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Literature review

Rehabilitation of distal radioulnar joint instability

Rééducation des instabilités radio-ulnaires distales

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A B S T R A C T

Distal radioulnar joint (DRUJ) instabilities are common and often combined with other injuries of the interosseous membrane and/or the proximal radioulnar joint. Once they are diagnosed and the treatment is chosen, physiotherapists have limited choices due to the lack of validated protocols. The benefits of proprioception and neuromuscular rehabilitation have been brought to light for the shoulder, knee and ankle joints, among others. However, no program has been described for the DRUJ. The purpose of this article is to study the muscular elements responsible for active DRUJ stability, and to propose a proprioceptive rehabilitation program suited to this condition.

R É S U M É

Les instabilités de l'articulation radio-ulnaire distale (RUD) sont fréquentes et souvent associées à d'autres lésions au niveau de la membrane interosseuse et/ou de l'articulation radio-ulnaire proximale. Lorsque le diagnostic est posé et le choix du traitement établi, les orientations à suivre pour les rééducateurs de la main sont limitées par le manque de protocoles validés. Si l'intérêt de la proprioception et de la rééducation neuromusculaire a été mise en évidence pour l'épaule, le genou et la cheville notamment, aucun programme n'a été décrit en ce qui concerne l'articulation RUD. L'objet de cet article est d'étudier les éléments musculaires responsables de la stabilité active de l'articulation RUD et de proposer un programme de rééducation proprioceptive adapté à cette analyse.

1. Introduction

Stability of the distal radioulnar joint (DRUJ) depends on the integrity of the bones, ligaments and muscles surrounding it [1]. Because of its anatomy–both osseous and ligamentous–it is described as an intrinsically unstable joint [2].

Instability is defined as the inability to absorb physiological stresses without dislocating. It can be congenital, posttraumatic or post-surgical, most often combined with injuries of the radioulnar complex [3]. Therefore, its clinical study must be included in a more comprehensive analysis of the radioulnar complex [4,5].

As a matter of fact, the radioulnar complex is composed of the two radioulnar joints, to which a third element must be added: the interosseous membrane (IOM) and the two forearm bones. A disturbance in one of these elements can create stiffness in pronation–supination, two of these elements must be injured for instability of the whole radioulnar frame to occur [5]. A three-hinged door is a good example to understand this mechanism. If one hinge is rusty the door cannot be moved, but if one hinge is removed or unscrewed the door stays stable thanks to the two other hinges (Fig. 1).

Therefore, the Darrach procedure–which consists of resecting the ulnar head–does not lead to large-scale instability of the forearm if the IOM and the proximal radioulnar joint (PRUJ) are intact.

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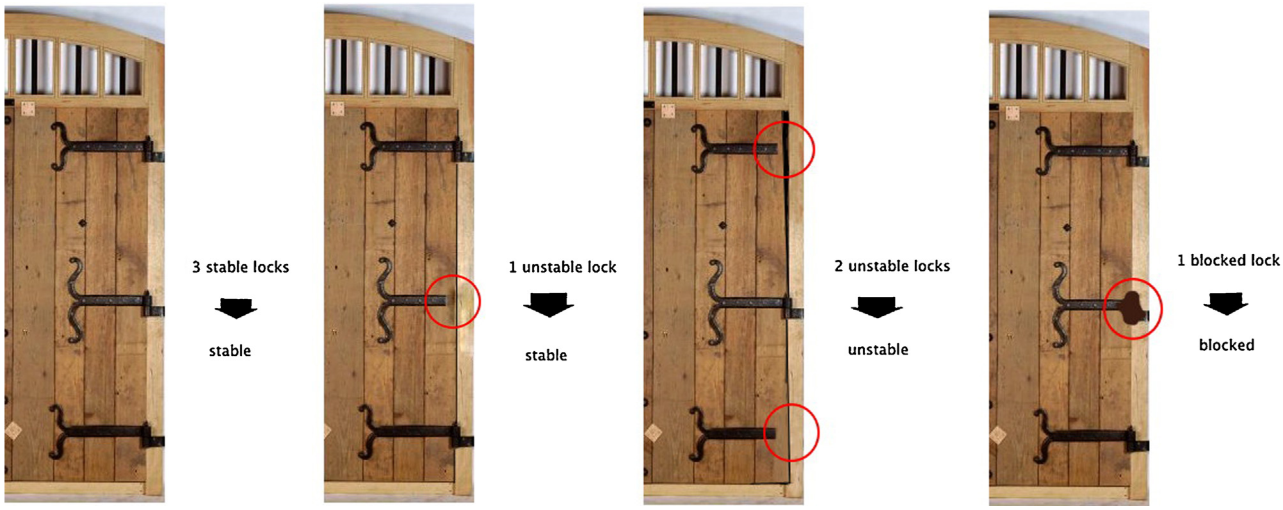

Fig. 1. The concept of latches in the radioulnar complex. Overall instability of the radioulnar complex is only possible if two latches are unstable; however, one jammed latch will impede the whole complex (Based on Soubeyrand).

2. Anatomy and physiology of the distal radioulnar joint

2.1. Bones, capsules and ligaments

The DRUJ is a cylindrical joint composed of the ulnar head and the radius sigmoid notch. It allows an average of 5.5 mm antero-posterior translation [6]. It also participates in the pronation–supination movement, in which the radio-carpal complex moves around the ulna, which considered as the fixed element for this movement.

Like the PRUJ, it is neither congruent (the bones do not interlock), nor concordant (different radii of curvature between the concave and convex surfaces) [7]. This implies that the bone configurations do not favor joint stability. Congruence is highest in neutral rotation, where around 60% of the joint surfaces are in contact. It is lowest in extreme pronation or supination, where only 10% of the joint surfaces are in contact [8].

As this bone configuration does not favor stability, it must be compensated by a powerful system of capsules and ligaments. They have a mechanical and a proprioceptive role, allowing a better motor response from the stabilizing muscles [9,10].

2.1.1. The triangular fibrocartilage complex (TFCC)

The TFCC is a biconcave fibrocartilage covered with cartilage, stretched between the ulnar styloid process and the medial part of the distal radius epiphysis. Various studies [11–14] have shown it has an essential role in stabilizing the DRUJ. It plays both the role of radioulnar ligament and of meniscus hanging between the two bones of the forearm and the carpus. Because of this specificity, it is subject to large multidirectional loads:

- it absorbs longitudinal stress, as 20% of the axial loads from the wrist are transferred to the ulna. Furthermore, it transfers longitudinal loads from the radius to the ulna, along with the IOM;
- it limits pronation–supination, with differential tension in the fibers from the deep and superficial layers;
- it opposes radioulnar diastasis, particularly when "clamping" as it makes the capitate ascend, leading to a spreading stress on the DRUJ.

Only 10–40% of the ulnar part of the TFCC is vascularized; the middle and radial parts are not vascularized at all, making spontaneous healing impossible. It can sometimes have a central perforation, without any traumatic cause.

The TFCC consists of several elements.

2.1.1.1. Ulnomeniscal homologue. The UMH is an avascular fibro-cartilage, nourished through synovial imbibition. Its thickness (1–2 mm) is inversely proportional to the radioulnar index: if the ulna is "long", the ulnomeniscal homologue will be thinner than if the ulna is "short" [15].

2.1.1.2. Radioulnar ligaments. These ligaments link the radius sigmoid notch to the ulnar styloid process and ulnar fovea. This ligament system is made of two layers, superficial and deep. The superficial layer ends medially on the styloid process and is composed of two bundles (anterior and posterior). The deep layer ends medially on the ulnar fovea by the ligamentum subcruentum–which is also composed of an anterior and a posterior bundle [13].

During pronation, the posterior bundle from the superficial layer tightens and wraps itself around the ulnar styloid process, while the anterior bundle of the deep layer opposes the anterior gliding of the radius (mainly at the end of the movement). During supination, the opposite mechanism is observed: tension in the anterior bundle of the superficial layer and the posterior bundle of the deep layer [7].

The two bundles of the superficial layer form a 56° angle and those of the deep layer form a 105° angle, which allows them to be efficient stabilizers over a large range of motion in pronation–supination [8].

2.1.1.3. Extensor carpi ulnaris sheath. The extensor carpi ulnaris (ECU) sheath is an integral part of the TFCC. It is the sixth and last extensor compartment: the extensors are stabilized on the dorsal part of the wrist by the extensor retinaculum.

2.1.1.4. Ulnocarpal ligaments. The ulno-triquetral and the ulno-lunar ligaments link the ulnomeniscal homologue to the proximal carpal row [7].

2.1.2. Capsule

The capsule plays an important role in stabilizing the joint. This role is both proprioceptive–thanks to the capsular mechanoreceptors–and mechanical [16].