

An Extension of the Collin Subclassification to Better Characterize Subscapularis Involvement in Massive Rotator Cuff Tears: A Retrospective Cohort Study from the La Tour Group

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Background: Massive rotator cuff tears (MRCTs) display considerable anatomical variability, and existing classification systems do not fully account for patterns involving the superior and inferior subscapularis. Although the Collin subclassification provides a functional anatomical framework, certain anterior and anterosuperior configurations remain unclassified.

Purpose: The purpose of this study was to propose an extension of the Collin subclassification to integrate these subscapularis-related patterns.

Methods: A retrospective review was performed on 1338 patients who underwent arthroscopic repair of MRCTs by a single expert surgeon between January 2016 to April 2026. Tears were first classified as massive, and then according to the original Collin subclassification. Subscapularis involvement was documented with specific attention to superior and inferior portions. When lesions did not match existing types, three new subtypes extending the original type B pattern (complete subscapularis and supraspinatus) were defined: B^A (isolated complete subscapularis without posterosuperior involvement), B^D (complete subscapularis, supraspinatus, and infraspinatus), and B^E (five-tendon tear including complete subscapularis, supraspinatus, infraspinatus, and teres minor).

Results: Three previously unclassifiable patterns were found: B^A in 33/432 patients (7.6%), B^D in 9/432 patients (2.1%), and B^E in 2/432 patients (0.5%), representing 10.2% of MRCTs with subscapularis involvement.

Conclusion: This study extends the Collin subclassification of MRCTs by introducing three new subtypes — B^A, B^D, and B^E — that capture patterns of complete subscapularis involvement not accounted for in the original system. These configurations represented 10.2% of subscapularis-involved MRCTs in our cohort and 41.1% of type B lesions, highlighting meaningful anatomical heterogeneity within this category. While the proposed extension improves descriptive completeness, its prognostic value and impact on surgical decision-making remain to be determined through future outcome-based studies.

What this study adds: This study extends the Collin subclassification of massive rotator cuff tears by introducing three new subtypes (B^A, B^D, and B^E) that capture patterns of complete subscapularis involvement previously left unclassified. It shows that these configurations represent a clinically relevant proportion of MRCTs, thereby improving anatomical characterization and potentially refining surgical decision-making.

Potential impacts on research, practice, or policy: This extended subclassification may improve future research by enabling more precise phenotyping of massive rotator cuff tears and by supporting outcome studies focused on reparability, prognosis, and indication for tendon transfer or RSA.

Study Design: Retrospective cohort study

Level of Evidence: Level III

Keywords : Shoulder; Classification; Database; Description; Treatment options.

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Introduction

Massive rotator cuff tears (MRCTs) represent a major diagnostic and therapeutic challenge in shoulder surgery [1][2]. Multiple definitions have been proposed, including those by Cofield [3] and Gerber et al. [4], but inconsistency persists across in the literature. In 2015, Lädermann et al. [5] provided a clinically meaningful definition, describing MRCTs as involving at least two tendons, as Gerber et al. did previously, while additionally requiring retraction of at least one tendon beyond the humeral head apex (Patte ≥ 2), thereby introducing a three-dimensional component and a connotation of difficulty [6].

To better characterize the anatomical variability of MRCTs, Collin et al. proposed a five-type subclassification in 2014 based on patterns of tendon involvement [7]. This system established a clear link between anatomical patterns and shoulder function, especially with respect to active elevation, and has become a reference in clinical practice. However, clinical experience has highlighted several configurations that are insufficiently captured by the original classification. Although the superior and inferior portions of the subscapularis have been described anatomically as distinct entities—with different insertions (tendinous vs. muscular), separate innervation, and divergent functional roles [8][9][10]—certain rupture patterns remain incompletely addressed. Complete tears involving both subscapularis portions (i.e., two-tendon subscapularis tears), whether isolated or combined with posterosuperior involvement, lack specific subtypes within Collin's framework. Given that the superior and inferior subscapularis constitute two separate functional units [10][11][12], complete rupture of both portions meets the definition of a MRCT [5]; yet such patterns have not been formally classified.

The purpose of this study was to propose an extension of the Collin subclassification by integrating additional subtypes involving isolated or combined lesions of the superior and inferior subscapularis. We hypothesized that the original Collin subclassification does not adequately capture all MRCT patterns involving complete subscapularis disruption—either because certain configurations are truly unclassifiable within the existing framework (e.g., isolated anterior massive tears) or because anatomically distinct patterns are insufficiently differentiated within existing categories (e.g., combined anterior and posterosuperior tears grouped broadly as type B).

Methods

Between January 2016 and April 2026, all patients undergoing arthroscopic rotator cuff repair performed by the senior author (A.L.) were assessed for eligibility for inclusion

in this retrospective study. Data were extracted from a prospective rotator cuff repair database (Follow Health, Rennes, France), the use of which had been ethically approved (Association des médecins du canton de Genève et société médicale #12-26). The inclusion criteria included: patients aged 18 years to 80 years, anterior rotator cuff tears involvement [7], two complete tendons [5], grade 2 or 3 Patte retraction of at least one tendon [6], and rotator cuff muscle fatty infiltration limited to Goutallier grade 0 to 2 [13]. Patients with the following conditions were excluded: open rotator cuff repair, revision RCR [14], shoulder pathologies such as previous fractures or progressive glenohumeral osteoarthritis, rotator cuff muscle fatty infiltration Goutallier grade 3 or 4 [15], inability to provide informed consent, or incomplete documentation.

Institutional Review Board

This study was approved by the local ethics committee under several successive protocols covering the study period: CCER 2015-15 (trial registration number NCT02725346), CCER 2016-00818 (trial registration number NCT02943005), CCER 2019-02076 (trial registration number NCT04321005), and CCER 2020-02670. All approvals apply to the present study, as patients were prospectively enrolled in a rotator cuff repair database over the corresponding periods and consented to the use of their data for research purposes, including secondary analyses. All patients provided written informed consent for their participation and for the use of their data and images for research purposes.

Equity, Diversity and Inclusion Statement

The studied population included women and men originating from various countries in Southern Africa, North America, Oceania and Europe in a usual proportion for such pathology. We do not present data on race, socioeconomic status or other social determinants.

Study Variables

Tear patterns were assessed using a sequential approach. Preoperative cross-sectional imaging (MRI or CT-arthrography) was reviewed to identify the tendons involved and to estimate tear size and retraction. The definitive classification was established intraoperatively through systematic arthroscopic evaluation, which enabled precise identification of each tendon, including the superior and inferior portions of the subscapularis, using the classification proposed by Lädermann et al. [5] for MRCT, and subsequently using the original five-type system described by Collin (**Figure 1**) [7]. Intraoperative tear classification was performed by the senior author (A.L.) in collaboration with shoulder-trained fellows present during each procedure. The final classification was established by consensus in the operating

room before being recorded in the operative report and the prospective database.

Because type D and type E lesions do not involve the subscapularis, they are fully compatible with the original

Collin classification and did not require further subclassification. These types were therefore not considered for the development of new subtypes but remain included in the overall cohort description.

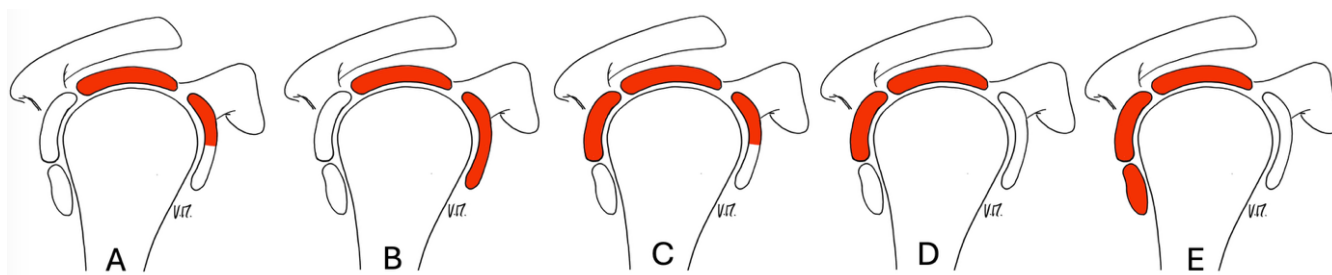


Figure 1. Schematic representation of the five MRCT patterns described by Collin et al. in 2014 [7]. Type A: Superior subscapularis and supraspinatus tear ; type B: entire subscapularis and supraspinatus tear; Type C: superior subscapularis, supraspinatus and infraspinatus tear; Type D: Supraspinatus and infraspinatus tear; Type E : Supraspinatus, infraspinatus and teres minor tear. Reproduced from Vincent Martinel, with the permission.

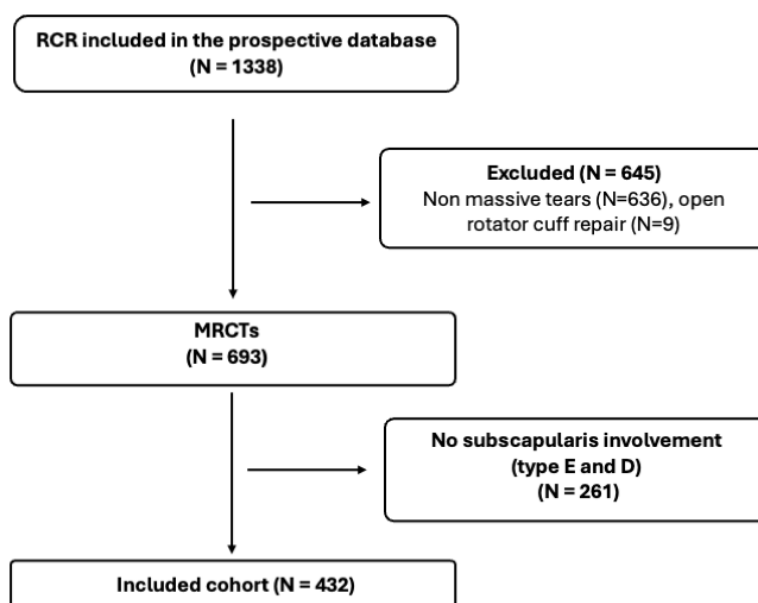


Figure 2. Flowchart.

Special attention was given to subscapularis lesions. The involvement of the superior and/or inferior portions was specifically recorded [8][9][10]. When lesions did not fit any existing Collin type, three new subtypes were defined. These new subtypes were not prespecified but were defined inductively based on recurring tear patterns observed intraoperatively that could not be adequately categorized within the original Collin classification.

The following baseline characteristics were also assessed: age, sex, body mass index, hand dominance, and affected

side.

Statistical Analysis

Descriptive statistics were used to summarize demographic and tear-related variables, including means (with standard deviations or ranges) for continuous variables and absolute frequencies with percentages for categorical variables. Given the small sample sizes of certain newly defined subtypes, inferential statistical comparisons between subgroups were not performed, as they would lack adequate statistical power and could yield misleading results. The primary objective of

this study was to describe the distribution and anatomical characteristics of tear patterns rather than to compare subgroups.

Results

During the study period, 1,338 patients underwent arthroscopic rotator cuff repair, of whom 693 (52,0%) met the criteria for MRCTs. In those, 432 (62,3%) involved the subscapularis and were included in the analysis. The flowchart is presented in **Figure 2** and the demographics are summarized in **Table 1**.

Three previously unclassified tear configurations involving complete disruption of the subscapularis were identified and defined as new subtypes (Figure 3):

- B^A (isolated complete two-tendon subscapularis tear): 33 patients (7,6%)
- B^D (combined B and D pattern): 9 patients (2,1%)

- B^E (combined B and E pattern, five-tendon tear): 2 patients (0.5%)

Collectively, these newly defined anterior and anterosuperior patterns represented 10,2% of MRCTs with subscapularis involvement. Within the original Collin type B category, the proposed subtypes B^A, B^D, and B^E accounted for 41.1% of cases, indicating that more than one-third of lesions previously grouped as type B are more precisely described by the extended subclassification. Illustrations of the extended classification system, including the newly defined anterior subtypes, are shown in **Figure 2**.

The distribution of tear types is summarized in **Figure 4**.

Type A: Superior subscapularis and supraspinatus tear ; type BA: entire subscapularis ; type B: entire subscapularis and supraspinatus tear; type BD : entire subscapularis, supraspinatus, and infraspinatus ; type BE: entire subscapularis, supraspinatus, infraspinatus, and teres minor tear; Type C: superior subscapularis, supraspinatus and infraspinatus tear.

Table 1. Demographics of MCRTs involving the subscapularis.

Cuff Tear Type	A	B	BA	BD	BE	C	TOTAL
	n = 135	n = 63	n = 33	n = 9	n = 2	n = 187	n = 432
Age (years) (Mean ± SD [Min-Max])	55.3 ± 8.3 [22-74]	57.9 ± 7.7 [37-74]	53.3 ± 8.5 [30-72]	57.6 ± 8.1 [46-70]	72.0 ± 19.8 [58-86]	59.6 ± 8.6 [15-82]	57.5 ± 8.7 [15-86]
BMI (kg/m ²) (Mean ± SD [Min-Max])	26.2 ± 4.4 [17.3-42.4]	26.1 ± 3.4 [19.0-34.9]	26.0 ± 4.4 [18.7-34.5]	29.0 ± 9.3 [21.6-49.4]	22.5 [n=1]	26.4 ± 4.0 [19.7-40.4]	26.3 ± 4.2 [17.3-49.4]
CATEGORICAL VARIABLES							
Sex, n(%)							
- Female	48 (35.6%)	9 (14.3%)	3 (9.1%)	4 (44.4%)	1 (50.0%)	55 (30.9%)	120 (28.0%)
- Male	83 (61.5%)	53 (84.1%)	30 (90.9%)	5 (55.6%)	1 (50.0%)	123 (69.1%)	295 (68.8%)
Operated arm, n(%)							
- Right	90 (66.7%)	33 (52.4%)	20 (60.6%)	4 (44.4%)	2 (100.0%)	140 (75.7%)	287 (66.9%)
- Left	45 (33.3%)	29 (46.0%)	13 (39.4%)	5 (55.6%)	0 (0.0%)	47 (25.4%)	139 (32.4%)
Dominant arm operated, n(%)							
- Yes	91 (70.0%)	37 (58.7%)	22 (66.7%)	3 (33.3%)	2 (100.0%)	140 (74.9%)	295 (69.7%)
- No	39 (30.0%)	25 (39.7%)	11 (33.3%)	6 (66.7%)	0 (0.0%)	47 (25.1%)	128 (30.3%)
COMORBIDITIES							
Hypertension, n(%)	23 (21.7%)	10 (18.9%)	7 (24.1%)	4 (50.0%)	1 (100.0%)	43 (27.7%)	88 (25.0%)
Hypercholesterolemia, n(%)	14 (13.3%)	10 (18.9%)	4 (13.8%)	2 (22.2%)	0 (0.0%)	29 (18.7%)	59 (16.8%)
Diabetes, n(%)	24 (22.9%)	12 (22.6%)	8 (27.6%)	2 (25.0%)	0 (0.0%)	39 (24.7%)	85 (24.1%)
Traumatic, n(%)	53 (40.2%)	43 (68.3%)	28 (84.8%)	5 (55.6%)	1 (50.0%)	104 (55.6%)	234 (54.9%)

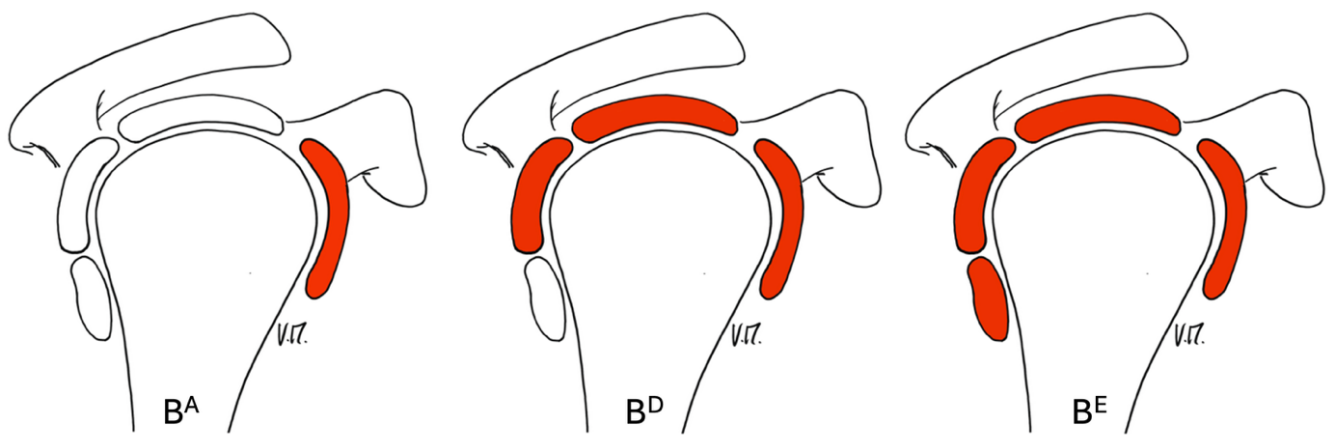


Figure 3: Updated Collin subclassification integrating newly defined subscapularis-related tear patterns type B^A: entire subscapularis ; type B^D : entire subscapularis, supraspinatus, and infraspinatus ; type B^E: entire subscapularis, supraspinatus, infraspinatus, and teres minor tear. Reproduced from Vincent Martinel, with the permission.

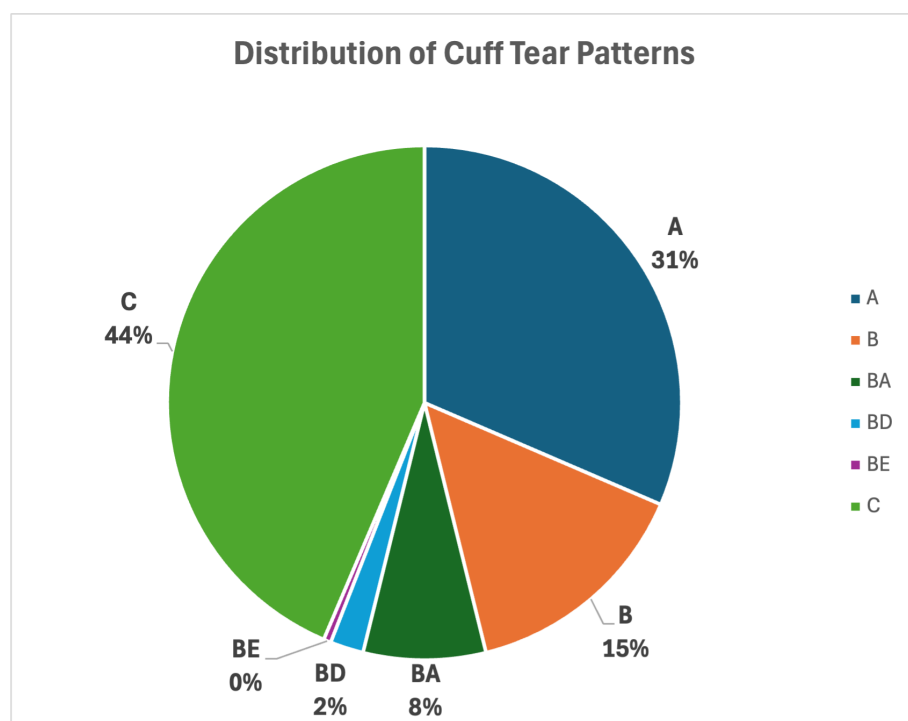


Figure 4: Distribution of MRCTs according to the updated Collin classification.

Discussion

This study proposes an extension of the classification of massive rotator cuff tears initially described by Collin et al. in 2013. Based on a large single-center cohort of 693 arthroscopically treated MRCTs, our findings show that several lesion patterns involving the subscapularis could not be adequately categorized within the original system. These unclassifiable patterns represented 10.2% of subscapularis-involved massive tears in our population. Notably, within the original Collin type B category, the newly defined subtypes B^A, B^D, and B^E accounted for 41.1% of cases, underscoring the

substantial heterogeneity of anterior cuff involvement that is not captured by the original classification. The introduction of three new subtypes (B^A, B^D, and B^E) therefore aims to improve the anatomical completeness, functional relevance, and clinical utility of the classification, particularly with respect to anterior cuff insufficiency.

It is important to distinguish between two types of classification gaps addressed by this extension. First, type B^A represents a truly unclassifiable pattern within the original framework: an isolated anterior MRCT involving complete disruption of both subscapularis portions without posterosuperior involvement. No existing Collin type

accounts for this configuration, as all original types (A through E) include supraspinatus involvement. Second, types B^D and B^E represent patterns that share the complete subscapularis component of type B but differ substantially in their posterosuperior extension. While these lesions could theoretically be grouped broadly under or adjacent to type B, doing so obscures clinically meaningful differences in tear extent, biomechanical consequences, and surgical complexity. Separating these patterns therefore serves both descriptive accuracy and clinical utility.

Existing classification systems, including Collin's original subclassification, consider subscapularis involvement primarily through disruption of its superior portion. However, the inferior subscapularis contributes significantly to humeral head depression and anterior stabilization, and its functional role has become increasingly recognized [12][16]. In our cohort, complete rupture of both the superior and inferior subscapularis (type B^A) occurred in 7.6% of MRCTs, representing a distinct pattern of massive anterior cuff failure that was not captured by the original classification. This finding reinforces the concept that the subscapularis should be regarded as a two-tendon unit in classification systems, as previously proposed [8][10]. Furthermore, the combined subtypes B^D and B^E, accounting for 2.1% and 0.5% of cases respectively, demonstrate that complete subscapularis disruption frequently coexists with posterosuperior involvement, a configuration with direct implications for surgical strategy and prognosis.

Accurate identification of lesion patterns has direct implications for treatment. Anterior MRCTs and combined anterior–posterosuperior lesions often require different strategies for mobilization, repair sequencing, or tendon transfer [5]. A subclassification that distinguishes between isolated posterosuperior insufficiency and true anterior disruption may therefore improve surgical planning and prognostic stratification. By separating B^A, B^D, and B^E as distinct anatomical categories, the proposed system provides clinicians with greater precision without adding unnecessary complexity. Importantly, this modification remains anchored in anatomical logic and is based on straightforward arthroscopic criteria - the presence or absence of tendon disruption - which are directly assessable during surgery. However, formal reliability testing is needed to confirm its reproducibility across observers.

Few studies have specifically analyzed massive tears involving complete subscapularis disruption. Most published classifications (including those of Ellman [17], Gerber et al. [4], and Patte [6]) focus primarily on tear size or tendon retraction rather than anatomical combinations. The classification proposed by Lafosse et al. in 2007 [18] offers a detailed morphological description of subscapularis tears;

however, it was developed from a limited number of cases (0 to 7 per subtype) and does not account for concomitant posterosuperior cuff involvement. As such, it does not address the global tear patterns that the Collin subclassification and its proposed extension aim to capture. Our findings are consistent with previous observations suggesting that subscapularis tears remain underdiagnosed and frequently underestimated in clinical practice [19].

The strengths of the present study include the large prospective cohort size, the consistency of evaluation by a single expert surgeon, and the systematic recording of intraoperative findings. The exclusive use of arthroscopic observations allowed precise assessment of subscapularis involvement, particularly of the inferior portion, which may be difficult to evaluate preoperatively [20].

Limitations

Limitations include the retrospective design, the single-surgeon design, the selected surgical cohort, and the absence of formal inter- and intraobserver reliability testing [21], which is a critical issue for rotator cuff tear classification systems. Given the ten-year data collection period, such analysis was not feasible in the present study design. However, all tear classifications were established through a systematic consensus-based process involving the senior surgeon and shoulder-trained fellows during each procedure, providing a structured approach to minimize misclassification. Future studies should formally assess the reproducibility of the extended classification using independent observers reviewing standardized arthroscopic recordings. Furthermore, the exclusion of patients with advanced fatty infiltration (Goutallier grade 3–4), revision cases, and open repairs means that this cohort represents a selected population of primary arthroscopic repairs with reparable tissue quality. This selection was deliberate, as reliable intraoperative assessment of tear patterns requires adequate tissue visibility and quality; however, it limits the external validity of the reported subtype distribution. Additionally, this work focuses on anatomical patterns and does not correlate lesion types with clinical outcomes like the original Collin's subclassification.

Conclusion

This study extends the Collin subclassification of MRCTs by introducing three new subtypes - B^A, B^D, and B^E - that capture patterns of complete subscapularis involvement not accounted for in the original system. These configurations represented 10.2% of subscapularis-involved MRCTs in our cohort and 41.1% of type B lesions, highlighting meaningful anatomical heterogeneity within this category. While the proposed extension improves descriptive completeness, its prognostic value and impact on surgical decision-making

remain to be determined through future outcome-based studies.

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Conflicts of Interest

Philippe Collin serves as a paid consultant for Stryker and Enovis and receives royalties from both companies. He is also a co-founder of Med4Cast and Follow Health and serves on the board of the International Board of Shoulder and Elbow Surgery (IBSES). Alexandre Lädermann serves as a paid consultant for Arthrex, Stryker, and Medacta and receives royalties from Stryker and Medacta. He is the co-founder of FORE, Med4Cast, and BeeMed, holds equity in BeeMed and Follow Health and is at the board of the French Arthroscopic Society. Gabriel Levy, Georgios Mamarelis, and Vincent Martinel do not have conflict of interest. Jean Gaillard did this study during a fellowship supported by funding from the Société Française de Chirurgie Orthopédique et Traumatologique (SOFOT).

Contribution

Philippe Collin: Reviewing, describe the original classification. Alexandre Lädermann: Data collection, design, reviewing, founding. Gabriel Levy: Data collection, writing original article. Georgios Mamarelis: Reviewing. Vincent Martinel : Illustration. Jean Gaillard : Data collection, design, writing original manuscript.

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Use of Artificial Intelligence

During the preparation of this work, the author used ChatGPT (OpenAI, San Francisco, CA, USA) to organize the answer and correct the English. After using this tool/service, the author

reviewed and edited the content as needed and takes full responsibility for the content of the publication.

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