Original article

Relationship between palmar skin creases and osseous anatomy - a radiological study identification

Chauhan, P.[1]*, Kalra, S.[2], Jain, SK.[1], Munjal, S.[1] and Anurag, A.[1]

[1]Department of Anatomy, Shri Guru Ram Rai Institute of Medical and Health Sciences Patel Nagar, Dehradun, Uttarakhand, 248001, India
[2]Department of Anatomy, University College of Medical Sciences, and Associated GTB Hospital, Delhi, 110095, India
*E-mail: drpujachauhan@yahoo.co.in

Abstract

Functional association of the Palmar creases overlying the various osseous structure of the hand have proved as an important anatomical landmark. This fact can be of use in various orthopaedic and surgical procedures on the hand. These lines upon the skin may not exactly mark the line of underlying joint, therefore it is important to know the relationship between the two. The study was performed on the right hands of 50 subjects. Most consistent creases were marked using a 25 gauge copper wire on the palm and radiographs were taken in AP view. Various measurements were taken from the crease to the associated joint/osseous structure. Statistical analysis proved significant positive correlation in the distance between distal transverse crease(DTC) and metacarpophalangeal (MCP) joint and proximal digital crease (PDC) and MCP joints in the index finger and middle finger with p value of 0.03 and 0.008 respectively, whereas, highly significant negative correlation was found in the distance between proximal transverse crease (PTC)-MCP joint and proximal digital crease(PDC)-MCP joint of the index finger($p = 0.038$). PTC was consistently proximal to MCP joint in the study group. It was observed that in majority of cases the associated joints do not lie under the flexion creases, therefore if any joint exposure is essential, then for better field of surgery incision can be placed parallel to the crease so that it exactly overlaps the joint if the position of joint with respect to the crease is known.

Keywords: flexion crease, palmar crease, hand reconstruction.

1 Introduction

The study of palmar skin creases has evoked substantial interest among forensic science experts, astrologers, clinicians and geneticists. These are exclusive to any human being and no two people can have exactly identical creases in hand. Both primary genetic determination and development secondary to flexion function have been suggested as the mechanisms underlying the crease development. The evidence offered has been mostly indirect, related to the timing of the onset of the fetal hand movement and the crease aberrations in malformed hands and fingers (KIMURA, 1991). Flexion lines are of significance and concern as they are the surface registration of the mobility of the parts. They indicate the folding points of the skin and subcutaneous tissue and mark the site of skin joint, brought into action by the underlying bony joint. The major markings are found in the vicinity of synovial joints, where the skin is strongly attached to the underlying deep fascia .These flexion lines develop during early fetal life and are unique features of the hand. Documentation of pre-natal stage of development of the flexion creases on human palm revealed that most flexion creases develop concurrently with the appearance of fetal volar pads and the rest develop independently of them. A study on development of human palmar and digital flexion creases documented that the palmar creases are consistently seen by 13 weeks of gestation (STEVENS, CAREY, SHAH et al., 1970). The volar pads are present from 8 to 14 fetal weeks. A hand malformation or specific insult that occurs before the time of crease development and that alters the form or function of the fetal hand can cause secondary alterations in the crease patterns of the hand. However, there are also studies to indicate that digital and palmar hand creases are secondary features, being the consequence of flexional folding of palmar skin in early fetal life (KIMURA and KITAGAWA, 1986; POPICH and SMITH, 1970). But contrarily, a research in the inheritance of liability estimated from the incidence among relatives suggested that these palmar creases are inherited in polygenic manner and genetic factors and environmental both interplay to produce these creases (TAY, 1979).

Because of the functional association of the various osseous structure of the hand with the palmar creases, these can be used as an important anatomical landmark to the underlying structures and can help in inspection and palpation of the hand and prediction of structures, which are liable to be damaged in relation to a specific surface wound. Palmar skin creases are considered to be ideal lines for giving incision in hand surgeries and the design of every skin incision must take into account the structure and mobility of area it crosses, its relationship to deeper structures, the blood supply to skin, the sensory nerve distribution, the previous wounds and cosmetic considerations (TUBIANA, THOMINA and EVELYN, 1984). A mislaid incision can often lead to the damage of underlying important structures and unsightly tender contracted scar. The correlation can also be of practical therapeutic value in orthopaedic rehabilitation of hand malformations. The most important objective of this study was to measure the distance between Palmar/digital skin creases and the related joints (joint causing deepening of the skin crease), quantification of these measurements, their statistical analysis to find out the relationship between the creases and osseous anatomy and to study its clinical implications.

2 Materials and methods

The study was conducted on 50 adult female volunteers. Exclusion criteria included any known medical history of congenital anomaly, surgery or trauma of the hand. Twenty five Gauge copper wire was used to mark 8 consistently present skin creases on the right hands of all the volunteers (Figure 1). The creases marked were thenar crease (TC), proximal transverse crease (PTC), distal transverse crease (DTC), palmar digital crease (PDC), proximal interphalangeal crease (PIP) and distal interphalangeal crease (DIP). Radiographs were taken in an anteroposterior (AP) view with fingers extended (0° flexion) and wrist in neutral position. In the neutral position the wrist is in 0° flexion, extension, ulnar deviation and radial deviation. Although in this study the hands were placed in a standardized position to obtain radiographs, it is rational to believe, that, because of the relative immobility of the creases the relationships described here would retain validity regardless of the hand or fingers and this position was selected for the study because many palmar hand procedures are performed in this position. Markers placed along palmar skin creases of 50 hands radiographically demonstrated creases superimposed on osseous anatomy.

Various measurements from each skin crease to its nearest and functionally associated joints/osseous structure were taken directly from the radiographs of the hand with the help of Vernier Calipers. Perpendicular line was measured which was drawn from the mid-point of metacarpophalangeal joint of various fingers to the distal/ proximal palmar creases. Distance between thenar crease and hook of hammate was also measured. The position of thenar crease was also noted on X-Ray with respect to second metacarpal, second inter-metacarpal space, third metacarpal and third intermetacarpal space. A horizontal line was measured which was passing from the thenar crease to the hook of hamate medially and from hook of hamate to first carpometacarpal joint laterally. The effect of potential radiograph magnification was determined by measuring skin crease to skin crease distances directly in 5 hands and obtaining same measurements from their respective radiographs. Comparison was done statistically by applying paired *t*-test. The test statistics for $T = D - mD \div SD/n$ where,

- D = Sample average difference between each pair of observation
- SD = Sample standard deviation
- m = sample size, i.e. the number of pairs of observation
- mD = Population mean difference under the null hypothesis

When the null hypothesis is true and the population mean difference is mD, the statistic has a T-distribution with n-1 degree of freedom. The error due to hand size was determined by measuring the length of the 3rd metacarpal and size ranking the hands by this measurement followed by grouping them in 3 categories consisting of: Subjects within ±2SD of the mean value Lying below –2SD Lying above +2SD, and the subject falling within ±2SD were chosen for study. To eliminate the gender specific differences, the study group comprised exclusively of the female volunteers.

All the measurements taken were expressed as mean values and Standard Deviation. Various distances of the same finger were correlated statistically for any positive/ negative/no correlation by using Karl Pearson's test of correlation. Differences in the mean distances which were proximal and those, which were distal, were compared for significance for the same parameter by applying Student's *t*-test. Normal curve distribution of various parameters in sample study group was observed by expressing the results with the help of graphs and confirmed by using Kolmogorov Smirnov's statistical test of normality. Quantification of these relationships would aid in hand examination and placement of surgical incisions and provide additional insight into anatomic and functional associations of the hand with these creases.

Figure 1. Radiograph of right hand with copper wire placed on the digital creases, transverse creases, wrist creases and thenar crease.

3 Results

In the present study, distal transverse crease (DTC) was proximal to MCP joint of all the fingers in majority of volunteers (95-100%). In index finger, the DTC reached the level of MCP joint in only 18% volunteers. Distance gradually increased from index to ring finger and there was abrupt fall in the mean distance of the little finger (Table 1). In index and little finger the crease was almost equidistant from MCP joint.

Distance between the DTC and MCP joint in the study group was:

- **Index finger**: Proximal to the joint- 3 observations were between 20-25 mm and 5 were between 5 -9.9 mm.

Table 1. Mean distance of palmar creases from metacarpo-phalangeal joints.

Sl.No.	Distance	Position	No. of volunteers	Mean ± Standard Deviation
1.	Index dist. tr.-mcp jt.	P	5	8.7 ± 7.02
		D	3	12 ± 6.08
2.	Middle dist. tr.-mcp jt.	P	46	11.78 ± 4.55
		D	4	6.75 ± 7.02
3.	Ring dist. tr.-mcp jt.	P	49	13.45 ± 4.01
		D	1	14.5
4.	Little dist. tr.-mcp jt.	P	50	8.8 ± 3.48
		D	0	0
5.	Index px. tr.-mcp jt.	P	50	11.64 ± 4.97
		D	0	0
6.	Middle px. tr.-mcp jt.	P	50	21.68 ± 6.16
		D	0	0
7.	Ring px. tr.-mcp jt.	P	48	25.12 ± 7.26
		D	0	0
8.	Little px. tr.-mcp jt.	P	23	26.86 ± 12.93
		D	0	0

Distal to the joint- 2 (4%) observations were recorded in the range of 1-5 mm and 1 (2%) in the range of 15.1-20 mm. In one case (2%), DTC was found to be overlapping with the joint, in the rest of the volunteers, DTC didn't reach till the measurable point.

- **Middle finger**: Proximal to the joint- 12 cases (24%) were between 15-19.9 mm, 18 (36%) fell in the range of 10-14.9, 10 (20%) between 5-9.9 mm and 6 (12%) were between 0.1-4.9 mm. Distal to the joint- 2 (4%) observations were recorded in the range of 1-5 mm, 1 (2%) was in the range of 5.1-10 mm and 1 (2%) case was in the range of 15.1-20 mm.
- **Ring finger**: All the observations were proximal to the joint. 2 (4%) observation were in 20-25 mm, 21 (42%) were between 15-19.9 mm, 15 (30%) in 10-14.9 mm range, 11 (22%) were between 5-9.9 mm and only 1 (2%) was in the range of 1-4.9 mm.
- **Little finger**: All the cases were proximal to the joint. 1 (2%) observation fell between 20-25 mm, 1 (2%) between 15-19.9 mm, 16 (32%) between 10-14.1 mm, 28 (56%) between 5-9.9 mm and 2 (4%) were found to be in the range of 0.1-4.9 mm, 2 were overlapping the joint.

In *middle finger*, maximum observations, n = 46; were proximal to the joint and were in the range of 5-20 mm. In *ring finger*, the crease was proximal to the joint with the most frequent range of 5-20 mm in 100%. In *little finger* also, all the observations were proximal with the most frequent range of 5-15 mm.

4 Discussion

Studies of palmar and digital creases in the normal hand may be of diagnostic value in particular syndromes, as well as being of functional significance in serious malformations of the hand .The importance of this study involves not only diagnostic purposes but more important for various reconstructive hand surgeries. Not only the aesthetic benefits of reconstructive surgery are paramount but perfectly executed reconstruction can return this very important part of the body to near perfect condition.

In compliance with our observations, Bugbee and Botte (1993), also reported DTC to be proximal in middle, ring and little fingers. However, there was no mention about the index finger. In the present study, the crease was found to be farthest (distance = 13.4 mm) from the MCP joint of ring fingers which is in conformity with (distance = 10.3 mm) as reported by Bugbee and Botte (1993) and was nearest to the joint in the little fingers (present study: distance = 8.8 mm, study by Bugbee and Botte (1993) distance = 7.9 mm). In index finger, test of correlation was found to be significantly positive when distance between PDC & MCP joint and DTC & MCP joint were compared (Pearson's correlation Coefficient = -.699, P = .036). Middle finger also showed highly significant negative correlation when the distance between the DTC & MCP joint between PDC & MCP joint were compared (Pearson's correlation Coefficient = -.374, P = .008).

PTC was found to be proximal to the MCP joint of all the digits in maximum number of volunteers (96%) except the little finger). There was a gradual increase in the distance of the crease to the MCP joint from index to little finger. This crease reached the level of MCP joint of little finger in 48% cases, whereas Bugbee and Botte (1993) did not mention about its presence in relation to little finger. This crease was farthest from the joint in little finger in our study in contrast to that of proximal digital crease. Both the studies (present study: D = 25.1 mm, Bugbee and Botte (1993): D = 22.1 mm) reported this crease to be nearest to the joint in index finger (present study: D = 11.6 mm, Bugbee and Botte (1993): D = 9.1 mm). Difference in the observations was in the range of 2-3 mm. Other researchers (BUGBEE and BOTTE, 1993), also reported that the line joining the radial border of proximal transverse crease and ulnar border of distal transverse crease accurately overlapped the metacarpal neck in majority of volunteers (73%), where as in our study it was passing through the metacarpal neck in maximum cases (46%) and was overlapping the head of metacarpal in 38% volunteers. Correlation of distances was seen only in the readings of index finger. Significant negative correlation was seen in the distance between PTC and MCP joint; and PDC and MCP joint. (Pearson's correlation Coefficient = -.294). In the present study, thenar crease in the palm, which originated from its radial border in common with the proximal transverse crease, was located in 2nd intermetacarpal space in majority of cases (76%), contrary to another study by Bugbee and Botte (1993), which reported it to be crossing the 3rd metacarpal in maximum cases (54%). The position of the crease was least common on the third intermetacarpal space. In the proximal palm, thenar crease crossed scaphoid in maximum number of volunteers (26%) (Figure 2), but Bugbee and Botte (1993) reported it to be crossing the capitate in the majority (47%). In the current study the thenar crease was 3 to 4 mm nearer to the first carpometacarpal joint and the similar was the case with the hook of hamate.Thenar crease was passing through second intermetacarpal space in 38 (76%) volunteers. It was passing through the third metacarpal in 10 (20%) and the third intermetacarpal space in 2 (4%) volunteers (Figure 3). In the present study distance of thenar crease from the first carpo metacarpal joint and the hook of hamate was observed to be 7.2 mm and 15.6 mm respectively. Whereas Bugbee and Botte (1993), reported this distance to be 22.6 mm and 18.7 mm respectively which probably indicates the racial differences and shows that North Americans have wider carpal region as compared to Indians. In another research (KOMATZ, DAIJO and YOSHIDA, 1978) digital flexion creases on the little fingers of 283 male and 268 female individuals were studied. Two males and two females were found to have an extra interphalangeal transverse crease situated between the metacarpophalangeal and proximal interphalangeal creases. The extra crease of the little finger was unilateral or bilateral. None of the little fingers with extra crease had radiographic anomalies of the bones or joints, or evidence of dyskinesia. In the present study none of the fingers or palm had an extra crease.

The knowledge of these creases in relation to the osseous anatomy and the joints of the hand can be of great use to the operating surgeon in various procedures on hand such as for tendon repairs, corrective procedures for webbed fingers, carpal tunnel hand surgery, trigger finger surgery, ganglion cyst removal etc. In Dupuytren's contracture accepted indications (TOWNLEY, BAKER, SHEPPARD et al., 2006) for surgical intervention include metacarpophalangeal joint contracture of 30° and any degree of proximal interphalangeal joint contracture (TOWNLEY, BAKER, SHEPPARD et al., 2006). For contracture release fasciotomy/fasciectomy, is done via zigzag incisions along natural palmar and digital creases to prevent volar contractures and allow adequate exposure. Resurfacing after a total degloving injury to the hand is one of the most difficult management problems in hand surgery. In a report the authors resurfaced a totally degloved hand using extremely thin and broad perforator-based cutaneous free flaps, and the donor defects were covered with split-thickness skin grafts (KIM, KIM, KIM et al., 2003). Several procedures, including the formation of palmar and digital creases and interdigitation, defatting were performed to obtain the final appearance and function of the hand.

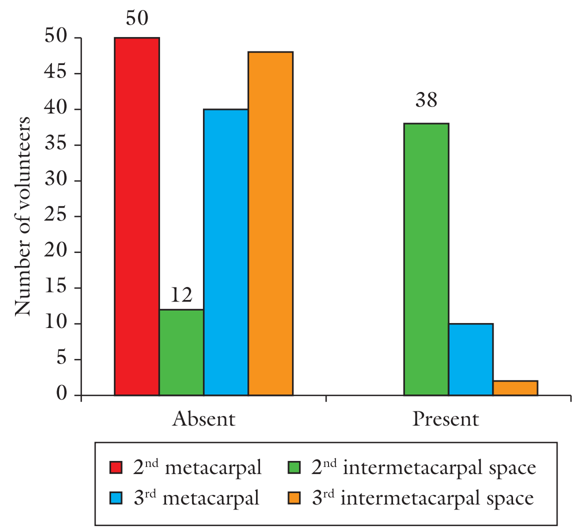

Figure 2. Comparative analysis of thenar crease in proximal palm.

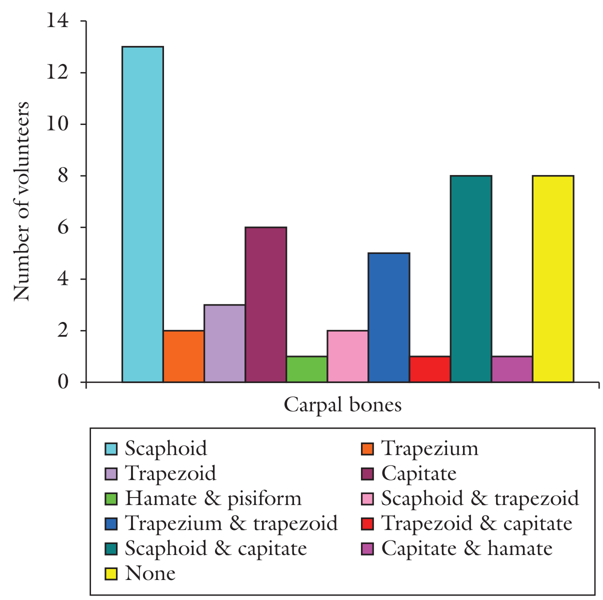

Figure 3. Comparative analysis of of thenar crease in mid palm.

5 Conclusion

The hand serves important functions can be severely hinder anyone with a hand defect or injury from doing the job due to physical trauma such as due to burns, accidents or a birth defect. Reconstructive hand not only does improve the appearance of the hand, but its primary utility is that of restoring the hand's functionality, allowing the long-suffering individual to live a nearly perfectly normal life. The knowledge of these creases in relation to the osseous anatomy and the joints of the hand are extremely essential in hand surgeries.

References

BUGBEE, WD. and BOTTE, MJ. Surface anatomy of hand: The relation between palmar skin creases and osseous anatomy. *Clinical Orthopaedics and Related Research*,1993, vol. 296, p. 122-126. PMid:8222413.

KIM, KS., KIM, ES., KIM, DY., LEE, SY.and CHO, BH. Resurfacing of a totally degloved hand using thin perforator-based cutaneous free flaps. *Annals of Plastic Surgery*, 2003, vol. 50, n. 1, p. 77-81. PMid:12545113. http://dx.doi.org/10.1097/00000637-200301000-00013

KIMURA, S . Embryologic development of flexion creases. *Birth defects*: original article series, 1991, vol. 27, n. 2, p. 113-129. PMid:1786348.

KIMURA, S. and KITAGAWA, T. Embryological development of human palmar, plantar and digital flexion creases. *Anatomical Record*, 1986, vol. 216, p. 1199391-197. PMid:3777451. http://dx.doi.org/10.1002/ar.1092160211

KOMATZ, Y., DAIJO, K. and YOSHIDA, O. Extra interphalangeal transverse creases of the little finger. *Japanese Journal of Human Genetics*, 1978, vol. 23, n. 1, p. 31-37. http://dx.doi.org/10.1007/BF01871380

POPICH, GA. and SMITH, DW. The genesis and significance of digital and palmar band creases: Preliminary report. *Journal of Pediatrics*, 1970, vol. 77, n. 6, p. 1017-1023. http://dx.doi.org/10.1016/S0022-3476(70)80086-5

STEVENS, CA., CAREY, JC., SHAH, M. and BAGLEY, GP. Development of human palmar and digital flexion creases. *Journal of Pediatrics*, 1970, vol. 113, n. 1, p. 128-132.

TAY, JSH . The genetics of plamar creases: A study in the inheritance of liability estimated from the incidence among relatives. *Annals of Human Genetics*, 1979, vol. 42, n. 3, p. 327-332. PMid:434775. http://dx.doi.org/10.1111/j.1469-1809.1979.tb00666.x

TOWNLEY, WA., BAKER, R., SHEPPARD, N. and GROBBELAAR, A. Dupuytren's contracture unfolded. *British Medical Journal*, 2006, vol. 332, n. 7538, p. 397-400. PMid:16484265. PMCid:1370973. http://dx.doi.org/10.1136/bmj.332.7538.397

TUBIANA, R., THOMINA, JM. and EVELYN, M. *Examination of hand and upper limb*: The skin of hand. Philadelphia: WB Saunders Company, 1984.

Received February 15, 2011
Accepted June 21, 2011