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Utilization of the web index in the measurement of web creep after syndactyly surgery

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Abstract

The aim of this study was to explore the feasibility of using a web index to measure web creep after syndactyly surgery. A total of 19 hands in nine children (six preoperatively and 13 immediately postoperatively) underwent measurement of their web position. A preliminary study confirmed that the web index measured on the child's hand at the time of surgery was similar to that measured on photographs taken at the same time. Subsequently, an intra- and inter-observer error rate found excellent agreement among four observers measuring the web index using photographs. Of 13 postoperative webs using a winged central rectangular web flap without skin grafting, 12 were re-measured using photographs at an average of 88 months (range 78 to 96) after surgery. There was evidence of minor web creep in one web only. Our study demonstrates the efficacy of web index calculation on photographs to measure web position in children after syndactyly surgery. The study also demonstrates the effectiveness of the graftless winged central rectangular web flap technique in avoiding web creep.

Level of evidence: IV

Keywords

Syndactyly, web index, web creep

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Introduction

Web creep (or web drag) is a complication of syndactyly surgery, reported as occurring in 3% to 22% of cases (Keret and Ger, 1987; Percival and Sykes, 1989). The measurement or assessment of web creep remains somewhat unsatisfactory, with descriptive terms such as 'adequate' (Sharma et al., 2009), 'satisfactory' (Nakamura et al., 1989; Percival and Sykes, 1989), 'maintained at an appropriate level' (Ostrowski et al., 1991) or 'no gross recurrence' (Killian and Neimkin, 1985). Others have used radiological and clinical techniques, including photographs, to quantify the extent of web creep but have acknowledged difficulties in doing so (Brown, 1977; Paterson and Nancarrow, 1998; Richterman et al., 1998; Shewell et al., 1992; Toledo and Ger, 1979; Vekris et al., 2010; Withey et al., 2001).

An objective means of measuring web position is needed if we are to compare syndactyly release methods, using web creep as an outcome measure. Withey et al. (2001) described a grading of web position to describe web creep, but a formal calculation of palmar web index has not been applied to children.

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The reliability and reproducibility of using a palmar web index method to measure web position in healthy adults has been established (Tonkin et al., 2015). Although there is a mild alteration in web position in adult hands relative to those of children, Shewell et al. (1992) found that this was considered to be minimal.

The primary aim of this study was to examine the reliability and reproducibility of the assessment of the web index on photographs of children's hands with simple and complex syndactylies. The secondary aim was to apply this web index to assess the efficacy of use of a winged modification of a dorsal rectangular web flap without the use of skin grafts or skin graft alternatives (Tonkin, 2009).

Methods

The study was approved by the hospital's Human Research Ethics Committee.

Measurement of web index

Figure 1 shows the method of calculation of the web index. With the palm facing up on a flat surface the syndactylyzed fingers (pre- or postoperative) are held passively abducted. This is standardized at the point of maximum abduction obtained through gentle abduction with adjacent fingers held in relaxed positions. Marks are made with a pen on both fingers, indicating the centre point of the most proximal basal finger crease at the base of the finger and the most proximal of the proximal interphalangeal (PIP) joint creases. A longitudinal line is drawn along the whole length of each finger either side of the syndactyly connecting these marks, continuing into the palm. Perpendicular lines are drawn from the centre point of the web to meet the longitudinal lines. The distance 'A' for each finger is the distance between the point at which the perpendicular line meets the longitudinal line and the proximal PIP joint crease. The distance 'B' is the distance between the proximal basal crease and the proximal PIP joint crease for each finger. The web index is calculated by adding the ratio A/B for each finger and dividing by two (Tonkin et al., 2015).

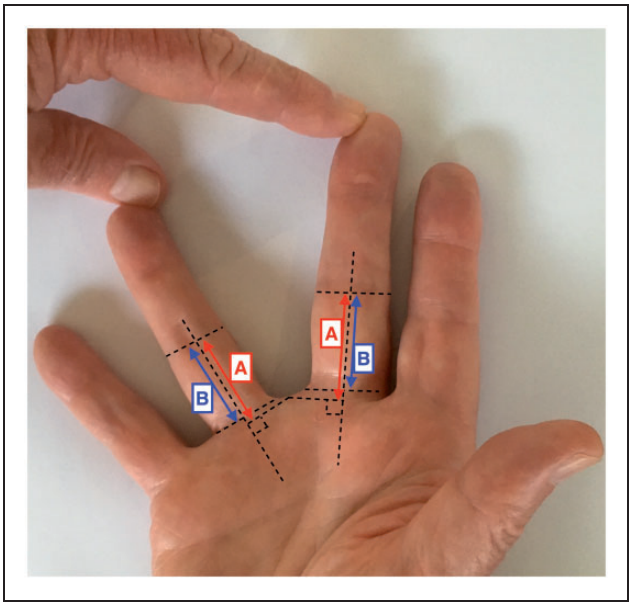

Figure 1. The web index is calculated using the formula A/B + A/B divided by 2.

Application of web index measurement in children with syndactyly

For the purpose of this study, photographs were first taken by one surgeon of 19 hands in nine children with syndactyly, six of preoperative webs and 13 immediately after surgery. All photographs were taken at the time of surgery with the child anaesthetized. A copy was made of each photograph to allow measurement of each photograph 2 weeks apart. The web index was then calculated on the child's hand at the time of surgery. The average web index measured from the two photographs was compared with that measured on the patient at the time of surgery.

Four observers (observer 1 [the surgeon] and three other observers) measured and compared the web index from each of the two photographs to determine the intra-observer error of the method of measurement. The same four observers compared with the others each of their average web index measurements from the two photographs to obtain an inter-observer error. The web indices were recalculated on a third set of photographs taken at an average of 88 months after surgery in seven children (12 postoperative webs) and compared with the average web indices calculated from the photographs taken immediately after surgery.

Surgical technique

All webs were operated upon using a winged dorsal web flap (Tonkin, 2009) (Figure 2). This is a modification of the dorsal tri-lobed flap proposed by Niranjan and De Carpentier (1990) and the winged dorsal web flap of Giele and Rostek (2000). Use of the latter design, however, results in a direct continuity in the plane of the suture line between the base of the web flap and the fingers. The flap design utilized transfers of skin from an available area on the dorsum of each finger just distal to the metacarpophalangeal joint to

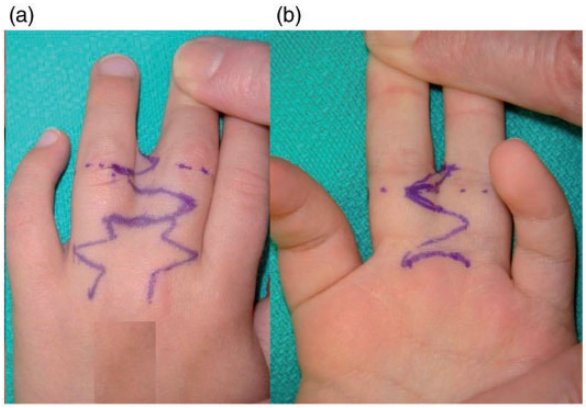

Figure 2. (a) The dorsal winged web flap. This extends two-thirds of the distance between the MP and PIP joints. The triangular wings are at the midpoint of the lateral lines and extend across the whole of the dorsum of each finger and (b) The distal end of the flap is mildly concave to meet the mildly convex incision at the palmar aspect of the syndactylized fingers.
MP: metacarpophalangeal; PIP: proximal interphalangeal

the side of the finger adjacent to the central flap. The triangular flaps are rotated through to the sides of the fingers where there is a shortness of skin, without continuity of suture line in the same plane between the base of the web flap and fingers. Aggressive defatting in the web and under the interdigitating finger flaps is employed (Figure 3). Finger flaps at the base of the web flap are palmar based to ensure no continuity of suture lines between the base of the web flap and the fingers, and is considered an important factor in the prevention of web creep (drag) (Figure 4). Closure is possible without the use of skin grafting. The downside is the presence of a scar on the dorsum of the fingers at the donor site of the triangular wings of the flap (Figure 5).

Statistical analysis

1. A paired *t*-test was used to compare the average web index as calculated by observer 1 (the surgeon) from two photographs with the surgeon's measurement at surgery. A *p*-value <0.05 indicates a statistically significant difference between the measurement methods.
2. Reliability was examined with a two-way random effects model to take into consideration repeated measures. Reliability is presented as both inter- and intra-observer reliability. The value for these measures can range from 0 to 1, with a higher value indicating a greater agreement between observers.

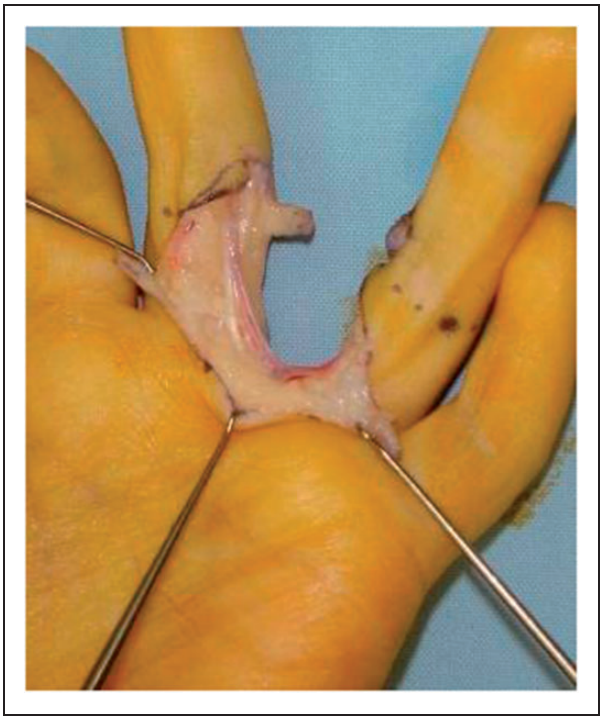

Figure 3. Extensive defatting of flaps and fingers.

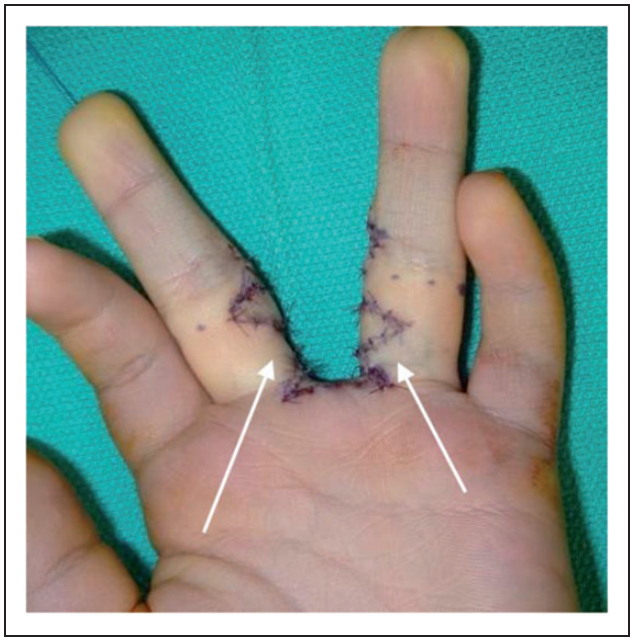

Figure 4. Palmar-based flaps either side of the inset of the base of the web flap (white arrows). This prevents a longitudinal suture line between the base of the central web flap and the fingers.

3. If a high degree of reliability is established, a comparison will be made between the immediate postoperative photographic measurements of observer 1 with the follow-up measurements of

the same observer. A paired *t*-test will be used for the comparison, with a *p*-value of 0.05 indicating a statistically significant difference between the two measurements.

Results

In total, 19 webs of nine children were subjected to intra- and inter-observer analysis: five (10 webs) were analysed both preoperatively and postoperatively, one was assessed preoperatively only and eight were assessed postoperatively only.

One of the 19 webs was a complex syndactyly; three were simple complete and 10 were simple incomplete: seven of these had webbing beyond the distal interphalangeal (DIP) joints and three between the PIP and DIP joints.

The mean age at time of measurement was 19.5 months (range 10 to 89). The mean age at surgery (13 webs in eight children) was 15 months (range 10 to 25). The mean follow-up of 12 webs in seven children was 88 months (range 78 to 96). The results are demonstrated in Table 1. One child with complex syndactyly affecting one web was unable to be contacted. In one web the scar was hypertrophic (Figure 6). The change in index for this latter web was 0.3 (from 1.4 immediately postoperatively to 1.1 at follow-up).

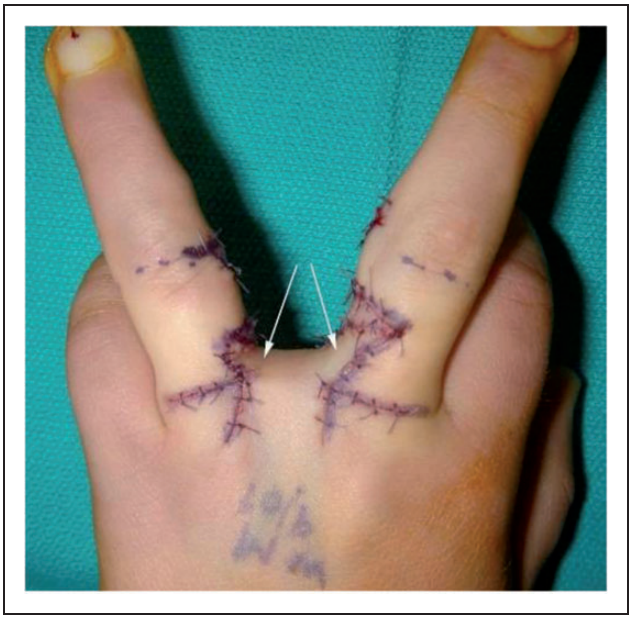

Figure 5. Dorsal suture lines using dorsal winged flap. Arrows point to rotation of the wings through 90°.

Inter- and intra-observer reliability

There was no significant difference between the two methods, i.e. the surgeon's measurements on hand at the time of surgery and the mean measurement made on photographs taken at the time of surgery (Table 1) ($p = 0.8069$). Intra-observer reliability was determined by the average web index measurement obtained from measuring photographs 2 weeks apart, resulting in a co-efficient of 0.9900 (95% CI: 0.9808 to 0.9956) indicating good intra-observer reliability.

Inter-observer reliability, as determined by the comparison of the average web index of four observers, revealed an excellent agreement (co-efficient 0.9876, 95% CI: 0.9771 to 0.9945).

In terms of web creep measurements, there was no significant statistical difference ($p = 0.4551$) between the mean immediately postoperatively (1.208) and mean follow-up measurements (1.179).

Table 1. A comparison of the web index (WI) averages at the end of surgery versus the recent follow-up.

Patient	WI immediately postoperatively	WI follow-up	Difference	Qualitative observation of web position
1	1.3	1.4	0.1	Deeper
2	0.95	1	0.05	Deeper
3	1.3	1.1	0.2	Creep
4	1.15	1.3	0.15	Deeper
5	1.1	1	0.1	Creep
6	1.2	1.2	0	Same
7	1.3	1.2	0.1	Creep
8	1.4	1.1	0.3	Creep
9	1.1	1.2	0.1	Deeper
10	1.3	1.3	0	Same
11	1.2	1.2	0	Same
12	1.2	1.15	0.05	Creep
Average	1.21	1.18	0.1	

Figure 6. Scar hypertrophy along the sides of the fingers.

Discussion

The aim of this study was to explore the feasibility of using a web index to measure web creep after syndactyly surgery. We found that measuring the web index can be undertaken on photographs with the same accuracy as measuring the patients. Subsequently, we also found there was excellent inter- and intra-observer reliability and reproducibility in performing these measurements on photographs.

The presence of web creep is one of the main outcome assessments used to judge the relative success or failure of surgery for syndactyly when comparing different techniques, such as the use of different web flaps and the use of skin grafts and alternatives. Infection, delayed healing and skin graft loss is incriminated as increasing the risk of web creep as is the formation of hypertrophic and keloid scarring (Tonkin et al., 2008). In this study, we found that the use of a dorsal, rectangular, winged, central web flap appeared to be effective in decreasing web creep as measured by the web index calculation.

Any measurement of web creep must consider the accuracy of the measurement of web position so that the immediate postoperative position may be compared with subsequent measurements. The web index measurement method by Tonkin et al. (2015) has been shown to be reliable and reproducible in the normal adult hand. The application of the web index measurement in children may be more problematic than that in an adult hand because of the age of the child (Tonkin et al., 2015). The use of photography offers the opportunity to save time and reduce stress while making these measurements (Paterson and Nancarrow, 1998; Shewell et al.,1992). Photographs also offer the ability to overcome long distances of travel for follow-up and loss of clinic time, such as during the current COVID-19 epidemic (Herren et al, 2022). In this study, we found an excellent correlation with the calculation of the web index performed on the hand itself at the time of surgery and the web index measurements on photographs, with an excellent intra- and inter-observer agreement.

In this study, the web index measurement has been used to allow a comparison of the postoperative web position with the web position 7 years after surgery to determine if web creep has occurred or is occurring. The web index measurement has not been used to determine a normal web index for each web in children. Previous studies suggest that these will remain relatively similar to those of the normal adult hand (Shewell et al., 1992). Further study of normal web indices in children would be necessary to confirm this.

As calculated by the method used, a web index of 1 more or less equates with a web at the level of the proximal basal finger crease. Observation of the web indices obtained postoperatively indicates an average web index of 1.2 indicating that in these cases, the web was just proximal to the proximal basal finger crease. Withey et al. (2001) compared the web position with that of the adjacent web and separated web creep into one-third, two-thirds or greater of a distance between the adjacent web position and the PIP joint crease. As with many methods, the position of finger abduction was not standardized, and their method was not assessed for intra- and inter-observer consistency. However, we have used their common-sense clinical grading system in deciding when web creep is significant and, beyond that, which may be considered as measurement error. Further analysis is necessary to confirm how changes in web index equate with web creep. We have allowed a web index difference of greater than or equal to 0.3 in follow-up measurements to indicate web creep. This equates with a web position at or distal to the proximal basal finger crease. If one considers that a web index of approximately 1.2 is normal, then our criteria is considered generous in determining whether web creep has occurred. A difference of less than 0.3 can be considered

a measurement error as this amount of change in the web index is less than a 25% change in web position.

From the seven patients followed up for 7 years, one web of 12 measured a web index change of 0.3, In this web, there was evidence of hypertrophic scar formation along the sides of both fingers (Figure 6). However, these two suture lines (hypertrophic scars) were not connected, and without the 'firebreak' of the palmar-based flaps on either side of the central web, it is possible that the web creep would have been greater. However, in this case, it should be noted that the web index at the end of surgery was measured as 1.1, so the web position at the follow-up remained just proximal to or at the basal crease level. However, our method demands that this be classified as web creep as the alteration in web index was 0.3.

All surgeries were performed using the modified winged flap to reconstruct the web space in all patients. The results indicate that this method is an effective means of avoiding or minimizing web creep (drag) at longer follow-up (7-year follow-up of 12 of 13 webs), which was the second aim of this study. The authors consider that the avoidance of connection in the same plane of the web base and finger suture lines is a major factor in preventing web creep, while allowing primary sutures without the use of skin grafts or skin graft substitutes, for simple complete and incomplete and complex syndactylies.

The present study has some limitations. First, the numbers of children and webs are small. Second, although the use of photographs decreases the measurement time in the operating theatre and demands less reliance on the cooperation of the child in the clinic, both Shewell et al. (1992) and Paterson and Nancarrow (1998) conceded that photographic measurements were only reproducible if they were marked and measured by the same observer. We have followed their advice in this study; the reference points of the basal and PIP joint creases were all marked by observer 1 (surgeon). The other observers marked the web point and drew the longitudinal and perpendicular lines and measured the web index using the formula described. Whether the intra- and inter-observer agreement would have been excellent if the observers had marked the reference points remains unknown. The comparison between immediate postoperative and follow-up measurements suggests that the web index does not change significantly with growth nor are the reference points altered by surgery.

In conclusion, our study demonstrated the reliability and reproducibility of the assessment of the web index on photographs of children's hands with simple and complex syndactylies. Furthermore, the modified winged flap technique is effective at maintaining web position after surgery at long-term follow-up.

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Ethical approval Ethics approval for this study was granted by the North Shore Private Hospital Human Research Ethics Committee.

Informed consent Written consent was obtained from parents for photographs as a component of surgery and inclusion in research projects.

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References

Brown PM. Syndactyly – a review and long term results. Hand. 1977, 9: 16–27.

Giele H, Rostek M. Syndactyly division without skin grafts by using dorsal flaps. In: T Ogino (Ed.) Congenital differences of the upper limb. Kyoto: Yamagata University School of Medicine. 2000: 78–80.

Herren D, Verstreken F, Lluch A, Naqui Z, van der Heijden B. The impact of COVID-19 315 pandemic on hand surgery: a FESSH perspective. J Hand Surg Eur. 2022, 47: 562–7.

Keret D, Ger E. Evaluation of a uniform operative technique to treat syndactyly. J Hand Surg Am. 1987, 12: 727–9.

Killian JT, Neimkin RJ. Syndactyly reconstruction by a modified Cronin method. South Med J. 1985, 78: 414–8.

Miura T, Nakamura R, Horii E, Sano H. Three cases of syndactyly, polydactyly, and hypoplastic triphalangeal thumb: (Haas's malformation). J Hand Surg Am. 1990, 15: 445–9.

Nakamura J, Yanagawa H, Kubo E, Endo T. New modified method for the surgical treatment of syndactyly. Ann Plast Surg. 1989, 23: 511–8.

Niranjan NS, De Carpentier J. A new technique for the division of syndactyly. Eur J Plast Surg. 1990, 13: 101–4.

Ostrowski DM, Feagin CA, Gould JS. A three-flap web-plasty for release of short congenital syndactyly and dorsal adduction contracture. J Hand Surg Am. 1991, 16: 634–41.

Paterson P, Nancarrow JD. Defining a normal finger web in children. J Hand Surg Br. 1998, 23: 496–8.

Percival NJ, Sykes PJ. Syndactyly: a review of the factors which influence surgical treatment. J Hand Surg Br. 1989, 14: 196–200.

Richterman IE, DuPree J, Thoder J, Kozin SH. The radiographic analysis of web height. J Hand Surg Am. 1998, 23: 1071–6.

Sharma RK, Tuli P, Makkar SS, Parashar A. End-of-skin grafts in syndactyly release: description of a new flap for web space resurfacing and primary closure of finger defects. Hand (NY). 2009, 4: 29–34.

Shewell PC, Nancarrow JD, Fatah F. Quantifying interdigital web morphology. J Hand Surg Br. 1992, 17: 198–200.

Toledo LC, Ger E. Evaluation of the operative treatment of syndactyly. J Hand Surg Am. 1979, 4: 556–64.

Tonkin MA, Willis KR, Lawson RD. Keloid formation resulting in acquired syndactyly of an initially normal web space following syndactyly release of an adjacent web space. J Hand Surg Eur. 2008, 33: 29–31.

Tonkin MA. Failure of Differentiation Part I: Syndactyly. Hand Clinics. 2009 25: 171–93.

Tonkin MA, Chew EM, Ledgard JP, Al-Sultan AA, Smith BJ, Lawson RD. An assessment of 2 objective measurements of web space position. J Hand Surg Am. 2015, 40: 456–61.

Vekris MD, Lykissas MG, Soucacos PN, Korompilias AV, Beris AE. Congenital syndactyly: outcome of surgical treatment in 131 webs. Tech Hand Up Extrem Surg. 2010, 14: 2–7.

Withey SJ, Kangesu T, Carver N, Sommerlad BC. The open finger technique for the release of syndactyly. J Hand Surg Br. 2001, 26: 4–7.