

# ANATOMICAL STUDY OF SENSORY ANASTOMOSES IN THE HAND

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## ABSTRACT

**Objective:** The aim of this study is to evaluate the prevalence, topography and morphometry of sensitive nervous anastomoses in the hand. **Methods:** Thirty anatomic parts irrespective of race, gender and age have been dissected. Measurements of anastomoses' length, origin and terminus regarding the transverse carpal ligament were noted. The anastomoses were classified according to the scheme proposed by Meals & Shaner and modified by Bas & Kleinert.

**Results:** Type 1 anastomosis was the most prevalent. The distance between the origin of the anastomosis to the distal limit of the transverse carpal ligament was 0.7 cm in average. **Conclusion:** This study showed that Berretini anastomosis is high prevalent, usually beginning in the ulnar and distal nerve until the transverse carpal ligament. **Level of Evidence IV, Case Series.**

**Keywords:** Anastomosis, surgical. Median nerve. Ulnar nerve.

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## INTRODUCTION

Anastomosis between the median and ulnar nerves are the most common form of anomalous innervation, causing variations in the innervation of the intrinsic muscles of the hand.<sup>1,2</sup> Anastomoses are reported in the proximal forearm, rarely distal and in the palmar region between the recurrent branch of the median nerve and the deep branch of the ulnar branch.<sup>3</sup>

From the anatomical drawings of Berretini, in 1741, began the first reports and studies of nerve anastomosis between the ulnar and median nerves in the hand at the level of the third commissure, known as the "turning point" region<sup>4-6</sup> or "ramus communicans cum nervi ulnari" on Terminologia Anatomica.<sup>7</sup> In the late 19<sup>th</sup> century began the first detailed descriptions of the anastomosis by Berretini. Meals and Shaner,<sup>6</sup> Dogoan *et al.*<sup>8</sup> were the first to classify this communication according to their anatomical directing, and Ferrari and Gilbert<sup>9</sup> (Figure 1) described its anatomical and angular measurement compared with the transverse carpal ligament. Despite the knowledge of its existence, there are few anatomical reports about the sensitive communicating branches between median and ulnar nerves.

The authors aimed to assess the prevalence of sensitive nerve anastomoses in the hand, as well as to specify their topography and morphology in relation to the transverse carpal ligament.

## MATERIALS AND METHODS

This is an anatomical study conducted by the Laboratory of Morphology, Irmandade da Santa Casa de Misericórdia de São Paulo, through the dissection of 30 formalin preserved anatomical parts, including hand and wrist, being 17 left and 13 right, regardless gender and age. Exclusion criteria were any signs of regional disease or previous trauma that could alter their anatomy. Fourfold magnification was achieved with a loupe and microsurgical instruments were used for dissection. Skin, subcutaneous tissue, palmar fascia and palmar vascular arch were resected with exposure of the transverse carpal ligament, common digital nerve and digital nerves.

Every nerve communications between the ulnar and medial nerves and their branches in hand have been recorded, precisely between the third and fourth common digital nerve on the palm of the hand. The total length of the anastomosis and the distance between the origin and the end of the anastomosis and the distal end of the transverse carpal ligament were measured in centimeters, using a millimeter ruler. (Figure 2) When present, anastomoses were classified according to Meals and Shaner<sup>6</sup> and then by this technique modified by Bas and Kleinert<sup>10</sup> (Figure 3) which divides the anastomoses into four types: type 1 corresponds to the communication that originates the ulnar nerve proximally and proceed distally to join the median nerve; type II refers to the communication that originates proximally to the median nerve and extends distally to join the

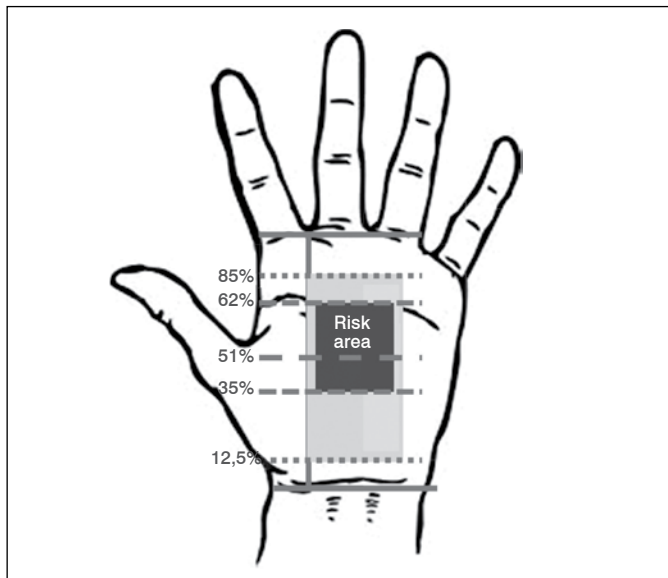
All the authors declare that there is no potential conflict of interest referring to this article.

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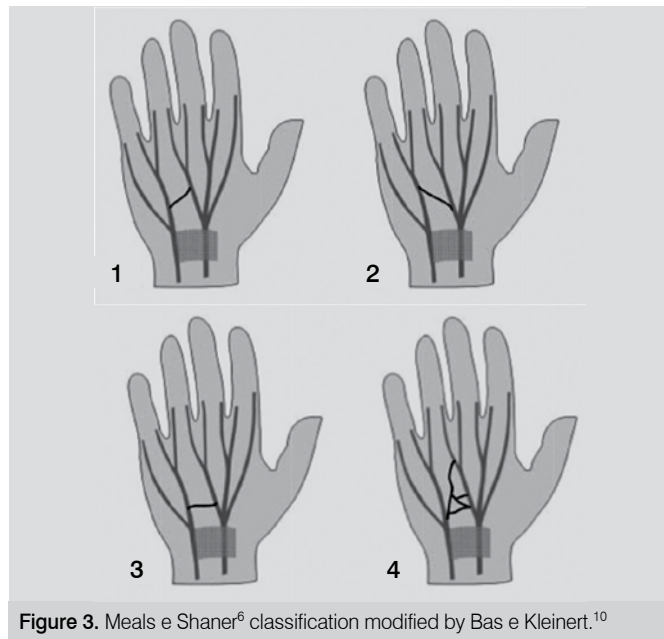
**Figure 1.** Anatomical ratios and major lesion risk areas on Berretini anastomoses according to Ferrari and Gilbert.<sup>9</sup>



**Figure 2.** Measurement diagram of lengths of distances between the end of the anastomosis and the distal extremity of the transverse carpal ligament.

ulnar nerve; type III corresponds to the perpendicular transverse communication between the median and ulnar nerves, however, is not possible to determine which nerve corresponds to the point of origin; and, finally, type IV refers to multiple communicating branches, anatomically complex, from both the median and ulnar nerves. Photographic images were recorded using a digital camera with fourfold magnification.

For statistical analysis software SPSS V17, Minitab 16 and Microsoft Excel 2010 were used. For descriptive statistics, we calculated mean, median, standard deviation, coefficient of variation, quartile one and quartile three, minimum and maximum values and confidence intervals. For analytical statistics, the independent variables were compared using the Mann-Whitney test and the degree of association between these variables was assessed by Spearman's correlation test. We decided to use non-parametric tests (less than 25 samples) and we have adopted for statistical significance  $p < 0.05$ .

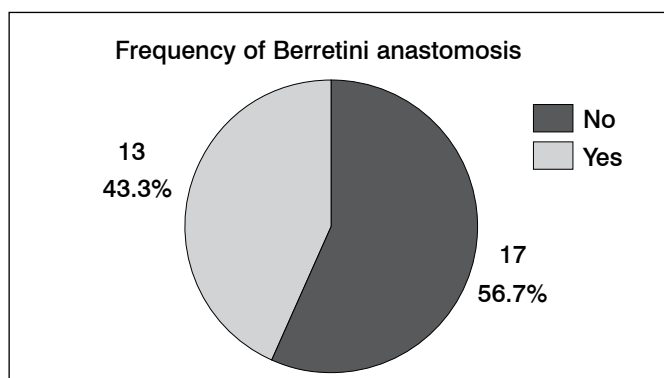


**Figure 3.** Meals e Shaner<sup>6</sup> classification modified by Bas e Kleinert.<sup>10</sup>

## RESULTS

Nerve communication between the median and ulnar nerves (Berretini anastomosis) was found in 13 (43.3%) of the 30 dissected anatomical specimens. (Figure 4) In the remainder, there was not any type of nerve anastomosis in the palm of the hand. (Figure 5) All communications originate from the ulnar nerve. The average distance between the origin of the anastomosis and the distal end of the transverse carpal ligament was 0.67 cm in the right side and 0.73 cm in the left side. The average distance between the end of the anastomosis and the distal edge of the transverse carpal ligament was 2.25 cm in the right side and 2.51 cm in the left side, and the average length was 2.92 cm in the right side and 3.24 cm in the left side. No statistically significant difference was observed between both sides. Table 1 shows the descriptive values for the 13 subjects in whom the anastomosis was found.

According to the classification of Meals and Shaner<sup>6</sup> modified by Bas and Kleinert,<sup>10</sup> anastomosis type I were observed in ten anatomical parts (76.9%), (Figure 6); Type III in one (7.7%), (Figure 7); Type IV in two (15.4%), (Figure 8); of the 13 cases presenting anastomosis, as shown in Table 2. No anastomosis type II was found.



**Figure 4.** Frequency of Berretini anastomoses on the 30 anatomical parts studies.



Figure 5. Without Berretini anastomosis.



Figure 7. Berretini anastomosis type III.

**Table 1.** Complete descriptive values to full length Berretini anastomosis, distance between origin and end of the anastomosis and the distal end of the transverse carpal ligament.

Descriptive	Length	Origin	End
Mean	3.09	0.70	2.39
Median	2.9	0.6	2.6
Standard Deviation	1.53	0.61	1.15
VQ	50%	88%	48%
Q1	1.7	0.3	1.7
Q3	4.1	0.8	3.3
Min	0.9	0	0.3
Max	6.3	2.2	4.1
N	13	13	13
CI	0.83	0.33	0.62

(VQ: variation coefficient; Q1: quartile 1; Q3: quartile 3; Min: minimum value; Max: maximum value N: number of parts; CI: confidence interval.

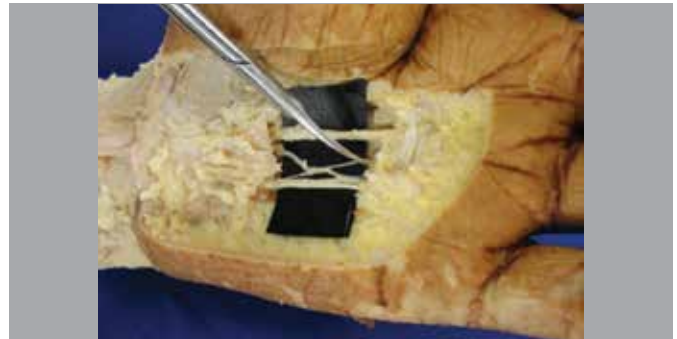


Figure 8. Berretini anastomosis type IV.



Figure 6. Berretini anastomosis type I.

**Table 2.** Distribution of the types of anastomoses according to the classification of Meals and Shaner<sup>18</sup> modified by Bas & Kleinert<sup>10</sup>.

Type	N	%	P value
Type 1	10	76.9%	Ref.
Type 3	1	7.7%	<0.001
Type 4	2	15.4%	0.002

**Table 3.** Length, origin and end of anastomoses.

Type	Length		Origin		End	
	Type 1	Type 3/4	Type 1	Type 3/4	Type 1	Type 3/4
Mean	3,21	2,70	0,85	0,20	2,36	2,50
Median	2,95	2,90	0,75	0,30	2,45	2,60
Standard Deviation	1,65	1,21	0,62	0,17	1,23	1,05
N	10	3	10	3	10	3
CI	1,03	1,37	0,39	0,20	0,76	1,19
P value	0,612		0,050		1,000	

In the last column of Table 2 we show p values for comparisons of each type when compared to the most prevalent as a reference (Ref.). This study demonstrated that Berretini anastomosis type I was the most prevalent and considered statistically different from the other types.

In Table 3 we compared the values in length, origin and end of anastomosis between types I and 3/4. We noted that there is statistically significant difference between the types only for origin values. Parts classified as type I had an average of 0.85cm from the origin compared to an average of 0.20cm of parts types III and IV.

## DISCUSSION

The sensitivity of the palmar surface of the hand is supplied by the median and ulnar nerves, with its classic early divisions in the midline of the ring finger. Two nerve communications between the median and ulnar nerves in the palm are known: one is deep, has a motor nature, known as Riche-Cannieu anastomosis, whereas the second, superficial and sensitive, is described as Berretini anastomosis.<sup>9</sup>

Several published studies have evaluated the prevalence of different types of anastomoses between the median and ulnar

nerves in the palmar region of the hand. However, the prevalence of these anastomoses is variable, with studies reporting between 6 and 94%.<sup>5,11</sup> Authors like Bas and Kleinert,<sup>10</sup> Stancic *et al.*,<sup>12</sup> and Don Griot *et al.*<sup>13</sup> reported the presence of Berretini anastomosis in 67, 81, and 94%, respectively. The present study identified 43.3% of this anatomical variation. Even considering the large variability between studies, we can state categorically that this is not an occasional finding as the first reports supposed.

The classification proposed by Meals and Shaner<sup>6</sup> is most used for topographic characterization of these superficial sensitive anastomoses between the median and ulnar nerves, due to the fact that the authors explained the variability due to the sensory innervation of the fingers. In 1999, Bas and Kleinert<sup>10</sup> added type IV classification, featuring a plexiform distribution of anastomosis, found in 17% of the parts. Subsequently, Tagil *et al.*<sup>14</sup> found a prevalence of type IV in 10% of hands.

There is also a complete agreement between the frequencies of different types of anatomical anastomosis studies. The results of Meals and Shaner,<sup>6</sup> Bas and Kleinert,<sup>10</sup> Stancic *et al.*<sup>12</sup> Don Griot *et al.*<sup>13</sup> and Tagil *et al.*<sup>14</sup> are shown in Table 4, in comparison to the current study.

Type I anastomosis was the most prevalent, corroborating other studies in the literature.<sup>14</sup> As in studies by Stancic *et al.*,<sup>12</sup> we did not find in any sample type II anastomosis (origin on the median nerve distally with the ulnar nerve).

**Table 4.** Prevalence of sensory type Berretini anastomose on different studies.

	Meals & Shaner (1983)	Bas & Kleinert (1999)	Stancic <i>et al.</i> (1999)	Don Griot <i>et al.</i> (2000)	Tagil <i>et al.</i> (2007)	Present study
Type I	76%	37%	65%	83%	40%	33.34%
Type II	2%	13%	0%	3.50%	3.30%	0%
Type III	0%	0%	16%	7.50%	6.70%	3.40%
Type IV	0%	17%	0%	0%	10%	6.70%

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The average distance from the origin of type I anastomosis was 8.5 mm distal to the transverse carpal ligament, a value also variable in other studies in the literature, with measures of 4.8 mm (Stancic *et al.*)<sup>12</sup>, 5.6 mm (Tagil *et al.*)<sup>14</sup> and 16 mm (Don Griot *et al.*)<sup>13</sup>. Regarding the origin of types III and IV of the Berretini anastomosis, average values of 2.36 mm were found close to that found in the study of Don Griot *et al.*,<sup>13</sup> who reported an average value of 2 mm for type III.

Stancic *et al.*<sup>12</sup> realized that 28% of their anatomical parts presented the origin of nerve anastomosis with proximal origin to distal limit of the carpal tunnel. According to the author, this would be a risk factor for iatrogenic injuries. In the present study two cases originating in the exact distal limit of the carpal tunnel were found. All others showed their origin after this anatomical limit.

Berretini anastomosis presents clinical significance in the risk of iatrogenic injury during the approach to the carpal tunnel, especially in endoscopic procedure with indirect vision, which can cause sensory loss in the area comprised between the middle and ring fingers. Loukas *et al.*<sup>5</sup> concluded that the extent of sensory loss is dependent on the topography of the individual Berretini anastomosis.

Ferrari and Gilbert<sup>9</sup> described a "danger zone", defined as an area that extends from the half of the hypothenar eminence limited distally by the transverse crease of the carpal on the palmar region and radially by a longitudinal fold between the thenar and hypothenar eminence, in which there is greater possibility of iatrogenic lesions in the approach to the carpal tunnel. According to Agge *et al.*<sup>15</sup> and Jimenez *et al.*,<sup>16</sup> these lesions are more frequent after endoscopic carpal tunnel release, although this technique has lower risk of complications in general, and provides quicker return to functional activities.

## CONCLUSIONS

The present study showed a high prevalence of Berretini anastomosis, usually beginning in the ulnar nerve and distal to the transverse carpal ligament.