</tr>
<tr>
<td>Godin et al., 2019</td>
<td>NR</td>
<td>Reverse total shoulder arthroplasty</td>
<td>88</td>
<td>67 (76.1%)</td>
<td>NR</td>
<td>1 Physician clearance after assessment</td>
</tr>
<tr>
<td>Jensen and Rockwood, 1998</td>
<td>52.4</td>
<td>Hemiarthroplasty and Total shoulder arthroplasty</td>
<td>24</td>
<td>23 (96%)</td>
<td>4.5</td>
<td>2 Physician clearance after assessment</td>
</tr>
<tr>
<td>Kolling et al., 2018</td>
<td>77.1</td>
<td>Reverse total shoulder arthroplasty</td>
<td>166</td>
<td>127 (77%)</td>
<td>NR</td>
<td>1 Time (3 months)</td>
</tr>
<tr>
<td>Lefevre et al., 2013</td>
<td>74.2</td>
<td>Total shoulder arthroplasty</td>
<td>3</td>
<td>2 (67%)</td>
<td>7</td>
<td>2 Time (3 months)</td>
</tr>
<tr>
<td>Liu et al., 2016</td>
<td>HA – 63.51 RSA – 72.26</td>
<td>Hemiarthroplasty and Reverse total shoulder arthroplasty</td>
<td>127 (51 HA, 76 RSA)</td>
<td>HA – 34 (67%)</td>
<td>1 Time (4–6 months)</td>
<td>1 Physician clearance after assessment</td>
</tr>
<tr>
<td>Mannava et al., 2018</td>
<td>NR</td>
<td>Total shoulder arthroplasty</td>
<td>136</td>
<td>94%</td>
<td>NR</td>
<td>2 Range of motion and strength goals</td>
</tr>
<tr>
<td>Simovitch et al., 2015</td>
<td>73</td>
<td>Total shoulder arthroplasty</td>
<td>67</td>
<td>40 (60%)</td>
<td>NR</td>
<td>3 Unrestricted return to sport</td>
</tr>
<tr>
<td>Walters et al., 2016</td>
<td>68.5</td>
<td>Reverse total shoulder arthroplasty</td>
<td>46</td>
<td>NR</td>
<td>NR</td>
<td>1 Time (4 months)</td>
</tr>
</tbody>
</table>

Overall, 3/13 (23%) studies cleared patients for an unrestricted return to sports without any additional restrictions. In 1/3 of the studies, physician clearance was also required. In the other two studies, patients also had to meet a specified amount of postoperative time before clearance was given, with one study also specifying successful restoration of full range of motion and muscle strength prior to full unrestricted clearance.

- **Return Per Patient Tolerance**

  Two studies (2/13, 15%) noted that patients were allowed to resume sports according to their own tolerances. However, in both studies, patients were restricted from participating in contact sports, with one study also recommending the avoidance of heavy weightlifting.
safely RTS. Preferred RTS times in this study spanned from three to six months, with three months being the most commonly reported. The variation apparent in recommended RTS times indicates a degree of heterogeneity in terms of surgeon preferences for the minimum necessary healing time postoperatively after shoulder arthroplasty. These variances in minimum times for clearance may be in part explained by differences in physician training and practice, and without further evidence in the literature, they complicate the task of creating a single standardised minimum time of recovery after surgery for when an athlete can be cleared for RTS.

It’s unclear whether one type of arthroplasty procedure necessitates a longer minimum healing time. A few of the studies included in our
review reported on more than one type of arthroplasty procedure; however, all such studies set the same minimum time or range regardless of the type of arthroplasty procedure performed. Previous studies have reported greater complication rates associated with rTSA versus anatomic TSA, but it is unknown whether rTSA necessitates a longer minimum healing time prior to RTS [22]. In addition, no distinction was made as to whether athletes involved in riskier sports should be mandated to wait longer prior to RTS, as all patients in our included studies were given the same RTS time regardless of desired postoperative sport. That said, this highlights potential areas where RTS criteria may be personalised to the individual athlete, taking into consideration both the risk of their desired sport and the specific operation performed to select the most optimal RTS time without compromising patient safety.

Additionally, this scoping review demonstrated heterogeneity in the degree of weight bearing allowed by physicians for patients after shoulder replacement. Three studies (3/13) placed limitations on patients in terms of weightlifting, while four (3/13) chose to allow an unrestricted return to sports. In addition, some studies placed a permanent weight limit, while others set temporary weight restrictions that could be disregarded after a set period of time. A previous case series by McCarthy et al., examined sports participation after shoulder arthroplasty and noted only a modest RTS rate of 40% for athletes involved in sports that demand significant weight bearing, often on the operated shoulder, such as weightlifting and bowling [23]. The authors noted that the RTS rates for these two sports were among the lowest relative to other less demanding sports [23]. The relatively lower RTS rate in such sports may suggest that even without explicit physician restrictions, patients may often self-limit themselves to demanding activities based on their respective tolerances. Whether significant weight bearing affects implant components in terms of loosening or wear as well as potentiating the risk of complications on the operated shoulder is still poorly understood. A small retrospective study by Cuff et al. demonstrated evidence of humeral component loosening in 12% of patients who were weight bearing on the operated extremity and a higher complication rate compared to those who were non-weight bearing after rTSA [24]. These findings have contrast with other investigations of non-athletic patients who rely on upper extremity weight bearing for activities of daily living, demonstrating no appreciable increase in patient complication rates [25,26].

Recent advances in modifying implant design, such as the use of a non-spherical humeral head in elite weightlifters, have demonstrated high RTS rates without radiographic evidence of implant loosening or instability on follow-up [27]. Future studies can better elucidate the degree of risk involved in weight bearing on the operated shoulder and explore whether these risks differ between TSA, rTSA, and HA to better guide physicians in establishing standardized RTS criteria in this regard. Given the current conflicting data, effective preoperative patient counselling, especially for those seeking to resume weight-bearing sports, may be beneficial in understanding and managing patient expectations after surgery.

Whether athletes can safely resume contact sports after shoulder arthroplasty is a contentious topic, with 5/13 (38%) studies recommending avoidance of contact sports and 3/13 (23%) studies allowing patients to return to all sports with no restrictions, indicating an almost even split between surgeon preferences in this regard. Similar to weight bearing, it is thought that direct impact or collision with the operated shoulder can promote acute dislocation, implant loosening, and wear. Our results were similar to a previous survey done by Golant et al., exploring options regarding return to sports for patients seeking arthroplasty, given to patients returning to sports after shoulder arthroplasty [17]. The percentage of physicians allowing return to contact sports for TSA, rTSA, and HA was reported as 45.4%, 17.9%, and 64.9%, respectively, with an overall 51% of physicians allowing return to contact sports across all arthroplasties, indicating a significant lack of consensus for this criteria [17]. In our analysis of studies reporting on rTSA, four studies advised patients to avoid contact sports, while only two allowed for an unrestricted return to sports, which aligns with the preferences reported by Golant et al. The relatively higher complication rate of rTSA as compared to TSA may explain the increased degree of surgeon hesitancy in allowing this patient group to undergo a full, unrestricted return to physical activity [22]. While contact sports are less commonly performed in the older athletic population that typically undergoes shoulder replacement, the significant discrepancy reported in terms of physician comfort level for return to contact sports after rTSA versus TSA and HA is notable and may indicate that a universal criterion in regard to contact sports participation across all arthroplasties is not appropriate [17,23]. This emphasises the importance of counselling patients preoperatively, understanding their desired activity goals, and, where possible, factoring these variables into medical decision-making when choosing the most appropriate arthroplasty technique for patients seeking to engage in contact sports postoperatively.

A previous meta-analysis of 11 studies by Papalia et al. noted a significantly higher RTS rate for TSA versus rTSA (90% vs. 77%) [28]. However, no distinction was made as to whether the lower RTS rate for patients undergoing rTSA can be attributed to limitations in shoulder function or a greater propensity for their surgeons to advise restrictions on RTS, which may indirectly lead to lower RTS rates in this group. In this case, the RTS rate may have been lower due to surgeon-imposed activity restrictions rather than the true physical limitations of the operated shoulder. While patients undergoing rTSA typically have rotator cuff deficiencies, the degree to which this impacts shoulder function after rTSA and directly precludes RTS is still poorly understood and presents a topic for future investigations.

Physician clearance was used in three of the articles for RTS criteria; however, no specification was provided as to the specific factors assessed by physicians prior to providing such clearance. As such, it is possible that other unmentioned RTS criteria were used by individual surgeons in clearing patients for RTS. Whether these criteria were entirely dependent on a physician’s assessment of a patient or if a discussion was initiated between the provider and patient to understand the patient’s readiness to resume sports is unknown.

Based on our results, we are unable to definitively conclude as to why the RTS criteria after shoulder arthroplasty are underreported in the current literature. We suspect this may in part be due to the demographic receiving shoulder arthroplasty, with older patients less likely to be involved in sports than younger individuals. Additionally, a significant degree of variation exists in terms of surgeon recommendations following shoulder arthroplasty, as highlighted by previous studies, making the task of selecting standardised RTS criteria to be used universally across providers challenging [17]. While it may be imprudent to establish set RTS criteria encompassing all athletes, it is imperative to identify criteria that may significantly impact athletic performance, surgical outcomes, and patient satisfaction that may then be tailored by providers to a patient’s desired activity goals, type of surgical procedure and allow for effective preoperative and postoperative counselling for patients who desire to RTS after surgery.

This study has several limitations worth noting. Scoping reviews are meant to be comprehensive, but there is always a risk of missing certain studies in our search. There is a possibility that not all RTS criteria were reported by the studies included, either due to constraints involved in the publishing process or by author choice. Three studies included in this review were from the same author, thus weighing our results in favour of a single surgeon’s or institution’s preferences in terms of RTS criteria after shoulder arthroplasty. This review included all patients characterised as “athletes” however we were unable to characterise the intensity of athletic activity performed by patients, which precludes our ability to draw definitive conclusions on whether riskier or higher-intensity sports warrant more stringent RTS criteria. Finally, this study did not assess the impact of certain RTS criteria on patient outcomes postoperatively. This is particularly relevant in cases where certain RTS criteria directly contrast with one another (i.e., resumption of contact sports and weight bearing) and presents an area where future research can provide more definitive conclusions to guide sports medicine
surgeons.

Future research in this field should focus on investigating the influence of the currently reported RTS criteria after shoulder arthroplasty on patient outcomes. Given the degree of contrast and heterogeneity between the criteria illustrated in this scoping review, there is a need for validation of specific RTS criteria in athletes undergoing shoulder arthroplasty to better aid clinicians in deciding when and how athletes can safely resume sports postoperatively to minimise both their time of absence and any restriction on participation.

5. Conclusion

Thirteen studies reported one or more RTS criteria following shoulder arthroplasty, with time after surgery being the most common RTS criterion used. These results emphasise the need for interprofessional discussion and communication amongst surgeons, athletic trainers, physical therapists, and athletic trainers to establish evidence-based RTS criteria following arthroplasty and promote a safe and effective return to sport.

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Declaration of interests

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