



ELSEVIER
MASSON



Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

CHIRURGIE
DE LA **main**

Chirurgie de la main 33 (2014) 23–28

Original article

Biomechanical comparison of the hand-based transplant used in bone-tissue-bone scapho-lunate ligament reconstruction

Analyse biomécanique comparative des prélèvements os-tissu-os à la main pour la reconstruction du ligament scapho-lunaire

A.M. Gay^{*}, A. Thoreson, R.A. Berger

Biomechanics laboratory, division of orthopedic research, Mayo Clinic, 200, First Street SW, Rochester, MN 55905, United States

Received 11 December 2012; received in revised form 14 October 2013; accepted 1 November 2013

Available online 11 December 2013

Abstract

Although work has been published comparing the five most commonly used transplant techniques to the properties of the scapho-lunate interosseous ligament (SLIL), no study has been carried out which compares the biomechanical properties of the different bone-tissue-bone autografts to each other, using a standard methodology of testing. The hypothesis of this study was that mechanically significant differences in the material properties of commonly used bone-tissue-bone exist when compared to each other. We tested the dorsal part of the SLIL and the five most quoted transplants in the literature: capitate to trapezoid; trapezoid to second metacarpal; third metacarpal-carpal; dorsal capitate-hamate; 4–5 extensor retinaculum. For each transplant, we measured failure load, failure displacement, width, and thickness. Anova was used to compare the different results obtained and the level of significance attributed to $P < 0.05$. Load to failure were: SLIL 94.3 ± 42.86 N; capitate to trapezoid 37.7 ± 23.13 N; trapezoid to second metacarpal 45.43 ± 14.28 N; third metacarpal-carpal 60.11 ± 19.94 N; dorsal capitate-hamate 63 ± 25.51 N; 4–5 retinaculum 15.67 ± 10.7 N. Only the dorsal capitate-hamate ligament showed to have no significant ($P > 0.05$) difference in term of load to failure, all the others was significantly weaker ($P < 0.05$). Previous biomechanical studies have identified the dorsal region of the SLIL as the most structurally and functionally important area of the SLIL. As a result, attention has been more specifically brought to the replacement of the dorsal portion of the SLIL. An attempt to achieve a reconstruction that reproduces more closely the SLIL has generated research on the use of bone-tissue-bone composite graft, several donor sites have been used in order to find the most similar. Our results suggest that, using a normalized method to compare the previously described grafts harvested at the wrist level, that the dorsal capitate-hamate ligament has the closest properties to the native dorsal scapho-lunate ligament.

© 2014 Published by Elsevier Masson SAS.

Keywords: Scaphoid; Lunate; Reconstruction; Chronic dissociation; Bone-tissue bone

Résumé

Bien qu'un travail ait déjà été publié, qui comparait les propriétés des cinq greffons os-tissu-os les plus utilisés à celle du ligament scapho-lunaire interosseux (LSLIO), aucune étude n'a été menée qui compare les propriétés biomécaniques des différents greffons os-tissu-os les uns aux autres, utilisant une méthodologie standard pour les tester. L'hypothèse de cette étude était que des différences significatives dans les propriétés mécaniques des greffons os-tissu-os communément utilisés existent quand on les compare les uns aux autres. Nous avons testé la partie dorsale du LSLIO et les cinq transplants les plus cités dans la littérature : capitatum-trapézoïde ; trapézoïde-2^e métacarpien ; carpe-3^e métacarpien ; capitatum-hamatum dorsal ; rétinaculum des extenseurs 4–5. Pour chacun d'entre eux, nous avons mesuré la charge à rupture, l'élongation à rupture, la largeur et l'épaisseur. Une analyse Anova a été utilisée pour comparer les différents résultats obtenus et son niveau de signification fixé à $p < 0,05$. Les charges à rupture étaient les suivantes : LSLIO $94,3 \pm 42,86$ N ; capitatum-trapézoïde $37,7 \pm 23,13$ N ; trapézoïde-2^e métacarpien $45,43 \pm 14,28$ N ; carpe-3^e métacarpien $60,11 \pm 19,94$ N ; capitatum-hamatum dorsal $63 \pm 25,51$ N ; rétinaculum des extenseurs 4–5 $15,67 \pm 10,7$ N. Seul le ligament capitatum-hamatum dorsale n'a montré aucune différence significative ($p > 0,05$) en termes de charge à rupture, tous les autres transplants étaient significativement plus faibles ($p < 0,05$). Des études biomécaniques préalables ont montré que la partie

^{*} Corresponding author.

E-mail address: andregay@me.com (A.M. Gay).

dorsale du LSLIO était la partie du LSLIO la plus importante structurellement et fonctionnellement. En conséquence, une attention plus particulière a été portée sur le remplacement de la partie dorsale du LSLIO. La tentative de réaliser des reconstructions qui reproduiraient le LSLIO au plus proche a généré une recherche sur les greffons composites os-tissu-os ; plusieurs sites donneurs ont été utilisés dans le but de trouver le greffon le plus similaire au LSLIO. Nos résultats suggèrent que, en utilisant une méthode normalisée pour comparer les greffons déjà décrits dans les littératures et prélevés au niveau du poignet, le ligament capitatum-hamatum dorsal a les propriétés les plus proches de celles du LSLIO natif. © 2014 Publié par Elsevier Masson SAS.

Mots clés : Scaphoïde ; Lunatum ; Reconstruction ; Dissociation chronique ; Os-ligament-os

1. Introduction

Scapho-lunate dissociation, a term coined by Linscheid et al. in 1972 [1], can be described as the loss of mechanical linkage between the scaphoid and the lunate, and is the most common carpal instability. When the injury is diagnosed acutely, the deformity is easily reducible, and the prognosis more favorable. Unfortunately, the diagnosis is frequently delayed. Therefore, alterations in articular contacts and load bearing result in a progressive degeneration of joints (scapho-lunate advanced collapse). This progressive degenerative disease occurs first between the radial styloid process and the scaphoid (stage 1A). Later, arthritic changes widen and affect both the radioscaphoid joint (stage 1B) and the capitolunate joint (stage 2).

Treatment of chronic dissociative scapho-lunate interosseous ligament (SLIL) injuries without wrist osteoarthritis is still a matter of controversy [2]. Several different approaches have been proposed to address this challenging problem. The most common surgical option was intercarpal fusion, which was far from ideal as patients suffered from a decreased range of motion and strength rating. Moreover, fusion does not restore normal wrist kinematics and eventually may lead to additional wrist arthrosis [3].

Biomechanical studies identified the dorsal region of the SLIL as the most structurally and functionally important area of the SLIL [4]. As a result, attention has been more specifically brought to the replacement of the dorsal portion of the SLIL. This finding led to develop scapho-lunate ligamentoplasty procedures in order to reconstruct the SLIL and then restore normal carpal kinematic; surgical procedures have been developed aiming at a more physiological repair such as ligamentoplasty using flexor carpi radialis [5] or extensor carpi radialis [6,7].

An attempt to achieve a reconstruction that more closely reproduces the dorsal support of the SLIL has generated research on the use of bone-tissue-bone (BTB) composite graft to reconstruct the dorsal part of the SLIL with good preliminary results [8–14]. The first technique was described using tarso-metatarsal ligament [15], later several donor sites has been described such as iliac crest periosteal composite graft, bone-retinaculum-bone from the dorsal radius [14], metacarpal-carpal composite, capito-hamate and capitatum-trapezoid ligaments composite [8], as well as vascularized composite grafts [10]. All these procedures are investigational; however, early to medium-length follow-up reports of these techniques have been favorable, and one or more BTB grafts undoubtedly will play a part in the future management of SLIL repair. Although all

these different possible donor sites have been described, no study has been carried out comparing the biomechanical properties of all these different BTB autografts, using a standardized methodology of testing, in order to find the autograft with the biomechanical properties closest to those of the dorsal SLIL.

The aim of this study was to conduct a biomechanical measurement of the most commonly described BTB autografts in SLIL reconstructive surgery, using a standardized measurement apparatus and to compare them to biomechanical properties of the posterior region of the SLIL. The hypothesis was made that mechanically significant differences in the material properties of commonly used BTB exist when compared to each other and to the ligament they are intended to reconstruct.

2. Material and methods

2.1. Study design

In order to define the autografts with the biomechanical characteristics most similar to the native dorsal region of the SLIL, we designed a biomechanical study focusing on thickness, width, cross-sectional area, failure load and stiffness of the different autograft characteristics. The study took place in the Mayo Clinic Biomechanics Laboratory. All tissues were obtained through the Deeded Body Program, department of anatomy, Mayo Clinic. Tissue handling was compliant with all Mayo Clinic and external regulatory agency policies and procedures, and the Institutional Review Board approved the study.

2.2. Bone-tissue-bone complex acquisition

We tested the dorsal part of the SLIL and the most quoted transplants in the literature: capitatum to trapezoid ligament; ulnar trapezoid to second metacarpal ligament, third metacarpal-carpal, dorsal capitatum-hamate ligament, 4–5 extensor retinaculum.

Ten fresh frozen forearms were used for this study, 7 left and 3 right hands from 9 different subjects (5 women, 4 men, mean age 67, range 51–78). After thawing the specimen at room temperature (22 °C) for 12 hours, each wrist was dissected under loupe magnification ($\times 2.5$), through a dorsal approach; the extensor retinaculum was first divided and a composite transplant including extensor retinaculum, periosteum and cortico-cancellous bone was harvested and the mid portion of

Download English Version:

<https://daneshyari.com/en/article/4049069>

Download Persian Version:

<https://daneshyari.com/article/4049069>

[Daneshyari.com](https://daneshyari.com)