High Variability of the Definition of Recurrent Glenohumeral Instability: An Analysis of the Current Literature by a Systematic Review

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Purpose: To determine the definitions for recurrence used in the literature, assess the consensus in using these definitions, and determine the impact of these definitions on recurrence rates. Methods: A literature search was performed in PubMed and EMBASE including studies from 2000 to 2020 reporting on recurrence rates after anterior arthroscopic shoulder instability surgery. Dislocation, apprehension, subluxation and recurrence rates were compared. Results: Ninety-one studies were included. In 68% of the eligible studies, recurrence rates are not well defined. Thirty (33%) studies did not report on dislocations, 45 (49%) did not report on subluxations, and 58 (64%) did not report on apprehension. Seventeen different definitions for recurrence of instability, 4 definitions of dislocations, and 8 definitions of subluxation were used. Conclusion: Recurrence rates are poorly specified and likely underreported in the literature, hampering comparison with results of other studies. This highlights the need for a consensus on definition of recurrence across shoulder instability studies. We recommend not using the definition recurrence of instability anymore. We endorse defining dislocations as a radiographically confirmed dislocation or a dislocation that is manually reduced, subluxations as the feeling of a dislocation that can be (spontaneously) reduced without the need for a radiographically confirmed dislocation, and a positive apprehension sign as fear of imminent dislocation when placing the arm in abduction and external rotation during physical examination. Reporting on the events resulting in a dislocation or subluxation aids in making an estimation of the severity of instability. Level of Evidence: Level IV, systematic review.

Depending on the risks for recurrent shoulder instability can be managed conservatively, with (arthroscopic) soft-tissue procedure, or (open) bony procedures. The arthroscopic Bankart repair is the most used procedure, including up to 87% of instability procedures. Several studies have assessed recurrence rates after shoulder instability surgery. The recurrence rate for the general population varies from 0% to 8% after Latarjet procedure to 3.4% to 35% after arthroscopic Bankart repair. Although most studies describe rates of recurrent dislocation (instability), there is no consensus on the definition of these terms. For example, Randelli et al. uses redislocation or subluxation as a definition of recurrent instability, whereas Gerometta et al. does not describe a definition of a recurrence of instability/dislocation. As a result, findings in previous studies were hard to compare. Kuhn has described that shoulder instability studies are procedure based and not condition based, resulting in unclear definitions of instability. He introduced the frequency, etiology, direction, and severity system for describing instability. Kennedy et al. has described that there is a wide variety of definitions of recurrence in the literature and that the recurrence rates vary according to level of evidence, age, follow-up time, and attrition rate. Although Kennedy et al. have noticed that there are many different definitions used in the literature, it is still unclear how many studies did not define these definitions. The purposes of our study were to...
determine the definitions for recurrence used in the literature, assess the consensus in using these definitions, and determine the impact of these definitions on recurrence rates. We hypothesized that for shoulder instability the definition of recurrence is poorly reported and that there is no consensus on the definition to be used.

**Methods**

This is a systematic review of available literature on the definition of recurrent anterior shoulder instability and is performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline. No review protocol was identified for this study.

**Literature Search and Study Selection**

A literature search was performed on August 5, 2020, in PubMed and EMBASE with predefined search terms (Appendix 1), including all studies mentioning recurrence rates in Dutch, German, Arabic, and English. The search was limited to studies between 2000 and 2020 to give insight into definition of recurrence in the most recent literature. The inclusion criteria included studies assessing recurrence rates after arthroscopic anterior shoulder instability surgery. Letters to the editors, instructional courses, animal/cadaver/in vitro studies,
| Article (reference) | Number of Patients (n) | Mean Follow-up | Open/Arthroscopic | Diagnostic Certainty | Type of Study | Description of Treatments | Postoperative Rehabilitation | Outcome Criteria | Procedure for Assessing Outcomes | Description of Subjects | Mean Modified Coleman Score |
|---------------------|------------------------|----------------|-------------------|----------------------|---------------|-----------------------------|-------------------------------|-----------------|---------------------------------|--------------------------|--------------------------|
| Thal et al.         | 72                     | 24             | +                 | +                    | Retrospective  | +                           | +                            | 1,3             | 2,3,4                           | 1,2                     | 69                       |
| Law et al.          | 38                     | 28             | +                 | +                    | Retrospective  | +                           | +                            | 1,3             | 3,4                            | 1,2                     | 59                       |
| Wolf et al.         | 45                     | 58             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 62                       |
| Park et al.         | 20                     | 29             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 61                       |
| Cho et al.          | 72                     | 25             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | —                              | 1,2                     | 69                       |
| Porcellini et al.   | 385                    | 36             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | —                              | 1,2                     | 61                       |
| Hantes et al.       | 63                     | 39             | +                 | +                    | Prospective    | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 94                       |
| Lützner et al.      | 39                     | 31             | +/−               | —                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 53                       |
| Flinkkilä et al.    | 174                    | 51             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 75                       |
| Imhoff et al.       | 190                    | 37             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 73                       |
| Park et al.         | 161                    | 37             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 69                       |
| Taverna et al.      | 26                     | 30             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 56                       |
| Kim et al.          | 110                    | 45             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 79                       |
| Van der Linde et al.| 70                     | 108            | +                 | +                    | Prospective    | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 96                       |
| Gasparini et al.    | 143                    | 81             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,3,4                           | 1                       | 73                       |
| Kemp et al.         | 40                     | 24             | +                 | −                    | Prospective    | +/−                         | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 74                       |
| Ahmed et al.        | 302                    | 68             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 94                       |
| Sommaire et al.     | 34                     | 34             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1                       | 70                       |
| Milano et al.       | 70                     | 24             | +                 | +                    | RCT            | +                           | +                            | 1,2,3,4         | 1,2,3,4                         | 1                       | 75                       |
| Owens et al.        | 39                     | 140            | +                 | −                    | Prospective    | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 82                       |
| Mohtadi et al.      | 54                     | 24             | +/−               | +                    | RCT            | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 87                       |
| Shin et al.         | 62                     | 47             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,3,4                           | 1                       | 70                       |
| Tordjman et al.     | 31                     | 61             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 67                       |
| Robinson et al.     | 84                     | 24             | +                 | +                    | RCT            | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 70                       |
| Lee et al.          | 170                    | 38             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 61                       |
| Torrance et al.     | 67                     | 33             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1                       | 76                       |
| Vermeulen et al.    | 147                    | 76             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1                       | 74                       |
| Chan et al.         | 131                    | 24             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | —                              | 1,2                     | 61                       |
| Park et al.         | 193                    | 37             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1,2                     | 74                       |
| Ruiz Ibáñ et al.    | 140                    | 64             | +                 | +                    | Prospective    | +/-                         | —                            | 1,2,3           | —                              | 1                       | 52                       |
| Su et al.           | 65                     | 56             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | —                              | 1                       | 59                       |
| Dickens et al.      | 29                     | One season     | +/-               | —                    | Prospective    | +/-                         | +                            | 1,2,3           | 1                              | 1                       | 53                       |
| Chen et al.         | 221                    | 50             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 2                              | 1                       | 69                       |
| Moore et al.        | 34                     | 52             | +                 | −                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1                       | 58                       |
| Yapp et al.         | 33                     | 170            | +/-               | −                    | RCT            | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1                       | 81                       |
| Rhee et al.         | 48                     | 35             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 73                       |
| Oh et al.           | 120                    | 28             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,2,3,4                         | 1,2                     | 71                       |
| Ono et al.          | 51                     | 121            | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,3,4                           | 1                       | 70                       |
| Nakagawa et al.     | 140                    | 24             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1                              | 1                       | 61                       |
| Iizawa et al.       | 68                     | 31             | +                 | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,3,4                           | 1,2                     | 72                       |
| Lavoué et al.       | 41                     | 72             | +/-               | +                    | Retrospective  | +                           | +                            | 1,2,3           | 1,3,4                           | 1                       | 67                       |
| Pandey et al.       | 136                    | 49             | +/-               | +                    | Retrospective  | +                           | +                            | 1,2,3           | 3,4                            | 1                       | 62                       |

(continued)
Table 1. Continued

| Article (reference) | Number of Patients (n) | Mean Follow-up | Open/Arthroscopic | Diagnostic Certainty | Type of Study | Description of Treatments | Postoperative Rehabilitation | Outcome Criteria | Procedure for Assessing Outcomes | Description of Subjects | Mean Modified Coleman Score |
|---------------------|------------------------|----------------|-------------------|----------------------|---------------|---------------------------|-----------------------------|-----------------|----------------------------------|--------------------------|----------------------------|
| Brzó ska et al.57    | 100                    | 83             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,2,3,4                           |                         | 77                         |
| Ernstbrunner et al.26 | 36                     | 158            | +/-               | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,2,3,4                           |                         | 68                         |
| Gül et al.27         | 62                     | 29             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 67                         |
| Loppini et al.28     | 670                    | 101            | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 62                         |
| Park et al.29        | 195                    | 24             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 67                         |
| Jeon et al.30        | 118                    | 28.2           | +/-               | +                    | Retrospective | +                         | +                           | 1,2,3           | 3,4                               | 1                        | 59                         |
| O’Neill et al.11     | 20                     | 24             | +/-               | +                    | Retrospective | +/-                       | -                           | 1,2,3           | 1,3,4                             | 1                        | 48                         |
| Zimmermann et al.31  | 271                    | 120            | +/-               | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 70                         |
| Flinkkilä et al.42   | 167                    | 122            | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,2,3,4                           | 1                        | 77                         |
| McRae et al.36       | 74                     | 24             | +                 | +                    | RCT           | +                         | +                           | 1,2,3           | 1,2,3,4                           | 1                        | 86                         |
| Bessière et al.35    | 93                     | 72             | +/-               | -                    | Retrospective | +/-                       | +                           | 1,2,3,4         | 2,3,4                             | 1,2                       | 78                         |
| Rose et al.65        | 65                     | 63             | +                 | +                    | Retrospective | +/-                       | -                           | 1,2,3,4         | 2,3,4                             | 1,2                       | 59                         |
| Bessière et al.34    | 51                     | 64             | +/-               | -                    | Retrospective | +/-                       | +                           | 1,2,3,4         | 1,3,4                             | 1,2                       | 73                         |
| Castagna et al.70    | 65                     | 63             | +                 | -                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 62                         |
| Thomazeau et al.36   | 125                    | 18             | +                 | +                    | Prospective   | +/-                       | +                           | 1,2,3           | 1,3,4                             | 1                        | 62                         |
| Kim et al.37         | 59                     | 77             | +                 | -                    | Retrospective | +                         | +                           | 1,2,3           | 3,4                               | 1,2                       | 66                         |
| Ozbaydar et al.71    | 93                     | 47             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 75                         |
| Boileau et al.72     | 91                     | 36             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 71                         |
| Calvo et al.73       | 61                     | 45             | +                 | +                    | Prospective   | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 79                         |
| Kim et al.39         | 62                     | 31             | +                 | +                    | RCT           | +/-                       | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 91                         |
| Kim et al.74         | 167                    | 44             | +                 | +                    | Prospective   | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 75                         |
| Sperber et al.38     | 30                     | 24             | +/-               | +                    | RCT           | +/-                       | +                           | 1,2,3           | 1,3,4                             | 1                        | 68                         |
| Nakagawa et al.39    | 257                    | 24             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1                        | 56                         |
| Nakagawa et al.40    | 93                     | 24             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 3,4                               | 1,2                       | 61                         |
| Chechik et al.43     | 83                     | 46             | +                 | -                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 65                         |
| Cole et al.48        | 37                     | 36             | +/-               | +                    | RCT           | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 62                         |
| Anderl et al.42      | 15                     | 26             | +                 | +                    | Prospective   | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 79                         |
| Constantiou et al.73 | 32                     | 217            | +                 | +                    | RCT           | +                         | -                           | 1,2,3           | 1,3,4                             | 1                        | 79                         |
| De Giorgi et al.43   | 22                     | 56             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 2,3,4                             | 1,2                       | 68                         |
| Salomonsson et al.99 | 62                     | 120            | +                 | -                    | RCT           | +/-                       | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 87                         |
| Garcia et al.44      | 24                     | 41             | +                 | +                    | Retrospective | +/-                       | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 67                         |
| Armandi et al.76     | 72                     | 49             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 75                         |
| Bougebri et al.77    | 45                     | 79             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 73                         |
| Kim et al.78         | 36                     | 42             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 64                         |
| McCabe et al.45      | 31                     | 41             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 64                         |
| Ng and Kumar79       | 87                     | 42             | +                 | +                    | Prospective   | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 79                         |
| Ee et al.51          | 79                     | 24             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 64                         |
| Boileau et al.47     | 19                     | 43             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 64                         |
| Sedeek et al.48      | 40                     | 30             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 64                         |
| Phadnis et al.49     | 141                    | 47             | +                 | +                    | Case-control  | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 64                         |
| Franceschi et al.50  | 50                     | 25             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,3,4                             | 1,2                       | 68                         |
| Zhu et al.62         | 49                     | 29             | +                 | +                    | Retrospective | +                         | +                           | 1,2,3           | 1,2,3,4                            | 1,2                       | 73                         |
| Mohtadi et al.83     | 83                     | 24             | +                 | -                    | RCT           | +                         | +                           | 1,2,3           | 1,2,3,4                            | 1                        | 81                         |

(continued)
conference papers, and studies published in journals with an impact factor <1 at the time of the literature search were excluded. Studies wherein the definition of recurrence was not explicitly defined were excluded. First, the studies were selected on title and abstract using the predetermined inclusion and exclusion criteria by 2 authors (H.A. and J.W.C.) independently. Hereafter full-texts were screened and studies were cross-referenced to search for additional studies. Disagreement was resolved by discussion. Agreement between the 2 observers was assessed using Cohen’s kappa, which is a scale of agreement ranging from 0 to 1. A kappa 0.21 to 0.40 corresponds with fair agreement, 0.41 to 0.60 with moderate agreement, 0.61 to 0.80 with substantial agreement, 0.81 to 0.99 with near-perfect agreement, and 1.00 with perfect agreement.

**Data Extraction**

First, we checked whether the authors reported on recurrence rates and how they defined recurrence of instability, subluxations, and dislocations. Afterward, the recurrence rates, dislocation rate, subluxation rate, and positive apprehension rate were extracted and presented. The methodological quality of each study was assessed separately by the same 2 authors using the Coleman Methodology Score. The total number of points correlates with poor (0-49 points), fair (50-69 points), good (70-84 points), or excellent (85-100 points) quality of the study.

**Results**

**Study Selection**

In total, 2,569 titles and abstracts were screened, from which 383 studies were full-text screened resulting in 89 studies being included in the final analysis (Fig 1). From the 282 studies that were eligible for inclusion, 193 (68%) were excluded because the definition of recurrence was not defined clearly. Cross-referencing resulted in inclusion of 2 additional studies. The 2 observers agreed on 83.7% of the articles with a Cohen’s kappa of 0.67.

**Critical Appraisal and Definition of Recurrence**

On the Coleman methodology score, one scored poor, 43 studies scored fair, 37 scored good, and 8 scored excellent (Table 1). From the included studies only 30 studies (34%) reported on the definition of a subluxation, and 26 studies (29%) reported on the definition of a dislocation. In total 17 different definitions for recurrence were used, 8 definitions for subluxations were used, and 4 definitions of a dislocation (Tables 2 and 3). The most frequently used definitions for a recurrence were dislocation or a subluxation (DS) and dislocation, subluxation, subluxation and/or
| Study            | Patients Undergoing Arthroscopic Treatment | Definition of recurrence | Dislocation N (%) | Subluxation N (%) | Apprehension N (%) | Recurrence of Instability N (%) |
|------------------|-------------------------------------------|--------------------------|-------------------|------------------|-------------------|--------------------------------|
| Thal et al.      | 72 DSA                                    |                          | 4 (6)             | 1 (1)            | 5 (7)             |                                |
| Law et al.       | 38 DSA                                    |                          | 2 (5)             | 2 (5)            | 2 (5)             |                                |
| Wolf et al.      | 45 DSA                                    |                          | 2 (4)             | 0                | 5 (11)            | 7 (15.5)                       |
| Park et al.      | 20 DSA                                    |                          | 2 (10)            | 1 (5)            | 3 (16)            |                                |
| Cho et al.       | 72 DSA                                    |                          | 5 (7)             | 6 (8)            | 11 (15)           |                                |
| Porcellini et al.| 385 DS                                    |                          | 31 (8)            | 31 (8)           | 3 (3)             |                                |
| Hantes et al.    | 63 DS                                     |                          | 1 (2)             | 5 (8)            | 2 (3)             |                                |
| Lützner et al.   | 39 DS                                     |                          | 6 (15)            | 5 (14)           | 9 (23)            |                                |
| Flinkkilä et al. | 170 DS                                    |                          | 15 (9)            | 18 (11)          | 33 (19)           |                                |
| Imhoff et al.    | 190 DS                                    |                          | 20 (11)           | 7 (4)            | 27 (14)           |                                |
| Park et al.      | 161 DS                                    |                          | 0                 | 4 (8)            | 12 (7)            |                                |
| Taverna et al.   | 26 DS                                     |                          | 0                 | 0                | 1 (4)             | 0                              |
| Kim et al.       | 60 DS                                     |                          | 3 (3)             | 0                | 5 (5)             | 3 (3)                          |
| Van der Linde el al. | 70 DS                                  |                          | 24 (35)           |                  | 24 (35)           |                                |
| Gasparini et al. | 143 DS                                    |                          | 19 (13)           | 14 (10)          | 33 (23)           |                                |
| Kemp et al.      | 40 DS                                     |                          | 2 (5)             | 6 (14)           | 8 (20)            |                                |
| Ahmed et al.     | 302 DS                                    |                          | 38 (13)           | 15 (5)           | 40 (13)           |                                |
| Kim et al.       | 34 DS                                     |                          | 2 (6)             | 0                | 2 (6)             |                                |
| Sommaire et al.  | 77 DS requiring revision surgery           |                          | 4 (5)             | 8 (10)           | 12 (16)           |                                |
| Milano et al.    | 70 DS                                     |                          | 3 (4)             |                  | 3 (4)             |                                |
| Owens et al.     | 41 Dislocation requiring manual reduction, subluxation, or revision | 6 (15) | 9 (22) | 15 (37) | |
| Mohtadi et al.   | 28 Self-report of 2 subluxation events or 1 dislocation | 0                      | 2 (7) | 2 (7) | |
| Shin et al.      | 63 Dislocation or symptomatic instability | 10 (16) | 2 (3) | 12 (19) | |
| Tordjman et al.  | 31 Walch-Duplay (< 51 points) + DS or Apprehension + feeling of instability | 5 (16) | 3 (10) | 8 (26) | |
| Robinson et al.  | 42 Radiographic dislocation/subjective slipping or apprehension/Apprehension and load-and-shift test | 3 (7) | | 3 (7) | |
| Lee et al.       | 170 Dislocation or a subjective feeling of instability with objective clinical apprehension requiring further treatment | 12 (7) | 20 (12) | 20 (12) | 32 (19) | |
| Torrance et al.  | 67 Dislocation or subluxation event that occurred within 2 years after surgery | 31 (14) | | | |
| Vermueen et al.  | 147 DS                                    |                          | 21 (14)           | 12 (8)           | 33 (22)           |                                |
| Chan et al.      | 131 DS                                    |                          | 22 (17)           | 12 (9)           | 34 (26)           |                                |
| Park et al.      | 193 DS requiring revision surgery          |                          | 6 (3)             |                  | 34 (7)            |                                |
| Ruiz Ibán et al. | 140 DS                                    |                          | 14 (10)           |                  | 20 (14)           |                                |
| Su et al.        | 65 DS                                     |                          |                  |                  | 27 (42)           |                                |
| Dickens et al.   | 29 DS                                     |                          |                  |                  | 1 (3)             |                                |
| Chen et al.      | 221 Dislocation or subluxation            |                          |                  |                  | 31 (14)           |                                |
| Moore et al.     | 34 DS                                     |                          | 1 (3)             | 2 (6)            | 3 (9)             |                                |
| Yapp et al.      | 32 DS                                     |                          | 4 (12)            | 3 (9)            | 7 (21)            |                                |
| Rhee et al.      | 48 DS requiring revision surgery          |                          | 1 (2)             | 3 (6)            | 1 (2)             |                                |
| Oh et al.        | 120 Dislocation or positive apprehension  |                          | 12 (10)           | 14 (12)          | 26 (22)           |                                |
| Ono et al.       | 51 DS                                     |                          | 9 (18)            | 7 (14)           | 16 (31)           |                                |
| Nakagawa et al.  | 140 DS                                    |                          | 17 (25)           |                  | 25 (18)           |                                |
| Iizawa et al.    | 64 DS                                     |                          | 1 (2)             | 4 (10)           | 11 (27)           |                                |
| Lavoué et al.    | 41 DS                                     |                          | 17 (25)           |                  | 5 (1)             |                                |
| Pandey et al.    | 136 DS                                    |                          | 15 (11.0)         |                  | 15 (11)           |                                |
| Brzóska et al.   | 100 DSA                                   |                          | 14 (14)           |                  |                   |                                |
| Study                        | Patients Undergoing Arthroscopic Treatment | Definition of recurrence | Dislocation N (%) | Subluxation N (%) | Apprehension N (%) | Recurrence of Instability N (%) |
|-----------------------------|--------------------------------------------|--------------------------|-------------------|-------------------|-------------------|-------------------------------|
| Ernstbrunner et al.26       | 36                                         | Any redislocation requiring reduction by a third party or medical professional | 6 (17)            | 3 (8)             | 3 (8)             | 6 (17)                        |
| Gül et al.27                | 62                                         | DS                       | 5 (8)             | 8 (13)            | 8 (13)            | 5 (8)                         |
| Loppini et al.28            | 670                                        | DS                       | 114 (17)          |                   |                   |                               |
| Park et al.29               | 195                                        | DS requiring revision surgery | 15 (8)           |                   |                   |                               |
| Jeon et al.30               | 118                                        | DSA                      | 27 (23)           |                   |                   |                               |
| O’Neill et al.11            | 20                                         | DSA                      | 8 (40)            |                   |                   |                               |
| Zimmermann et al.31         | 271                                        | DS                       | 87 (32)           |                   |                   |                               |
| Flinkkili et al.32          | 167                                        | DS                       | 50 (30)           |                   |                   |                               |
| McRae et al.96              | 74                                         | At least one re-dislocation or minimum of 2 subluxations 6 weeks after operation | 15 (20)           |                   |                   |                               |
| Bessière et al.13           | 93                                         | DS                       | 20 (22)           |                   |                   |                               |
| Rose et al.58               | 65                                         | DS                       | 14 (22)           |                   |                   |                               |
| Bessière et al.74           | 51                                         | DS                       | 12 (24)           |                   |                   |                               |
| Castagna et al.70           | 65                                         | DS                       | 14 (21)           |                   |                   |                               |
| Thomazeau et al.36          | 125                                        | DS                       | 4 (3)             |                   |                   |                               |
| Kim et al.37                | 59                                         | DS                       | 4 (7)             |                   |                   |                               |
| Ozbaydar et al.71           | 93                                         | DS                       | 10 (11)           |                   |                   |                               |
| Boileau et al.72            | 91                                         | DS                       | 14 (15)           |                   |                   |                               |
| Calvo et al.73              | 61                                         | DS                       | 11 (18)           |                   |                   |                               |
| Kim et al.57                | 62                                         | DSA                      | 4 (6)             |                   |                   |                               |
| Kim et al.75                | 167                                        | DSA                      | 4 (6)             |                   |                   |                               |
| Sperber et al.38            | 30                                         | DS                       | 7 (23)            |                   |                   |                               |
| Nakagawa et al.39           | 257                                        | DS                       | 42 (16)           |                   |                   |                               |
| Nakagawa et al.40           | 93                                         | DS                       | 22 (24)           |                   |                   |                               |
| Chechik et al.31            | 83                                         | DS                       | 16 (19)           |                   |                   |                               |
| Cole et al.28               | 37                                         | DSA                      | 9 (24)            |                   |                   |                               |
| Ander et al.42              | 15                                         | DSA                      | 6 (19)            |                   |                   |                               |
| Constantioun et al.43       | 32                                         | DS                       | 5 (23)            |                   |                   |                               |
| De Giorgi et al.43          | 22                                         | DS                       | 34 (55)           |                   |                   |                               |
| Salomonsson et al.49        | 62                                         | DS                       |                   |                   |                   |                               |
| Garcia et al.44             | 24                                         | DS                       |                   | 10 (42)           |                   |                               |
| Armangil et al.76           | 72                                         | Dislocation              | 4 (6)             |                   |                   |                               |
| Boughbeiri et al.77         | 45                                         | DS                       | 4 (6)             |                   |                   |                               |
| Kim et al.36                | 36                                         | DSA                      | 4 (5)             |                   |                   |                               |
| McCabe et al.45             | 31                                         | Dislocation, subluxation or revision instability surgery | 4 (11)           |                   |                   |                               |
| Ng and Kumar79              | 87                                         | Redislocation, any sensation of subluxation, or instability preventing return to full activity or requiring a further stabilizing procedure | 2 (2)            |                   |                   |                               |
| Ee et al.61                 | 79                                         | Redislocation, any sensation of subluxation, or instability preventing return to full activity or requiring a further stabilizing procedure | 2 (2)            |                   |                   |                               |
| Boileau et al.47            | 19                                         | DS                       | 1 (5)             |                   |                   |                               |
| Sedeek et al.48             | 40                                         | Recurrent dislocation, symptomatic subluxation or instability preventing return to full active duties or necessitating an additional surgical stabilization procedure | 3 (8)            |                   |                   |                               |
| Phadnis et al.49            | 141                                        | Recurrence of subluxation or frank dislocation or an ongoing or new feeling of instability | 19 (13)           |                   |                   |                               |

(continued)
apprehension (DSA). Fifty-two studies reported the definition of a recurrence as DS and 15 studies as DSA. The remaining 24 studies used 15 different definitions of a recurrence (Table 2).

Recurrence Rates Reported

Recurrence rates, as well as the rates of dislocation, subluxation and positive apprehension test results for each article, are reported in Table 2. In Park et al.,56 we could not extract the exact number of recurrent dislocations because only the amount of dislocations in group 1 were reported. Thirty studies (33%) did not report on recurrent dislocations, 45 studies (49%) did not report on recurrent subluxation, and 58 studies (64%) did not report on apprehension.

Overall recurrence rates ranged from 0% to 55%, dislocation rates from 0% to 35%, subluxation rates from 0% to 25%, and apprehension rates from 0% to 29%. The articles using the DSA definition had a total of 20 dislocations (2% from the studies reporting on dislocations), 8 subluxations (1%), 26 positive apprehension tests (3%) with an overall 107 recurrences (11%), whereas the studies defining recurrence as DS had 369 dislocations (7%), 225 subluxations (4%), 194 positive apprehension tests (3%), and an overall 1,006 recurrences (18%). Overall recurrence, dislocation, subluxation, and apprehension rates are shown in Figures 2 through 5. The articles varied in their reporting of dislocation, subluxation, and apprehension on the basis of the definitions of recurrence used (Table 4).

Discussion

The results of this study show that there are no uniform definitions of recurrence, subluxation, or dislocation after shoulder stabilization surgery used in the current literature. Using different definitions leads to a high level of heterogeneity. This could lead to misinterpretation of results and conclusions.

Recommendations

To optimize readability and comparability of studies, we have made recommendations regarding the definitions of (recurrent) instability, dislocation, subluxation, and apprehension. For dislocations, we suggest the definition of a radiographically confirmed dislocation or a dislocation that is manually reduced. For this definition the shoulders reduced by a care giver or by patients themselves should be differentiated. To avoid under-reporting of dislocations, all self-reported dislocation

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Table 2. Continued

| Study               | Patients Undergoing Arthroscopic Treatment | Definition of recurrence | Dislocation N (%) | Subluxation N (%) | Apprehension N (%) | Recurrence of Instability N (%) |
|---------------------|-------------------------------------------|--------------------------|-------------------|-------------------|-------------------|-------------------------------|
| Franceschi et al.50 | 50 Subluxation, 1 or more frank dislocations, or at least 1 episode of dead arm syndrome | Subluxation, 1 or more frank dislocations, or at least 1 episode of dead arm syndrome | 3 (6) | 2 (4) | 5 (10) | 5 (10) |
| Zhu et al.82        | 49 DSA                                     | 1 (2)                    | 2 (4)             | 1 (2)             | 4 (8)             |
| Mohtadi et al.83    | 87 DS                                      | 16 (18)                  | 4 (5)             | 20 (23)           |
| Zaffagnini et al.91 | 49 redislocation                           | 6 (12)                   |                  |                  | 6 (12)           |
| Elmund et al.84     | 76 DS                                      | 8 (11)                   | 6 (8)             | 14 (18)           |
| Carreira et al.85   | 85 DS                                      | 4 (6)                    | 3 (4)             | 7 (10)            |
| Gigis et al.102     | 38 DS                                      | 4 (6)                    | 3 (4)             | 5 (13)            |
| Shymon et al.103    | 71 redislocation event and/or the need for further surgical intervention |                          |                  | 17 (24)           |

*Only reported on dislocations.

1In a table the number is expressed as dislocations, while in the text as dislocations and subluxations.

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Table 3. Definitions of Dislocation and Subluxation

| Definition of dislocation | Definition of subluxation |
|--------------------------|---------------------------|
| Dislocation needing reduction (by medical professional or third party) | Instability without the need of reduction |
| Objective documentation of a dislocation either radiologically or clinically | Subjective sense of subluxation/instability |
| Increased translation of the humerus relative to the glenoid to the point of complete separation of articular surfaces | Sense of dislocation with a positive anterior apprehension test |
| More than 1 episode of instability which needed manual reduction by other people | Transient instability event that did not require reduction but demonstrated a positive apprehension and relocation sign with radiographic or magnetic resonance imaging evidence of a Bankart or Hill-Sachs |
| Symptomatic self-reported subluxation | "Dead-arm" phenomenon or instability which spontaneously reduced |
| Symptomatic translation of the humeral head relative to the glenoid articular surface without a dislocation | Subluxation at the time of the clinical assessment or through a history of at least 1 episode of dead arm syndrome |

not report on recurrent subluxation, and 58 studies (64%) did not report on apprehension.

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(e958)
**Fig 2.** Recurrence percentage for each definition. This figure shows the percentage of recurrence for each definition of recurrence: on the X-axis we have the different definitions and on the Y-axis the percentage of patients who have suffered a recurrence. When no percentage is reported, it means that it has not been reported in any study.

**Fig 3.** Dislocation percentage for each definition. This figure shows the percentage of dislocations for each definition of recurrence: on the X-axis we have the different definitions and on the Y-axis the percentage of patients who have suffered a dislocation. When no percentage is reported, it means that it has not been reported in any study.
Fig 4. Subluxation percentage for each definition. This figure shows the percentage of subluxations for each definition of recurrence: on the X-axis we have the different definitions, and on the Y-axis the percentage of patients who have suffered a subluxation. When no percentage is reported, it means that it has not been reported in any study.

Fig 5. Apprehension percentage for each definition. This figure shows the percentage of apprehension for each definition of recurrence: on the X-axis we have the different definitions, and on the Y-axis the percentage of patients having a positive apprehension sign. When no percentage is reported, it means that it has not been reported in any study.
with signs of a sustained dislocation in further radiographs, such as Hill-Sachs or bony Bankart lesion in comparison with the preoperative situation, could be categorized as a confirmed dislocation. For subluxations, we advise using the definition of the feeling of a dislocation that can be (spontaneously) reduced without the need for a radiographically confirmed dislocation. For a positive apprehension sign, we suggest using the definition as mentioned by Lädermann et al.\textsuperscript{100} as fear of imminent dislocation when placing the arm in abduction and external rotation during physical examination. We suggest not using the definition recurrence of instability anymore to avoid using multiple meanings of this term; if used we suggest using the definition as a dislocation or a subluxation and also report on these events separately. We chose this definition because of the fact that dislocations and subluxations can be regarded as a (partial) failure of the operation, whereas a positive apprehension test result does not always correlate with instability of the shoulder. This is because a positive apprehension could be related to changes in functional cerebral networks induced by prior instability that can persist even after stabilizing the shoulder.\textsuperscript{101} Finally, we endorse reporting on the events resulting in a dislocation or subluxation to be able to make an estimation of the severity of instability. For example, a shoulder that dislocates during normal daily activities is potentially more unstable in comparison with a shoulder dislocating after a collision during sports.

**Limitations**

Although DSA and DS have significantly different recurrence rates, the high number of studies not reporting dislocations, subluxations, and apprehension rates separately makes it unknown whether the recurrence rates would remain similar if all studies held the same criteria for defining recurrences in their cohort (e.g., not including apprehension in the definition could lead in less-reported recurrences). Because of corrections for multiple comparisons being not feasible for 17 definitions and because of the high variability in surgical techniques and patient characteristics, we did not compare the results for the different definitions. Remarkably, we had to exclude 68% of eligible studies because recurrence rates were not defined at all. Another limitation of this study is that we could not compare the results of the different techniques to assess whether other definitions could lead to other results. We agree with the results Kuhn\textsuperscript{7} and Kennedy et al.\textsuperscript{8} The difference with Kennedy et al.\textsuperscript{8} is that we were stricter in whether a definition is explicitly defined to

| Definition                                                                 | Total   | Dislocation N (%) | Subluxation N (%) | Apprehension (N) | Recurrence of Instability (N) |
|---------------------------------------------------------------------------|---------|------------------|------------------|-----------------|-------------------------------|
| DSA                                                                       | 938     | 20 (2)           | 8 (1)            | 26 (3)          | 107 (11)                      |
| DS                                                                        | 5681    | 369 (7)          | 225 (4)          | 194 (3)         | 1,006 (18)                    |
| Dislocation                                                               | 289     | 24 (8)           | 3 (1)            | 14 (5)          | 24 (8)                        |
| DS requiring revision surgery                                            | 513     | 5 (1)            | 17 (3)           | 41 (8)          |                               |
| Dislocation, subluxation, or revision                                     | 72      | 7 (10)           | 12 (17)          | 26 (36)         |                               |
| Self-report of 2 subluxation events or 1 dislocation                      | 28      | 0 (0)            | 2 (7)            | 2 (7)           |                               |
| Dislocation or symptomatic instability                                    | 63      | 10 (16)          | 2 (3)            | 12 (19)         |                               |
| Walch-Duplay (<51 points) + DS or Apprehension + feeling of instability   | 31      | 5 (16)           | 3 (10)           | 8 (26)          |                               |
| Radiographic dislocation/subjective slipping or apprehension/Apprehension and load-and-shift test + feeling of instability | 42      | 3 (7)            |                  | 3 (7)           |                               |
| Dislocation or a subjective feeling of instability with objective clinical apprehension requiring further treatment | 67      |                  |                  | 34 (51)         |                               |
| Dislocation or subluxation event that occurred within 2 years after surgery| 221     |                  |                  | 31 (14)         |                               |
| Dislocation or positive apprehension                                      | 120     | 12 (10)          |                  | 26 (22)         |                               |
| At least one redislocation or minimum of 2 subluxations 6 weeks after operation | 74      |                  | 14 (12)          | 15 (20)         |                               |
| Recurrent dislocation, symptomatic subluxation or instability preventing return to full active duties or necessitating an additional surgical stabilization procedure. | 119     | 6 (5)            |                  | 9 (8)            |                               |
| Recurrence of subluxation or frank dislocation or an ongoing or new feeling of instability | 141     | 12 (9)           |                  | 19 (13)         |                               |
| Subluxation, 1 or more frank dislocations, or at least 1 episode of dead arm syndrome | 50      | 3 (6)            | 2 (4)            | 5 (10)          | 5 (10)                        |
| Dislocation or revision                                                   | 71      |                  |                  | 17 (24)         |                               |

\textsuperscript{1}Percentages are percentages of total patients in studies mentioned to have an event (e.g., if a study does not report on subluxations, it is not used to calculate the percentage of subluxations)
avoid overestimation of the reporting of recurrence rates; for example, in Kennedy et al., an article was regarded as defining recurrences as a dislocation if they only reported on dislocations without explicitly defining recurrences. Kasik and Saper have also reported that there are different definitions of recurrences after arthroscopic Bankart repair in the adolescent athletes. However, just like the article of Kennedy et al., they also included articles that do not define recurrences explicitly.

**Conclusion**

Recurrence rates are poorly specified and likely underreported in the literature, hampering comparison with results of other studies. This highlights the need for a consensus on definition of recurrence across shoulder instability studies. We recommend not using the definition recurrence of instability anymore. We endorse defining dislocations as a radiographically confirmed dislocation or a dislocation that is manually reduced, subluxations as the feeling of a dislocation that can be (spontaneously) reduced without the need for a radiographically confirmed dislocation, and a positive apprehension sign as fear of imminent dislocation when placing the arm in abduction and external rotation during physical examination. Reporting on the events resulting in a dislocation or subluxation aids in making an estimation of the severity of instability.

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Appendix 1. Search terms

PubMed search:

(((Shoulder[Mesh] OR Shoulder Joint[Mesh] OR shoulder*[tiab] OR glenohumeral[tiab]) AND (Joint Dislocations[Mesh] OR dislocation*[tiab] OR *luxat*[tiab] OR joint instability[Mesh] OR instability[tiab])) OR shoulder dislocation[Mesh]) AND (Recurrence [Mesh] OR recurren*[tiab] OR relaps*[tiab] OR redislocat*[tiab] OR reluxat*[tiab] OR resubluxat*))

EMBASE search:

(((shoulder* OR glenohumeral) AND (dislocation* OR *luxat* OR instability)) AND (recurren* OR relaps* OR redislocat* OR reluxat* OR resubluxat*))