Assessing shoulder disability in orthopaedic specialist care: Introducing the Copenhagen Shoulder Abduction Rating (C-SAR)

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ABSTRACT

Background: Differences in shoulder-disability among common shoulder-disorders in orthopaedic specialist care is unknown. Furthermore, rating of shoulder-disability using patient-reported outcomes is time-consuming, and a faster approach is needed.

Objectives: First, compare shoulder-disability among common shoulder-disorders. Secondly, rate shoulder-disability according to the new and quick Copenhagen Shoulder Abduction Rating (C-SAR) and investigate criterion validity of C-SAR.

Methods: Cross-sectional study including 325 consecutive patients with shoulder-disorders in orthopaedic specialist care. We assessed shoulder abduction range-of-motion and pain during testing (NRS:0-10), and shoulder-disability using Shoulder Pain and Disability Index (SPADI) subscales. Patients were sub-grouped using C-SAR, which is based on shoulder abduction range-of-motion and pain during testing: Severe (range-of-motion <90°), Medium (range-of-motion >90°, NRS:<5), Mild (range-of-motion >90°, NRS:<5). Shoulder-disability was compared among diagnostic categories and C-SAR subgroups using ANCOVA-models.

Results: Most patients were diagnosed with either subacromial impingement (n=211) or full-thickness/complete rotator-cuff tear (n=18), but adhesive capsulitis (n=22) was the diagnostic category related to worst SPADI scores. Data for C-SAR subgrouping were available from 187/229 (82%) patients with rotator-cuff related diagnoses in secondary care.

Conclusion: In orthopaedic specialist care, adhesive capsulitis relates to highest level of shoulder-disability, while C-SAR is a promising test to rate shoulder-disability for most patients, namely those with rotator-cuff related disorders.

1. Introduction

Subacromial impingement syndrome, rotator cuff tears, adhesive capsulitis and glenohumeral labral tears account for the vast majority of shoulder disorders (Juel and Natvig, 2014; Malavolta et al., 2017). These common shoulder disorders are related to shoulder pain and impaired shoulder function, with accompanying limitations in shoulder activities.

In general, patients with more pronounced symptoms are of special interest, as higher levels of shoulder disability have been linked to increased societal costs (Kuijpers et al., 2006). These severe cases are more common in secondary care, as patients with persistent or pronounced symptomatology are often referred for orthopaedic specialist evaluation. Understanding the variability in severity between shoulder diagnoses in secondary care could add to our understanding of the societal burden related to each of these and provide valuable insight to allow researchers and policy makers to focus on improving rehabilitation for the most severe shoulder diagnoses. At this point it is unknown how shoulder disability differs among the most common shoulder diagnoses in secondary care.

The level of disability is best assessed from the patients perspective (Chin and Lee, 2008; Deshpande et al., 2011), which is why patient-reported outcome measures (PROMs) are optimal for this (Chin and Lee, 2008; Deshpande et al., 2011). While most shoulder-specific PROMs include items related to limitations in participation and more general activities (Roe et al., 2013), the Shoulder Pain And Disability
Index (SPADI) has a stringent focus on joint-specific disability (Roe et al., 2013; Roach et al., 1991), making it ideal for comparing the level of shoulder disability among common shoulder disorders.

Assessment of shoulder disability might also be useful to guide care (McClure and Michener, 2015), since a shoulder diagnosis in itself does not provide such information. Currently, the information is obtained through PROMs, but the use of PROMs in everyday clinical practice is often considered too time-consuming (Jette et al., 2009; Tygel, 2013). Therefore, there is a need for a quick method to rate the shoulder disability. The newly developed Copenhagen Shoulder Abduction Rating (C-SAR) test could be a solution to this. The C-SAR test is a simple and quick method, that combines abduction ROM and pain during the test to rate the level of shoulder disability into three levels: Mild, Medium and Severe. This impairment rating could prove a useful alternative to PROMs, but this requires that C-SAR scores are valid representation of patient-rated shoulder disability.

The current study has two purposes. First, to investigate and compare shoulder disability among patients diagnosed with the most common shoulder diagnoses in secondary care. Secondly, to rate shoulder disability in patients with shoulder disorders according to C-SAR and investigate the criterion validity of C-SAR scores, by comparing shoulder disability among C-SAR subgroups.

2. Materials and methods

2.1. Design, settings and procedures

This is a cross-sectional study including a consecutive cohort of patients referred to secondary care at Arthrosopic Center in Hvidovre Hospital, a public outpatient clinic in the capital region of Denmark. All patients referred for initial examination of their shoulder disorder at the department during a 3-months period (March to Jun 2014) were eligible for inclusion.

On the day of examination, one of six trained assessors (two physiotherapists, three physiotherapy undergraduates and one medical student) collected data on patient-reported shoulder function, kinesiophobia and pain, and conducted a clinical assessment of shoulder strength and ROM. For safety reasons, assessment of strength and ROM was omitted in cases where the patient reported a tendency to dislocation of the shoulder. After data collection, an orthopaedic shoulder specialist, blinded to all test results, performed a clinical examination of the shoulder. After data collection, an orthopaedic shoulder specialist, blinded to all test results, performed a clinical examination of the shoulder.

The study has been evaluated by the Capitol Region Committee on Health Research Ethics in Denmark, where it was evaluated as not requiring formal ethical approval (H-3-2013-FSP29). Written informed consent was obtained from all participants.

2.2. Participants

All patients with a shoulder disorder referred to the department were considered eligible for inclusion based on the following inclusion criteria: age 18 years or more, sufficient Danish language ability, informed written consent, and no competing disorder affecting the shoulder function or the ability to answer questionnaires. Based on the diagnosis provided by the orthopaedic specialist, all included patients were categorized into one of the following diagnostic categories: 1) Subacromial impingement syndrome (SIS) with or without concomitant AC-joint pathology and partial thickness rotator-cuff tear, 2) labral injury and/or glenohumeral dislocation sequelae (glenohumeral injury), 3) complete or full-thickness rotator-cuff tear (complete/full-thickness RC-tear), 4) adhesive capsulitis, or 5) other (Fig. 1, Study flow).

2.3. Outcomes

2.3.1. Descriptive variables

Age (years) and gender was collected from all patients. Worst pain last week was assessed using the validated 11-point numeric rating scale (NPRS, 0 = no pain, 10 = worst imaginable pain) (Jensen et al., 1999). Patient-reported function was assessed using the Quick Disability of the Arm, Shoulder and Hand (Q-DASH) (Gummesson et al., 2006). Q-DASH is scored from 0 (best) to 100 (worst) and consists of eight physical function items and three symptom items, each scored from 1 to 5. All items are weighted equally for calculation of the total score. The Q-DASH questionnaire covers symptoms related to the arm, shoulder and hand, as well as aspects related to limitations in body functions, activity and participation (Roe et al., 2013). The Danish version of Q-DASH has been found to have excellent reliability (Schønemann and Eggers, 2016), though it has not been investigated specifically for shoulder disorders.

2.3.2. Shoulder disability

Disability covers impairments, activity limitations, and participation restrictions as defined by the International Classification of Functioning, Disability and Health (World Health Organisation, 2022). Data on shoulder disability were collected using the Shoulder Pain and Disability Index (SPADI) (Roach et al., 1991), as SPADI is one of the most joint-specific shoulder PROMs, focusing on pain and shoulder impairments and limitations in shoulder-specific activities (Roe et al., 2013). Shoulder disability was quantified as the total SPADI score, which range from 0 (best) to 100 (worst) and is calculated as the average of the five-item pain sub-scale and the eight-item function sub-scale. The Danish version of SPADI has been found to have good reliability (Christiansen et al., 2013). Recently, however, Rasch analyses has revealed that the validity of the SPADI total score could be questioned (Christensen et al., 2018; Jerosch-Herold et al., 2017), and SPADI should therefore be reported as two separate sub-scales; SPADI-pain (five items) and SPADI-function (six items). For the current study, we report both the original total score and the sub-scale scores, with SPADI-pain scores being adjusted for differential item function by age and omitting two items from the SPADI-function sub-scale, as suggested by Christensen et al. (2018). The SPADI total score is reported to facilitate comparisons to existing evidence as many previous studies only report the total score.

2.3.3. Copenhagen Shoulder Abduction Rating (C-SAR)

Copenhagen Shoulder Abduction Rating (C-SAR) is a shoulder disability rating (Fig. 2) based on the results from the assessment of active abduction ROM and pain during the test. The use of active abduction ROM was deemed relevant because assessment of active range of motion is advised in the examination of patients with shoulder disorders (Godsi and Howe, 2015) and low levels of active abduction ROM have been reported in some shoulder patients (Engerbretsen et al., 2010). Furthermore, pain during active abduction is a key component in the test for painful arc syndrome (Kessel and Watson, 1977), which is often used in diagnostic examination (Hegehus et al., 2015), but the level of pain is not taken into account when performing the painful arc test. In this study, active abduction ROM was measured in degrees using a digital inclinometer. The subject was instructed to raise the arm as high as possible, in the coronal plane towards the ceiling, with the elbow fully extended. ROM was measured with the inclinometer aligned parallel to the humerus, close to the insertion of the deltoit muscle. The inter-tester reliability of the test is excellent with ICC 0.95 (95%CI 0.89
to 0.97), SEM = 1.6° and MDC90 = 4° (Kolber et al., 2011). After the test, patients were asked to rate their maximum pain experienced during the assessment on the 11-point NPRS. C-SAR scores were defined as: Severe, < 90° abduction ROM; Medium, > 90° abduction ROM with pain during abduction ROM assessment ≥6 (NPRS 0-10) and; Mild, > 90° abduction ROM with pain during abduction ROM assessment ≤5 (NPRS 0-10). We tested the reliability of C-SAR score based on test-retest data from a convenience sample of 20 patients with shoulder disorders, who were not included in this study, and found excellent inter-tester reliability (Weighted Kappa = 0.84 95%CI 0.68 to 1.00).

2.3.4. Data analyses

Descriptive statistics with means and standard deviations (SD) or median with interquartile range [IQR] were applied for continuous variables, and numbers (percentages) for categorical variables. SPADI, SPADI-function and SPADI-pain scores were compared among diagnostic categories using ANCOVA models (with no covariates included), making sure that model assumptions were met (i.e. no outliers, approximate normal distribution of residuals for each category of the independent variable, and homogeneity of variance). Groups were compared using the CONTRAST subcommand in SPSS. Patients were divided according to C-SAR score, separately for each diagnostic category and the distribution of ratings within each diagnosis presented as numbers (percentages). To investigate the criterion validity (Mokkink et al., 2010) of C-SAR scores, we used SPADI, SPADI-function and SPADI-pain scores as gold standard and compared these among C-SAR subgroups, using ANCOVA models (as described above). For all comparisons made using ANCOVA models, effect-sizes (ES) were estimated as the mean difference divided by the common SD. All analyses were conducted as available-case analyses and a significance level of 5% was applied. All analyses were conducted using IBM SPSS v24.

2.3.5. Sample size consideration

As the specific sizes of diagnostic groups were not known a priori, no formal sample size calculation was conducted prior to data collection. Of relevance when interpreting the contrasts estimates in this study, comparisons of equally sized groups, requires 26 and 64 patients in each group to have a statistical power of 80% to detect a large or medium ES, respectively (Cohen’s d 0.8 and 0.5, respectively), with a significance level of 0.05.

3. Results

The majority of the 325 included patients were diagnosed with SIS (65%), while glenohumeral injury (9%) adhesive capsulitis (7%), complete/full-thickness RC-tear (6%) or other diagnoses (14%) were less common (Fig. 1). The group diagnosed with glenohumeral injuries consisted of 17 patients with labral injury, 2 patients with glenohumeral dislocation sequelae, and 11 patients with both (Fig. 3). The mean age of the full cohort was 51 years (SD 16) and 48% were females.

3.1. Comparing shoulder disability among common shoulder disorders

Compared to patients with SIS, the patients diagnosed with adhesive capsulitis scored worse in SPADI (mean diff. 11 points (95%CI: 1 to 21), ES 0.5, p = .025) and SPADI-function (mean diff. 15 points (95%CI: 4 to 26), ES 0.6, p = .009), but SPADI-pain did not differ significantly (mean diff. 10 points (95%CI: 0 to 20), ES 0.4, p = .059). Patients diagnosed with complete/full-thickness RC-tear did not differ from those diagnosed with SIS or adhesive capsulitis in any of the analyses (p = .141 to p = .991) (Table 1 and Fig. 4). Patients diagnosed with glenohumeral injury scored better in SPADI, SPADI-pain and SPADI-function compared to all other diagnostic groups (ES 0.8 to 1.4, p < .01).
3.2. Disability rating and sub-classification of patients using C-SAR

Disability rating was possible for 212 (75%) of the 281 patients in the four diagnostic categories (see Fig. 1 for details). Distributions among C-SAR subgroups were fairly even or slightly skewed for patients with SIS and complete/full-thickness RC-tear (Fig. 5). Patients with adhesive capsulitis were all in the Severe C-SAR subgroup, while 7 out of 9 patients with glenohumeral injury were in the Mild C-SAR subgroup. Within the diagnostic categories of adhesive capsulitis and glenohumeral injury it was not deemed feasible to do further comparisons because of the small number of patients and the lack of distribution between C-SAR subgroups. Furthermore, considering the similarities of complete/full-thickness RC-tears and SIS, these groups were merged for further comparisons among C-SAR subgroups. From the 187 patients with SIS or complete/full-thickness RC-tear, C-SAR score was Severe for 34% (n = 64), Medium for 30% (n = 56), and Low for 36% (n = 67).

3.3. Validity of C-SAR score in patients with SIS or complete/full-thickness RC-tear

The subgroup with Mild C-SAR score had lower level of shoulder disability than those with Medium C-SAR score, as measured with SPADI (mean diff. 21 points 95%CI: 15 to 27, ES 1.0, p < .0001), SPADI-pain (mean diff. 20 points 95%CI: 14 to 27, ES 1.0, p < .0001) and SPADI-function (mean diff. 21 points 95%CI: 14 to 28, ES 1.0, p < .0001) (Table 2 and Fig. 6). Patients with Medium C-SAR score had lower levels of shoulder disability than those with Severe C-SAR score, when measured with SPADI-function (mean diff. 9 points 95%CI: 2 to 16, ES 0.4, p = .017), but not SPADI (mean diff. 6 points 95%CI: −1 to 12, ES 0.3, p = .085) and SPADI-pain (mean diff. 2 points 95%CI: −5 to 9, ES 0.1, p = .536) (Table 2 and Fig. 6).

4. Discussion

Firstly, our findings indicate that glenohumeral dislocation sequelae and/or labral injury (glenohumeral injury) are associated with less severe shoulder disability compared to SIS, complete/full-thickness RC-tear and adhesive capsulitis, while adhesive capsulitis was associated with more severe shoulder disability compared to SIS. A main finding of the current study is also that shoulder-disability can be assessed in patients with SIS or complete/full-thickness RC-tear using the newly developed Copenhagen Shoulder Abduction Rating (C-SAR). The C-SAR is a valid assessment of shoulder-disability, requiring only 10 s to perform.

In the current study, we compared shoulder disability, in terms of SPADI, SPADI-pain and SPADI-function scores, across the most common shoulder diagnoses. To the best of our knowledge, such comparisons have not previously been described. Most pronounced differences in shoulder disability were found when comparing patients with glenohumeral injury to the other three diagnostic groups (SIS, complete rotator-cuff tears, and adhesive capsulitis). These differences were medium to large (ES 0.8 to 1.4) with SPADI mean differences ranging from...
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19 to 31 points, thereby surpassing the minimal clinical important difference (MCID) of SPADI total score (MCID: 8-13). These findings are not surprising, considering that the cardinal symptoms related to glenohumeral injuries, such as laxity and sense of instability (Kirkley et al., 1998), are not included in SPADI. However, based on the results of the current study, it seems that glenohumeral injuries could be considered less severe when compared to SIS, complete/full-thickness RC-tear and adhesive capsulitis, considering that the level of shoulder disability has previously been linked to increased societal costs (Kuijpers et al., 2006) while pain, by itself, also affects health related quality of life (Skevington, 1998). In the other end of the shoulder disability spectrum, adhesive capsulitis was related to higher levels of shoulder disability when compared to SIS, with differences in SPADI approximating the MCID (mean diff. 11, \( p = .025 \)). For the SPADI sub-scales, the difference was only significant for function (\( p = .009 \)) and not for pain (\( p = .059 \)).

**Table 1**

Descriptive variables and shoulder-specific disability, separately for each of the four diagnostic groups.

<table>
<thead>
<tr>
<th>Subacromial impingement</th>
<th>Glenohumeral injury</th>
<th>Complete rotator-cuff tear</th>
<th>Adhesive capsulitis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Descriptive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age in years, mean ±SD</td>
<td>53 ± 14</td>
<td>32 ± 12</td>
<td>67 ± 12</td>
</tr>
<tr>
<td>Gender, %female</td>
<td>53%</td>
<td>17%</td>
<td>44%</td>
</tr>
<tr>
<td>Worst pain (0-10), median [IQR]</td>
<td>8 [6; 9]</td>
<td>6.5 [2; 8]</td>
<td>8 [7; 10]</td>
</tr>
<tr>
<td>Q-DASH (0-100), mean ±SD</td>
<td>45 ± 19</td>
<td>32 ± 22</td>
<td>49 ± 22</td>
</tr>
</tbody>
</table>

**Shoulder disability**

| SPADI (0-100), mean ±SD | 55 ± 22 | 36 ± 23 | 59 ± 24 | 66 ± 19 |
| SPADI-P (0-100), mean ±SD | 60 ± 22 | 40 ± 26 | 60 ± 28 | 69 ± 22 |
| SPADI-F (0-100), mean ±SD | 43 ± 25 | 24 ± 24 | 52 ± 23 | 58 ± 23 |

**Worst pain** (0-10), median [IQR]

Subacromial impingement: 8 [6; 9] 66 ± 19
Glenohumeral injury: 6.5 [2; 8] 66 ± 16
Complete rotator-cuff tear: 8 [7; 10] 48 ± 19
Adhesive capsulitis: 9 [8; 10] 69 ± 22

**Q-DASH (0-100), mean ±SD**

Subacromial impingement: 45 ± 19
Glenohumeral injury: 32 ± 22
Complete rotator-cuff tear: 49 ± 22
Adhesive capsulitis: 50 ± 17

**Abduction ROM (degrees), median [IQR]**

Subacromial impingement: 62.5 [43; 75]
Glenohumeral injury: 57.5 [26; 104]
Complete rotator-cuff tear: 54 [14; 141]
Adhesive capsulitis: 52 [5; 7.5]

**Pain in Abduction ROM (0-10), median [IQR]**

Subacromial impingement: 6 [3; 8]
Glenohumeral injury: 7.5 [6; 8]
Complete rotator-cuff tear: 8 [5; 9]
Adhesive capsulitis: 7.5 [6; 8]

**Table 2**

Shoulder disability, pain and abduction ROM for each C-SAR group of patients with SIS or complete/full-thickness RC-tear.

<table>
<thead>
<tr>
<th>C-SAR</th>
<th>Severe (N = 64)</th>
<th>Medium (N = 56)</th>
<th>Mild (N = 67)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPADI (0-100), mean ±SD</td>
<td>66 ± 19</td>
<td>61 ± 16</td>
<td>40 ± 18</td>
</tr>
<tr>
<td>SPADI-pain (0-100), mean ±SD</td>
<td>69 ± 20</td>
<td>66 ± 16</td>
<td>46 ± 20</td>
</tr>
<tr>
<td>SPADI-function (0-100), mean ±SD</td>
<td>57 ± 23</td>
<td>48 ± 19</td>
<td>27 ± 19</td>
</tr>
<tr>
<td>Q-DASH (0-100), mean ±SD</td>
<td>54 ± 19</td>
<td>43 ± 16</td>
<td>34 ± 17</td>
</tr>
<tr>
<td>Worst pain last week (0-10), median [IQR]</td>
<td>8 [7; 10]</td>
<td>8 [7; 9]</td>
<td>7 [5; 8]</td>
</tr>
<tr>
<td>Abduction ROM (degrees), median [IQR]</td>
<td>62 [43; 75]</td>
<td>122 [104; 141]</td>
<td>153 [122; 166]</td>
</tr>
<tr>
<td>Pain in Abduction ROM (0-10), median [IQR]</td>
<td>8 [5; 9]</td>
<td>7.5 [6; 8]</td>
<td>3 [1; 5]</td>
</tr>
</tbody>
</table>

Fig. 4. Level of shoulder disability (SPADI-pain and SPADI-function) for each of the four diagnostic groups, including 95% confidence intervals. *p < .05, **p < .01, ***p < .001, ****p < .0001.

Fig. 5. Distribution of C-SAR levels within each of the four diagnostic categories.

Fig. 6. Level of shoulder disability (SPADI-pain and SPADI-function) for each of the C-SAR levels in patients with SIS or complete/full-thickness RC-tear including 95% confidence intervals.
This could indicate that functional limitations differ more between patients with SIS and adhesive capsulitis, respectively, than do pain.

To the best of our knowledge, this is the first study to introduce a quick method for shoulder disability rating of shoulder disorders in specialist orthopaedic care, the Copenhagen Shoulder Abduction Rating (C-SAR). When subgrouping patients with SIS or complete/full-thickness RC-tear according to the C-SAR, the subgroups differed significantly in shoulder disability scores. Accordingly, having a Mild C-SAR score was related to significantly and clinically relevant better scores in SPADI when compared to both a Medium and Severe C-SAR score, with medium to large ES and mean differences surpassing the 8 to 13 points MCID for SPADI (Paul et al., 2004; Angst et al., 2008). Differences between patients with Medium and Severe C-SAR scores were less pronounced; Severe C-SAR scores were related to significantly worse SPADI-function scores when compared to Medium C-SAR scores (mean diff. 9 points, ES 0.4, \( p = .017 \)), but SPADI (6 points, ES 0.3, \( p = .085 \)) and SPADI-pain (2 points, ES 0.1, \( p = .536 \)) did not differ. This indicates that functional limitations are the main difference between patients with Severe and Medium C-SAR scores, which is further supported by the much lower abduction ROM in the patients with Severe C-SAR score (median ROM 62° [43; 75]) compared to patients with Medium C-SAR score (median ROM 122° [104; 141]), while pain intensities were similar in the two groups (median Worst pain last week: 8 [7; 10] and 8 [7; 9], Table 2). Collectively, these findings demonstrate that relevant differences in shoulder disability exists even though pain ratings are similar. In contrast, the severity of shoulder disorders is sometimes judged based on pain alone (Dunn et al., 2014), which is why relevant differences in disability might be overlooked.

Our results demonstrate that the level of disability differs to a high degree within the population of patients with SIS. However, the available guidelines (Danish Health Authority, 2016; Diercks et al., 2014; The Royal College of Surgeons of England, 2014; Vandvik et al., 2019) and level-one evidence (Abdulla et al., 2015; Dong et al., 2015; Hanratty et al., 2012; Hopewell et al., 2021; Beard et al., 2018; Paavola et al., 2018; Clausen et al., 2021) does not distinguish between patients based on the level of disability, which is why the treatment of SIS is guided by the same evidence, irrespective of the level of shoulder disability. In contrast, acknowledgement of the large variations in levels of shoulder disability within the SIS population will allow for the development of relevant stratified care. To give an example; an intervention that decreases disability in patients with low disability (e.g. Mild C-SAR score: pain during abduction \( \leq 5 \)) might not have the same effect in patients who are unable to abduct their arm above 90° (i.e. Severe C-SAR score), and vice versa. Hence, C-SAR might be a useful tool to guide stratified care, but further studies are needed to assess its prescriptive validity and responsiveness to change. As an interesting observation, a subgroup of patients with SIS or complete/full-thickness RC tear had SPADI scores similar to patients with adhesive capsulitis that indicated high levels of disability (66 vs 66 points, \( p = .95 \)) and this subgroup included 64 patients with Severe C-SAR. Thus, the number of patients with SIS or complete/full-thickness RC tear with Severe C-SAR was at least three times greater than the number of patients with adhesive capsulitis with Severe C-SAR (\( n = 16 \)), which is why it seems that a large proportion of the patients with the highest level of shoulder disability are to be found in the group of patients with SIS or complete/full-thickness RC-tear. This indicate that an increased focus on improving care for this distinct sub-group could have a substantial impact on the overall socio-economic consequences of shoulder disorders.

There are certain limitations to the current study. Firstly, diagnoses were based on the overall clinical judgement with the aid of paraclinical investigations, rather than relying on specific pre-defined criteria, possibly reducing the replicability of the results. However, considering the limited accuracy of diagnostic tests for the shoulder (Hegedus et al., 2012), it is not advisable to rely solely on such criteria in clinical settings. The procedure used in this study reflects clinical practice, thereby increasing the generalizability of our results (Loudon et al., 2015).

Secondly, in the consecutive cohort included in this study, diagnosis of complete/full-thickness RC-tear, adhesive capsulitis and glenohumeral injury were not common (6-9% with each diagnosis) resulting in group-sizes of less than 26, which was the cut-point used for sample-size justification. This increases the risk of type I errors for statistical comparisons among these groups. Thirdly, the cut-off criteria for C-SAR scores were not based on a data-driven approach, but rather on the face-validity and time-efficiency of the method. While more advanced criteria might be more sensitive in determining shoulder disability, this also comes with the risk that identified cut-offs are too specific to the sample, at the cost of generalizability. Further, our approach was assumed to best fit the aim of the study, namely to provide a quick method to easily obtain information on shoulder disability. Importantly, this study is the first to describe and test the C-SAR, and though our results show promising validity of the test, this needs further investigation.

5. Conclusion

We found that adhesive capsulitis is associated with the highest levels of shoulder disability, followed by SIS and complete/full-thickness RC-tears. We also found that the Copenhagen Shoulder Abduction Rating (C-SAR) can be introduced in specialist orthopaedic care as a quick method to obtain valid information on the level of shoulder disability in patients with SIS or complete/full-thickness RC-tear. Future studies should investigate the relevance of stratified care based on the C-SAR scores, as the same surgical and/or conservative treatment modalities might not be relevant across subgroups with different levels of shoulder disability.

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Conflict of interest

All authors declare no financial or nonfinancial conflicts of interests.

Author’s contribution

MBC contributed to conception and design of the study, analysis and interpretation of data, and acquisition of data. AW contributed to acquisition and analysis of data. KBC contributed to analysis and interpretation of data. MKZ contributed to conception and design of the study, and interpretation of data. MF contributed to acquisition and analysis of data. AC contributed to conception and design of the study. KT contributed to conception and design of the study and interpretation of data. PH contributed to conception and design of the study and interpretation of data. All authors have contributed to the manuscript, have approved the final version and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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