# Biomechanical Effects of Sagittal Band Continuity on Extension at the Metacarpophalangeal Joint

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## Introduction

Subluxation of the extensor digitorum communis (EDC) tendon at the metacarpal phalangeal (MCP) joint is a result of both acute and chronic injuries to the sagittal bands. Although there are many published techniques to address chronic subluxation, none address the function and continuity of the sagittal bands. The purpose of this study is to determine the biomechanical impact of the sagittal bands on joint function. Our hypothesis is that any discontinuity in the sagittal bands will increase the effort required to extend the digit at the MCP joint.

## Rationale and Background

Subluxation of the EDC at the MCP joint is a result of injuries that are both acute and chronic.[1] Short of direct repair of minor chronic defects, there have been no published surgical repair techniques that address the function and continuity of the sagittal bands. Furthermore, there are no studies investigating the biomechanical consequences of such an injury or its respective repair technique. We present a novel approach to the repair of the extensor apparatus in the chronic subluxation whereby the continuity of the sagittal bands are maintained. Our hypothesis is that the bilateral continuity of the sagittal bands plays an important role in joint extension, and that the maintenance of its continuity in any repair, whether chronic or acute, is paramount.

## Anatomy and Biomechanics

The contour of the metacarpal head is in a cam configuration whereby the tension of structures crossing the joint changes with the angle of extension.[2]

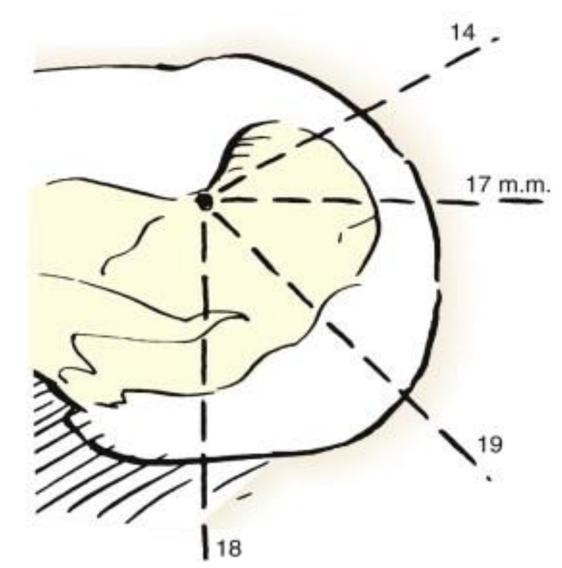



Figure from Green DP, Wolfe SW. *Green's operative hand surgery.* Philadelphia: Elsevier/Churchill Livingstone; 2011.

The extrinsic extensors along with the expansion of the lateral bands serve primarily to extend the MCP joints and are held in a centralized position by sagittal bands arising from the volar plate and the intermetacarpal ligament. The volar plate is firmly attached to the base of the proximal phalanx, providing a point of anchorage and equilibrium to the periarticular structures which converge to form the "force nucleus."[3] The sagittal bands form a sling which exerts a pull on the volar aspect of the base of the proximal phalanx to extend the MCP joint.[4] When the sagittal band system is damaged, the EDC may sublux or dislocate off the central axis of the finger, thus compromising the active extension of the MCP joint.[5]

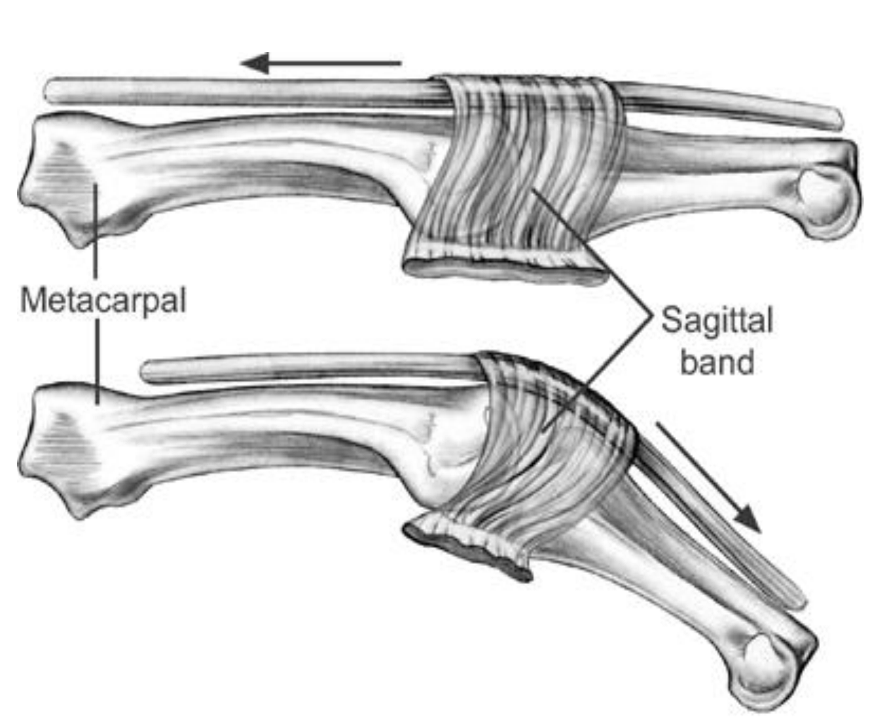
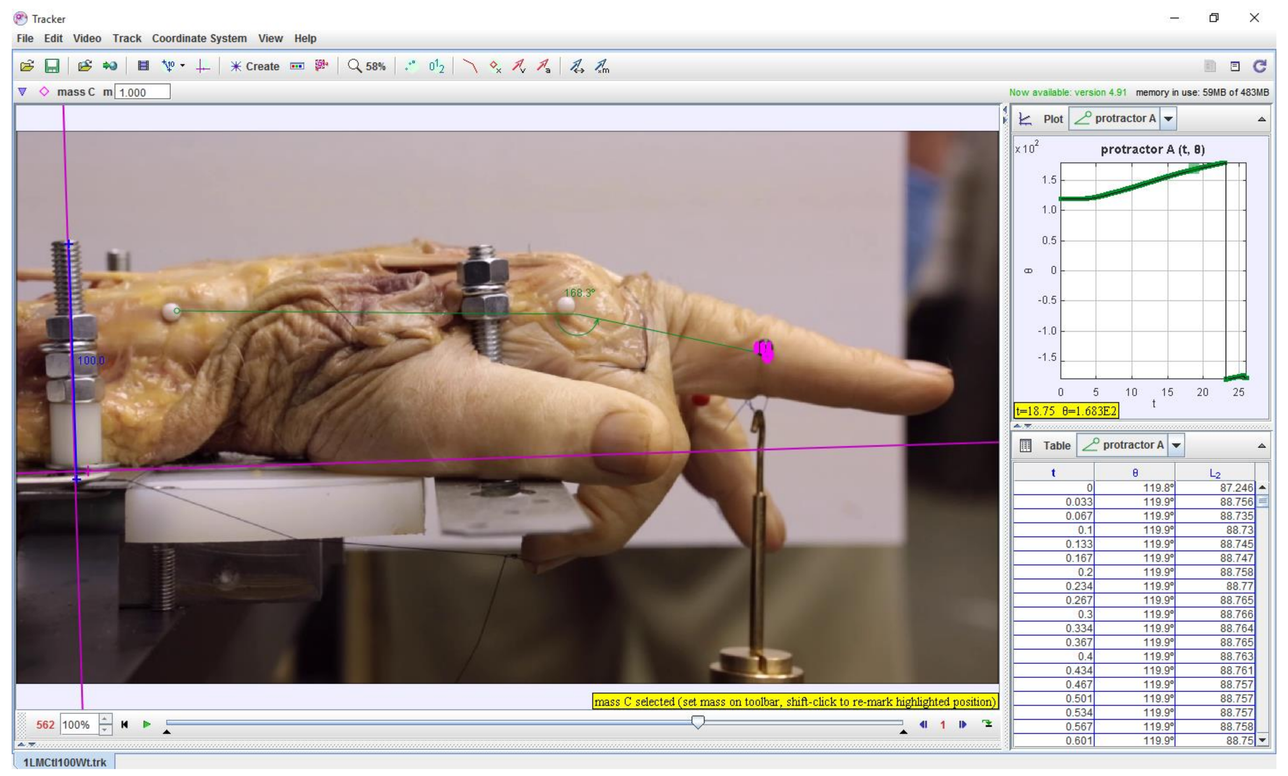



Figure from Berger RA, Weiss A-PC. *Hand surgery: Richard A. Berger & Arnold-Peter C. Weiss.* Philadelphia, Pa.; London: Lippincott Williams & Wilkins; 2002.

## Materials & Methods

20 digits from 10 cadaver hands were studied in this experiment. Each hand was secured to a testing base with the extensor tendon of either the long or ring finger attached to a torsion frame to measure the force and tendon displacement. A digital camera (Canon 5D MKIII) recorded high resolution video that was used to track the joint angles with software (Tracker, Open Source Physics). Measurements for each digit were grouped by weight (0g, 50g, 100g, and 150g serially added at the proximal interphalangeal joint) as well as defect (control, ulnar, and bilaterally incised sagittal bands). Force, power, work, and the change in joint angle as a function of tendon displacement were calculated and expressed in each group a percent change from control. Variables were compared using Student's *t*-test; $p<0.05$ is considered significant.



## Results

In the experiments with no weight added (unloaded), the magnitude of force, power, and work decreased by 21%, 22%, and 28% respectively ($p<0.0001$) in the groups with defects in the sagittal bands in comparison to their respective controls. However, these values were increased by up to 13% once there was weight added, although not by a significant margin. In unloaded digits, the change in angle correlating to each unit change in linear tendon displacement was increased by 15% ($p<0.0001$) with a defect in the sagittal bands, but this was diminished once any load was introduced. There were no significant differences between the ulnar and bilateral defect groups.

## Conclusion

Sagittal bands relate to the relationship between joint angle and tendon excursion in the unloaded digit. Although the amount of effort to extend the finger against load tends to increase when the sagittal bands are not intact, a higher powered data may be needed to find a significant difference if one exists. Nonetheless, the restoration of sagittal band continuity is an important consideration for centralization of the subluxed EDC tendon.

## References

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