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Literature review

Distal radioulnar joint instability

L'instabilité radio-ulnaire distale

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A B S T R A C T

Distal radioulnar joint (DRUJ) instability is a rare but disabling problem. Surgical treatment remains a challenge. The advent of arthroscopic techniques has helped to rebuild the triangular fibrocartilaginous complex (TFCC), especially its deep part. However, isolated TFCC damage is not responsible for instability. Its repair is sometimes not sufficient to restore DRUJ stability, or the chronicity of the injury prevents its direct repair. Open surgical procedures still have a role in these cases. They require a detailed knowledge of the various stabilizers of the DRUJ. Passive and active stabilizers other than the TFCC include the bones, joint capsule, oblique distal bundle of the interosseous membrane and the extensor carpi ulnaris. The objective of this review was to analyze current anatomical and biomechanical data on DRUJ stability. Different arthroscopic and open repair techniques for these structures will be reviewed. Lastly, a decision tree will be presented that can be used to better plan the management of this complex entity, because most of these injuries often occur in combination in RUD instability cases.

R É S U M É

L'instabilité radio-ulnaire distale (RUD) est un problème rare mais invalidant, dont la prise en charge reste complexe. L'avènement des techniques arthroscopiques a permis de reconstruire le complexe fibrocartilagineux triangulaire (TFCC), en particulier son faisceau profond. Cependant, une lésion isolée du TFCC ne peut être responsable d'une instabilité, et parfois sa réparation n'est pas suffisante pour rétablir la stabilité, ou tout simplement la chronicité de la lésion empêche sa réparation directe. C'est dans ces cas que la chirurgie à ciel ouvert a encore toute sa place. Elle nécessite une connaissance précise des différents stabilisateurs de la RUD. Les stabilisateurs passifs et actifs autres que le TFCC sont en particulier : les structures osseuses, la capsule articulaire, la portion distale oblique de la membrane interosseuse et l'extensor carpi ulnaris. L'objectif de ce travail est d'analyser les données anatomiques et biomécaniques actuelles de la stabilité de la RUD. Les différentes techniques arthroscopiques et à ciel ouvert de réparation de ces structures seront revues au cours d'une analyse de la littérature. Et, finalement, un organigramme décisionnel sera proposé parallèlement à ceux existant de la littérature, afin de planifier au mieux la prise ne charge de cette entité pathologique complexe, car la plupart de ces lésions sont souvent associées dans une instabilité RUD.

1. Introduction

Distal radioulnar joint (DRUJ) instability is common. However its pathophysiology is not straightforward and surgical treatment can be challenging. The range of clinical presentations spans from discomfort on the dorsal side of the wrist to obvious DRUJ instability.

The aim of this article was to review the anatomical bases of DRUJ stability, the clinical and paraclinical methods used to examine this joint, along with treatments to address the instability. The various elements of the clinical examination will be set out,

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along with additional assessments that can be used to diagnose and analyze these conditions by grouping most of the lesions into four categories:

- bone malunion;
- instability of the extensor carpi ulnaris (ECU);
- injuries to the triangular fibrocartilage complex (TFCC) and the distal bundle of the interosseous membrane (IOM);
- cartilage lesions that can occur in this joint.

Lastly, surgical and non-surgical treatment options will be described along with a treatment algorithm.

2. Anatomy

Stability of the DRUJ is a precarious balance that requires the contribution of passive and active stabilizers to achieve 150° of pronation–supination range. Failure of one or more of these stabilizers leads to DRUJ instability or dislocation.

2.1. Bones

The DRUJ has the following characteristics:

- the radius of curvature of the distal radius and distal ulna differ. It averages 10 mm for the head of the ulna and 15 mm for the radius [1];
- the ulnar notch can have one of four shapes [1]: flat 42%, ski slope 14%, sigmoid 30% and S-shaped 14%. A flat surface does not confer significant primary stability;
- Ekenstam [2] showed that the percentage of coverage of the radius' ulnar notch relative to the ulnar head was less than 50%, which allows rotation and translation movements during pronation–supination. The contact area at the extreme pronation and supination positions is only 2 to 3 mm;
- the joint surfaces are covered with cartilage over 90° to 135° of the ulnar head and only 47° to 80° of the ulnar notch on the radius. Together, these characteristics explain why the pronation–supination movement requires translation and rotation movements, thereby allowing residual instability to persist [1].

This innate bone-related residual instability requires that active and passive stabilizers contribute to optimal joint stability while providing a functional range of motion (Fig. 1).

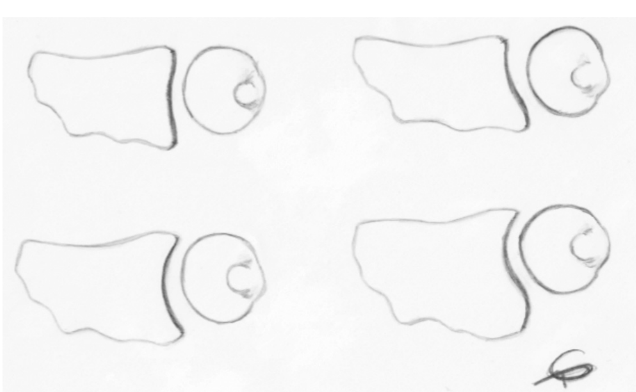

Fig. 1. Configuration of the ulnar notch of the radius in the transverse plane, according to Tolat [1]: flat (A), ski slope (B), sigmoid (C), S-shaped (D).

2.2. Passive stabilizers

Passive stabilizers are the capsule, ulnocarpal ligaments, TFCC and distal portion of the IOM.

2.2.1. Joint capsule and ulnocarpal ligaments

The joint capsule and ulnotriquetral and ulnolunate ligaments do not play a large biomechanical role [3]. Transection of the capsule increases the amplitude of pronation–supination but does not cause instability [4]. However, a cadaver study has shown that repairing the capsule restores the normal kinetics of pronation–supination, thus the capsule should be repaired in cases of acute instability [5].

2.2.2. Triangular fibrocartilage complex

The TFCC described by Palmer and Werner [6] consists of an intra-articular disc (or triangular ligament), the dorsal and palmar radioulnar ligaments (DRUL and PRUL), the ulnocarpal ligaments and the deep surface of the ECU sheath. Palmer and Werner attributed four functions to the TFCC:

- stable/flexible system for rotation of the radiocarpal unit around the axis of the ulna;
- ligament restraint for the carpus on its ulnar side;
- shock-absorber for loads transmitted to the ulnocarpal side through the intra-articular disc;
- continuous gliding surface between the ends of the radius and ulna during carpal movements.

Ishii et al. [7] showed that the radioulnar ligaments reinforce the joint capsule and have deep and superficial layers. The superficial portion is continuous with the intra-articular disc, while the deep portion inserts on the fovea (Fig. 2).

The biomechanical role of these two substructures is controversial. Various studies exploring the stability have contradictory findings. Ekenstam [2] described the DRUL as the main stabilizer in maximum supination, preventing volar subluxation of the ulnar head; conversely, the PRUL is the main stabilizer in maximum pronation. However, other studies have found the opposite. The studies of Schuind et al. [8] and Kihara et al. [9] suggest the DRUL is the most taut ligament in maximum pronation, while the PRUL is the most taut in supination. Ward et al. [4] confirmed these findings in a biomechanical cadaver study. Lastly, Nakamura and Makita [10] showed that the main stabilization action was shared by the deep and superficial elements. The portion nearest the fovea has isometric features when the DRUJ changes position, while the more distal portion is more extensible. During pronation, the deep palmar ligament and the superficial dorsal ligament are taut; they are slack during supination. This biomechanical configuration provides maximum stability during pronation–supination.

2.2.3. Distal oblique bundle (DOB) of the IOM

The role of the IOM in DRUJ stability has become more prominent in recent years since its DOB was described. This bundle is present in only 40% of cases [11]. The distal portion overlaps the DRUJ capsule and the DRUL and PRUL. Biomechanical studies [12–14] have shown the DRUJ is more stable when the DOB is intact. This contribution occurs over the entire pronation–supination range of motion, as the DOB is an isometric ligament. The cadaver study by Moritomo et al. [11–13] showed that:

- if the TFCC is torn and the DOB is intact, there is no dorsal instability but volar translation of the DRUJ is possible;
- if both the TFCC and the DOB are transected, the DRUJ is unstable even when the bone anatomy is intact.