Montreal Novel Fragment-Specific Classification of Complex Olecranon Fractures: Creation of a 3D Model, Radiological Validation, and Proposed Surgical Algorithm

Maxine Joly-Chevrier, Medical Student; *Julien Chapleau, MD, MSc; Rémi Paquet, MSc; Yvan Petit, PhD; George Y. Laflamme, MD, FRCSC; Dominique Rouleau, MD, FRCSC*

Purpose: Current classifications for proximal ulna fracture patterns come from qualitative observations and are not guiding surgical decision-making. They are not impartial enough for understanding the deforming forces on the fracture fragments. We propose a new classification system based on a biologic and anatomic stresses analysis. Our hypothesis is that fragments in complex fractures can be predicted by the tendinous and ligamentous insertions on the proximal ulna. A surgical algorithm based on fractured fragments will be proposed.

Methods: A literature review was conducted, followed by modeling of the proximal ulna soft-tissue insertions. Selected articles included location of these insertions. A 3D model of the ulna anatomy has been designed using data from the literature review with SliceOMatic and Catia V5R20 software. Proposed fragments and fracture lines were derived from the literature review. A retrospective radiological study was conducted. The radiological database was used to identify CT scans of multifragment olecranon fractures from 2009 to 2021. These have been reviewed and classified according to the novel "fragment-specific" classification, the Mayo, and the Schatzker classifications.

Results: The literature review targeting quantitative values for the elbow soft tissue identified 1152 scientific articles. 198 articles were filtered as directly relevant and 41 met the inclusions criteria. 12 papers presented quantitative data for an equivalent of 134 quantified elbows. Authors consensus was obtained, and the bony attachments of ligaments and tendons were mapped on a 3D olecranon model. Seven potential fracture fragments were identified. The radiological study was a cohort of 67 cases. A substantial interrater reliability (Cohen kappa, >0.6) was obtained. The 7 specific fragments were identified in the 67 cases of complex olecranon fractures based on preoperative CT scans: dorsal (40%), intermediate (42%), tricipital (100%), supinator crest (25%), coronoid (18%), sublime tubercle (12%), and anteromedial facet (18%). 18 cases (27%) were classified as Schatzker D (comminutive) and 21 (31%) Mayo 2B (stable comminutive).

Conclusion: This proposed classification system is anatomically based and considers the deforming forces from ligaments and tendons. By offering a more precise comprehension of complex proximal ulna fractures, it would lead to more accurate fracture evaluation in order to plan fixation.