

EFFECTS OF WRIST POSTURE AND TENDON LOADING ON CARPAL TUNNEL DIMENSIONS: AN MRI EVALUATION

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INTRODUCTION

Several mechanisms have been proposed to explain the nature of median nerve trauma in carpal tunnel syndrome (CTS), including increased pressure within the tunnel and contact forces on the nerve itself. However, greater understanding of the underlying mechanisms is necessary to advance management and prevention programs.

Wrist posture and tendon loading have been shown to increase carpal tunnel pressure, which may result in median nerve compression (Keir *et al.*, 1998). This change in pressure may be due to a change in carpal tunnel volume or the volume of its contents. Thus magnetic resonance imaging (MRI) studies have been used to evaluate parameters such as cross-sectional area (CSA) and the relationship of space availability and the median nerve (Horch *et al.*, 1997; Skie *et al.*, 1990). While previous studies have evaluated the CSA in flexed and extended wrists, volume has only been addressed in neutral wrist postures (Cobb *et al.*, 1992; Richman *et al.*, 1987). By evaluating numerous parameters in both healthy and symptomatic wrists, mechanisms by which CTS develops may be elucidated.

The purpose of the study was to determine the effects of finger and thumb forces combined with wrist flexion and extension on carpal tunnel shape (defined by volume, CSA and the space available for the median nerve). Furthermore, we sought to identify

the relationship between the space (CSA, volume) of the carpal tunnel and its contents.

MATERIALS AND METHODS

A total of ten wrists were imaged, 5 healthy controls and 5 volunteers diagnosed with CTS. Magnetic resonance images were collected with the use of a 1.5 Tesla Imaging System (Signa, Milwaukee, WI) at Sunnybrook & Women's College Hospital (Toronto, ON). To obtain high tissue contrast and resolution, 2-D axial images were acquired using fast gradient echo with fat suppression and a 17.5 cm diameter extremity coil. Repetition Time (TR) and Echo Time (TE) were 51 and 3 ms, respectively. A flip angle of 30° was chosen along with contiguous 3 mm slices, 12x12 cm field of view (FOV), 256x256 matrix and 10 acquisitions. Total imaging time was approximately 5 minutes per series.

Participants lay prone with their dominant arm abducted and flexed above the head. Wrists were imaged in seven different conditions, including three postures (neutral, 30° flexion and 30° extension), with and without maintaining a sub-maximal pinch grip of approximately 10 N. Also, a closed fist in a neutral wrist posture was imaged.

Carpal tunnel cross-sectional areas, volumes and space adjacent to the median nerve were calculated for the entire tunnel for each condition.

RESULTS AND DISCUSSION

Although a full quantitative analysis has not yet been completed, preliminary qualitative data analysis has revealed several findings consistent with the literature. For example, in wrist flexion the carpal tunnel takes on a more circular appearance with the finger flexor tendons lining up against the transverse carpal ligament (TCL) (Fig.1). In wrist extension, the shape of the tunnel appears more flattened as it progresses distally (Fig.2). We have graphically outlined the carpal tunnel borders in the figures to illustrate part of the process. In addition to the area indicated in the figures, the same will be done for its contents, as well as linear measures of depth and width.

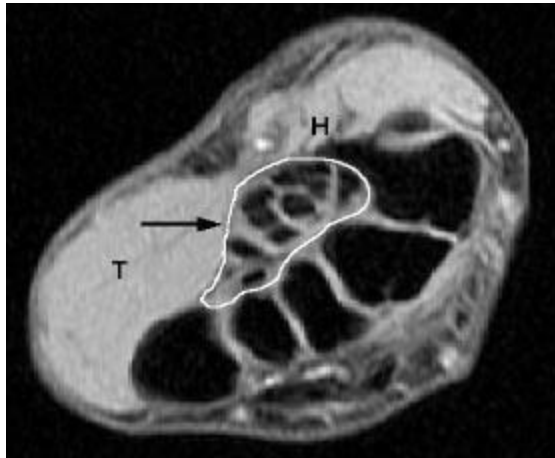


Figure 1: Axial image of the carpal tunnel. Flexed wrist at the level of the hook of the hamate (H). Thick arrow (TCL); thenar eminence (T); tunnel border outlined.

MRI slice orientation is typically aligned visually to the “best” fit. While this does not generally affect medical interpretation, it may introduce parallax error, which becomes important when calculating areas and volumes. This topic has not been discussed in the literature and, if considered, may result in changes in areas reported for the carpal tunnel. When calculating carpal tunnel CSA and volume, it is necessary to

obtain perpendicular cross-sections, or account for this potential confound.

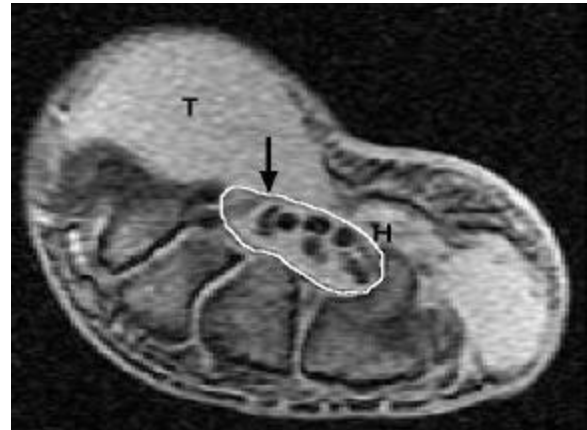


Figure 2: Axial image of the carpal tunnel with an extended wrist at the hook of the hamate (H). Thick arrow (TCL); thenar eminence (T); tunnel border outlined.

SUMMARY

Quantitatively examining carpal tunnel parameters in healthy and symptomatic wrists will help develop better strategies in prevention and rehabilitation of CTS.

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