

## BIOMECHANICAL STUDY OF VOLAR PLATE LESIONS IN THE FINGERS INTERPHALANGEAL JOINTS

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**Abstract...** *The volar plate is one of the reinforcement factors of the ventral portion of the articulation capsule. It acts as a joint hyperextension block. It is also useful to the flexor action angle because it increases the distance between the tendons and the joint rotation point. The proper treatment of volar plate lesions aims has as a goal to avoid PIP joint instability. It is important not to immobilize for a long time or for a too short time due the fact that both of them can affect the finger function. The volar plate lesions are found in many cases of hand traumas especially in ball sports players. None of these previous studies included the forces' magnitude needed to cross this ligament ruptured. This paper presents a biomechanical study it aims this study at identifying the region characteristics to later on raise hypotheses about rupture tensions and/or the maximum ultimate load of the volar plate.*

**Keywords:** volar plate, ligament, biomechanic, joint, stress

### 1. Introduction

The volar plate is a ligament formed with a fibrocartilage located ventrally to finger proximal interphalangeal joint (PIP) finger median region. This joint begins in the proximal phalangeal ventral face and ends in the median phalangeal ventral face. The volar plate is one of the reinforcement factors of the ventral portion of the articulation capsule. It acts as a joint hyperextension block.

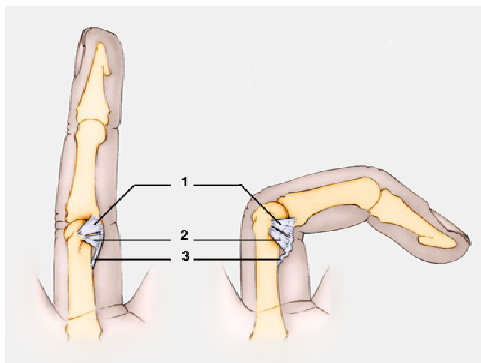


Figure 1- volar plate

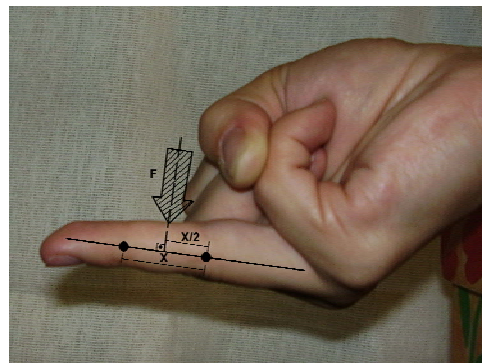


Figure 2 – median phalangeal

It is important not to immobilize for a long time to avoid joint rigidity in flexion for a too short time may cause its rupture or looseness which may cause the swan neck deformity.



Figure 3 – Swan Neck deformity

Percentage and types of accidents lesions of volar plate are observed in a number of patients with hand trauma, specially in ball sports players. Barroso et al (2003) observed in his studies that the main cause of volar plate lesions is due to trauma in sports players and that 31% of the accidents happen in soccer players. There in no study in which the magnitude of the force necessary to cause ligament rupture.

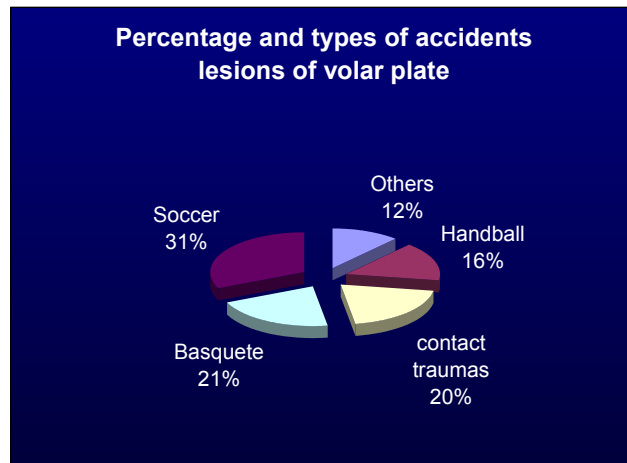


Figure 4 – sports

## 2. Objectives

By means of a biomechanical study of the volar plate behavior to obtain the characteristics of the region to raise hypothesis of rupture tensions and / or maximum stretch point of rupture.

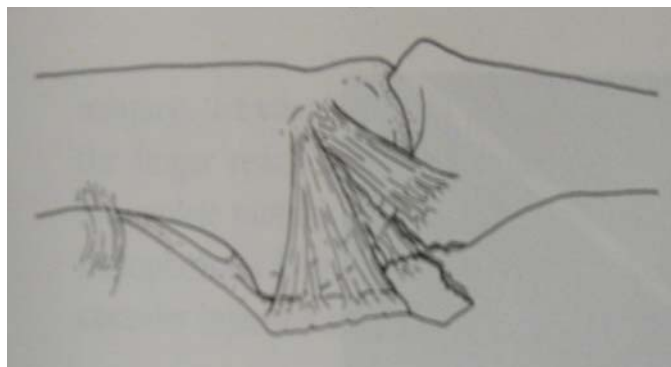


Figure 5 – trauma mechanism

## 3. Methodology

Initially, ten women (20-31years) were selected and none of them was athlete or presented previous lesions. According to Barroso et al (2003), the ring finger is the most susceptible to lesions (39% of the accidents). For this reason, this was the finger utilized for the measurements.

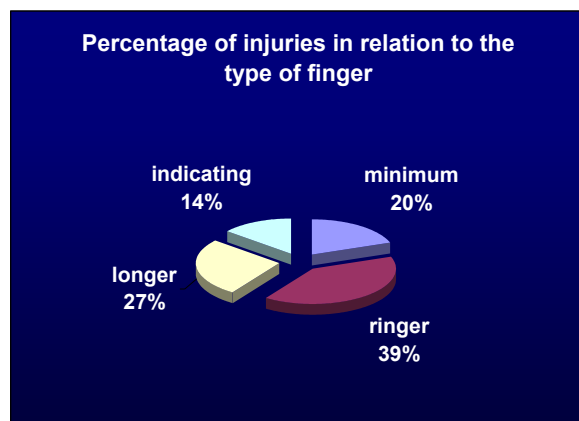


Figure 6 - fingers

Having analyzed the finger force it can be drawn a line that determines the longitudinal axis of the ring finger, mainly in the middle phalange region. The finger rotatc points were indicated. Performing the measure of the middle phalange we have that its length is X. In order to apply the force the phalange middle point was chosen. The distance between the application of the force and the point where the volar plate rupture happens will be X/2.

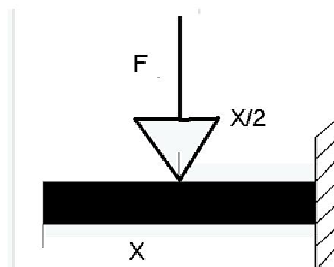


Figure 7 – perpendicular force

When the force is applied perpendicularly in this point f it is possible to calculate the solicitations in the rupture point. It was asked to the participants that rested the dorsal area of the ring finger in a standard surface, leaving free only the PIP joint. Using the dynamometer Pinch-gauge in opposite and perpendicular force to the movement anti-clock was applied until the participants felt very uncomfortable. The force was always applied by the same person, localized in A. The half part of the external margin of the dynamometer was also measured. Great care was taken to assure similar conditions during the measurements, avoiding mistakes and uncertainties.

Table 1

Nº	Dominat side	age	force (kgf)				everage Force (kgf)	Falange (cm)	Bending moment (kgf/cm)
01	right hand	29 years	5.0	4.25	4.2	5.25	4.69	2.0	4.69
02	right hand	22 years	6.0	5.0	5.0	5.25	5.31	2.10	5.57
03	right hand	29 years	4.7	5.5	5.2	4.5	5.0	2.20	5.5
04	right hand	20 years	5.2	5.5	5.0	4.75	5.12	2.0	5.2
05	right hand	24 years	5.2	4.25	4.2	4.75	4.62	2.15	4.85
06	right hand	28 years	5.0	5.0	4.7	4.5	4.81	2.15	5.14
07	right hand	28 years	4.7	4.75	4.7	5.0	4.81	2.0	4.81
08	right hand	23 years	4.0	4.0	4.5	4.0	4.12	2.0	4.12
09	right hand	21 years	5.2	5.25	4.7	4.75	5.0	2.0	5.0
10	right hand	31 years	5.5	5.25	4.7	4.75	5.06	2.10	5.31

Four measurements were performed for each subject. Soon after, the arithmetic mean was calculated to obtain force value (F1). The sum of forces in vertical must be zero, as the body is in static balance.

$$+\uparrow \quad \Sigma V=0$$

It was determined the direction of the force as positive from bottom to top. The middle phalange exerts a force F on the proximal phalange and the proximal phalange exerts a force V of the reaction. It was determined the positive anti-clock.

$$- F+V = 0$$

$$+ \Sigma M= 0$$

Using the formulae  $M=F.d$ , it was calculated the momentum of each subject  $M=F1.X/2$ . This was followed by calculation of the arithmetic mean of the momentums and though this mean a hypothesis of the necessary effort to rupture the volar plate ligament was raised f/cm.

Glaucia:  
 $F = 4,69\text{kgf}$   
 $D_{\text{falange}} = 2\text{cm}$   
 $+ \uparrow V = 0 \quad -F + V = 0$   
 $V = 4,69\text{kgf}$   
 $+ \uparrow M = 0 \quad F \times D/2 + M = 0$   
 $M = -4,69\text{kgf/cm}$

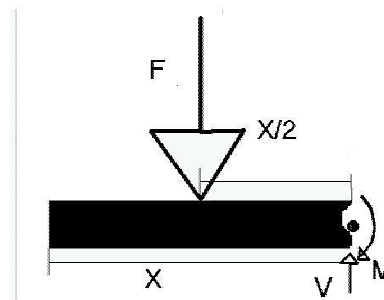


Figure 8 - moment

#### 4. Conclusion

After analyzing the results it was verified that arithmetic mean found in the momentums was 5.019 kgf.cm, that is, it is assumed that the lesion in the plate requires a force above this. In order to increase reliability to the results, it will be necessary to increase the number of the samples and carry out the experiments in various conditions (temperature and subjects tiredness).

It is hoped that more profound research in this field will lead to the development of resistance materials to improve more protection to athletes.

We understand that further researches observations on the influence of the other stabilizing structures of the PIP joint (collateral ligaments, extensor mechanism and others) and the measurement of the load including different angles of application.

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