Comparison Effectiveness of Custom-Made Versus Conventional Aluminum Splint for Distal Phalange Injury

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Background: *Finger splint is a simple and common method for finger immobilization. The flexible aluminum foam-padded splint is a convenient off-the-shelf inexpensive splint. But there're some studies favor expensively custom-made thermoplastic splint due to its less likely result in treatment failure. Therefore the authors have modified the conventional aluminum finger splint in the foam-padded part to improve the fitting and compliance of the patients.*
Objective: *To compare the fitting of custom-made aluminum finger splint with conventional aluminum finger splint.*
Material and Method: *Sixty volunteers were randomized to apply 30 conventional or custom-made aluminum splints on 4th digit in non dominated hand for one week. The fitting of each splint was measured by displacement of the splint between initial placement and one week later. Patient satisfaction and pain was measured by visual analog score (VAS).*
Results: *The slip and deviation in custom-made group were less than the conventional group significantly (mean of slip 0.86 mm vs. 2.23 mm, $p < 0.001$, mean of deviation 1.1 degrees vs. 2.23 degrees, $p < 0.001$) but the longitudinal migration was not significantly difference between both groups (mean 1.6 mm in custom-made group vs. 1.46 mm in conventional group, $p = 0.67$). The patient satisfaction demonstrated no significant difference between both groups (mean VAS 7.76 in custom-made group vs. 7.3 in conventional group, $p = 0.31$). Two patients terminated from the present study before one week in custom-made group and one patient in the conventional group (6.67% vs. 3.33%, $p = 0.554$).*
Conclusion: *The custom-made aluminum finger splint can improve the fitting to the finger pulp. However, patient satisfaction and compliance are not significantly different between both groups.*

Keywords: *Custom-made aluminum finger splint, Randomized controlled trial, Mallet finger, Fingertip injury*

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Finger splint is a simple method of immobilization for common finger injury, such as, distal phalange fracture, nail bed injury, finger tip injury and mallet finger. The purpose of splintage is to prevent re-injury and maintain alignment to facilitate bone and soft tissue healing. However, there're some conditions that require longer time of immobilization, such as mallet finger which the finger splint must be worn continuously for at least 6 weeks[1]. Although external splinting is the treatment of choice for uncomplicated mallet finger[2], the major problems of treatment failure were due to patient compliance[3] and skin-related complications[4]. So there're several types of finger splint have been done as a custom-made splint to improve in fitting, compliance and skin-related complications[5-7]. The flexible aluminum foam-padded splint is a convenient off-the-shelf inexpensive splint that can be provided in many width sizes and easily adjusted to each patient's fingers. But some recent RCT studies found a trend in favor of custom-made thermoplastic splint due to its less likely result in treatment failure[6,7]. However, custom-made thermoplastic splint is quite more expensive and unavailable especially in municipal hospital. Therefore the authors have modified the conventional aluminum finger splint especially in the foam-padded part to improve the fitting and compliance of the patients with the purpose that this technique can be easily done even by general practice physicians.

The present study aimed to compare the fitting and patient satisfaction between new custom-made aluminum finger splint and conventional finger splint. To test for the safety and efficacy of the new modified

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splint before using with the patients, so the author's designed the present study in volunteers with the shorter time of splinting. The authors hypothesized that the custom-made aluminum finger splint would demonstrate superior fitting and satisfaction to the conventional finger splint.

Material and Method

The custom-made foam-padded aluminum finger splints were done by modification of 0.75 inch aluminum splint (Alumafoam finger splints, Leadermed Ltd., Bangkok, Thailand) in the foam-padded part. First step, place patient's finger on the foam-padded to approximate size of foam removal (Fig. 1A-B). Then, cut the foam-padded along the marker and carve into a semicircular groove along the longitudinal axis of the splint (Fig. 1C-D) with the curve-tip wooden carving knife until it fit with the patient finger pulp (Fig. 2).

Sixty volunteers with normal hands were randomized equally into 2 groups, the custom-made splint and conventional splint group.

Thirty volunteers in the conventional splint group were applied with the 0.75 inch foam-padded aluminum finger splint on the volar aspect of the distal interphalangeal joint of non-dominant hand ring finger. With ensured extension from middle phalange to distal phalange and allowed fully flexion of the proximal interphalangeal joint. Then 0.5 inch Micropore™ (3M™) tape was applied to fit the splint with middle and distal phalange respectively (Fig. 3). Other thirty volunteers in the custom-made splint group would be applied in the same fashion with the modified semi-circular groove foam-padded finger splint.

The skin markings were performed with the permanent color pen adjacent to every borders of the splint. Every volunteer would be instructed to maintain and keep the splint dry. After one week, each volunteer would be evaluated. If the splint was lost, the volunteer will be just as non-compliance. The displacement was measured in three axes. Firstly, the proximal-distal migration along the longitudinal axis of the splint was measured by the distance from the marking line to the proximal border of the splint (Fig. 4; PD distance). Secondly, the lateral slip on coronal plane was measured by the maximum perpendicular distance from the lateral marking line to the lateral border of the splint (Fig. 4; L distance). Thirdly, the coronal deviation was measured by the degree of angulations between midline axis of the finger and midline axis of the splint which adjusted to 0 degree at the beginning of the study (Fig. 4; C angle).

The patient satisfaction was measured with visual analog score (VAS). The volunteers

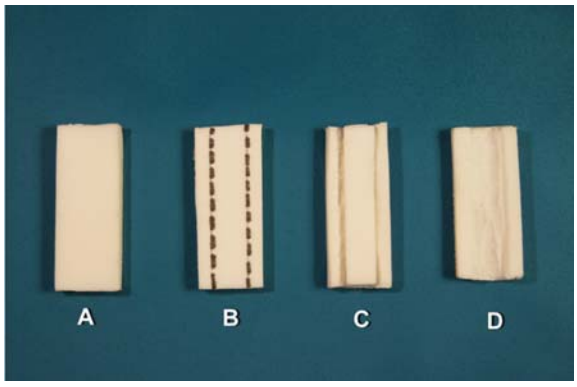

Fig. 1 (A)The conventional foam-padded aluminum splint; (B)Measure and mark size of patient finger pulp; (C)Cut and carve the middle portion of foam-padded according to patient pulp shape; (D)Custom-made splint after removed of middle portion foam-padded

Fig. 2 Straight and curve tip wooden carving knives

were asked for the comfortable, splint fitting and pain at the finger. The skin complications were observed after removal of the splint.

T-test was used for comparison mean of migration, slip, deviation and satisfaction between two groups with p-values ≤ 0.05 considered statistically significant.

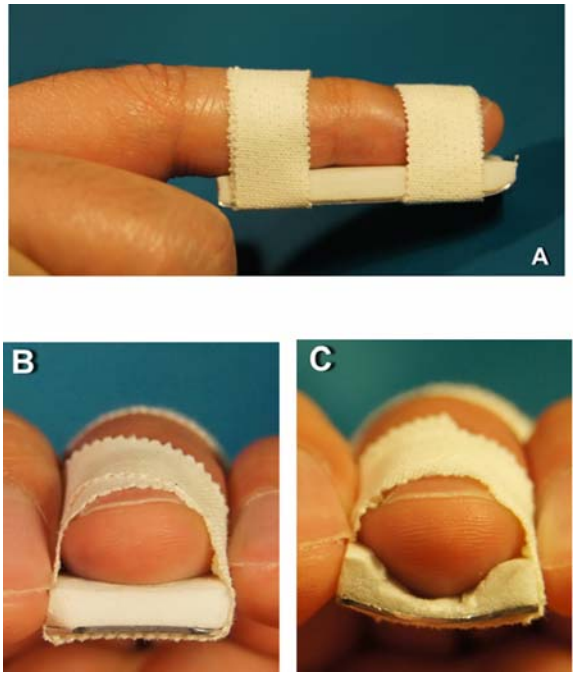

Fig. 3 (A)Lateral view of finger after applied an aluminum splint; (B) Frontal view of conventional aluminum splint; (C) Frontal view of custom-made splint

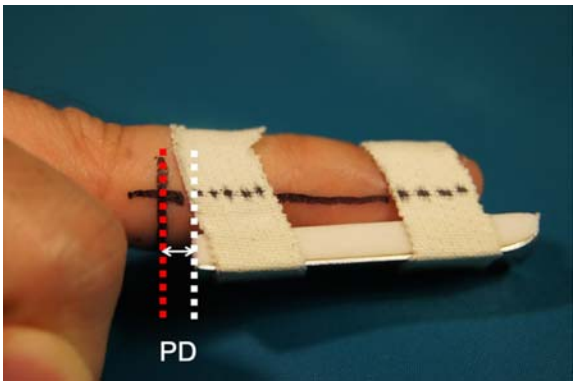

Fig. 4 The proximal-distal migration (PD distance) was measured by the maximum perpendicular distance between the marking line (black dot line) and the proximal border of the splint (white dot line)

The coronal deviation was measured by the angulations (C angle) between the midline axis of the finger (black dash line) and the midline axis of the splint (white dash line).

Results

The data of both groups was shown as Table 1. The mean age of both groups were not statistically significant different (mean age custom-made group 26.24 $\pm$ 4.27 yrs. vs. conventional group 25.74 $\pm$ 4.74 yrs., p = 0.67).

There're two non-compliance patients in custom-made group and one patient in conventional group (6.67% vs. 3.33%, p = 0.554). The cause that all volunteers terminated from the present study is the feeling that the splint is too tight.

The mean age, migration, lateral slip, coronal deviation angle, patient satisfaction and non-compliance patient were shown as Table 1.

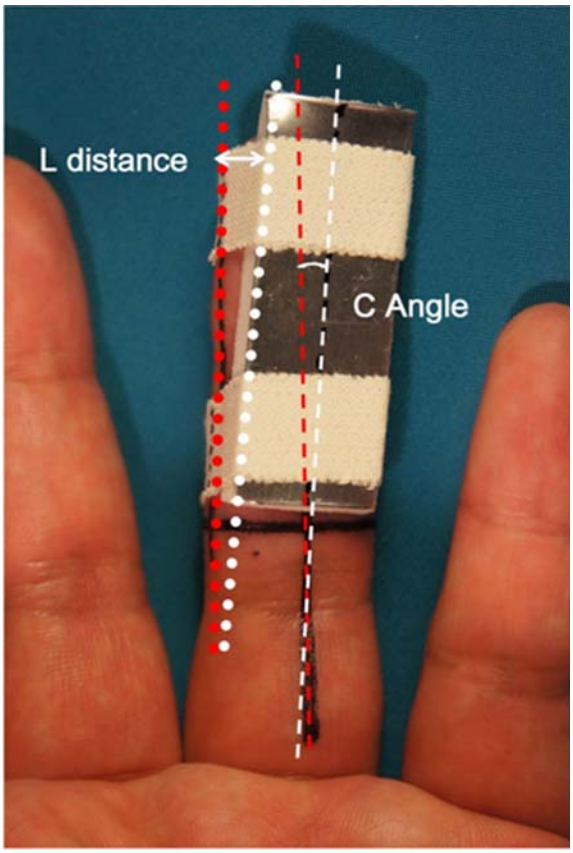

Fig. 5 The lateral slip (L distance) was measured by maximum perpendicular distance from the lateral marking line (black dot line) to the lateral border of the splint (white dot line)

Table 1. The result data compare between custom-made aluminum finger splint group and conventional finger splint group

	Custom-made splint	Conventional splint	p-value
Number of patients (n)	30 (Male: 15, Female: 15)	30 (Male: 15, Female: 15)	
Age (yrs)	26.24 ± 4.27	25.74 ± 4.74	0.67
Proximal-distal migration (mm)	1.6 ± 1.0	1.46 ± 1.9	0.67
Lateral slip (mm)	0.86 ± 0.53	2.23 ± 1.43	< 0.001
Coronal deviation angle (□)	1.1 ± 0.85	2.23 ± 1.43	< 0.001
Patient satisfaction (0-10)	7.76 ± 2.87	7.3 ± 3.0	0.31

Discussion

Finger splint is the effective treatment of choice for simple mallet finger injury. Although most of the studies report good result of finger splinting but they also report skin related complications range from skin irritation, skin maceration, dorsal skin ulcer and nail deformity with the incidence varied from 3%[8] to 33%[9] depended on type of splint and treatment protocol. Moreover patient compliance is one of the major problems[3] that results in treatment failure due to patients cannot tolerate the splint with the treatment period at least 6 weeks. These problems are seem to be higher in the closed-type splint such as non-perforated plastic Stack splint[9] and splints that are less adjustable to the size and shape of the finger[8]. Even though there's no report of skin-related complication incidence from tropical zone countries, such as Thailand, but from the authors' experience the skin-related complications from mallet finger treatments are quite common and due to the hot and humidified weather, there're very few patients that can tolerate closed-type finger splint for a long time. So the authors preferred the foam-padded aluminum malleable splint for mallet finger treatment and change new splint every week for at least 6 weeks. To enhance the fitting of the splint and patient compliance, the authors modified the conventional splint with the semicircular groove in the middle part of foam-padded to increase the stability especially in coronal plane and decrease the pressure on the pulp of the finger.

From the result of the pilot study in normal hands, the modification of the foam-padded aluminum splint can decreased the lateral slip distance and coronal deviation angle significantly compared to the conventional splint. Although the amplitude of slip and deviation may not clinically significant but it can prove that this modification can improve fitting of the foam-padded aluminum splint with quite easy technique that can be done without other sophisticated tools. However, the authors cannot found difference in patient satisfaction, compliance and skin-related complications between both groups. These possibly will be due to the short period of intervention and the present study was not done in the injury fingers that patients usually have pain, swelling and potential to skin-related complications.

As the result of the present study, the authors can use this custom-made aluminum finger splint as the alternative treatment of conventional finger splint. Further more, the authors would like to conduct the present study in using this splint in acute mallet finger injury patients to find out whether this modification can improve comfortable and compliance in the patients.

Conclusion

The authors' custom-made aluminum finger splint is a simple modification of conventional aluminum finger splint that can improve fitting by decrease lateral slip and coronal deviation. But patient satisfaction, compliance and complications are not statistically different between both groups.

Potential conflicts of interest

None.

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การศึกษาเปรียบเทียบประสิทธิภาพการใช้อุปกรณ์ดามนิ้วแบบเฉพาะบุคคลกับอุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไปสำหรับการบาดเจ็บกระดูกส่วนปลายนิ้ว

จตุพร โชติกวณิชย์, รุ่งศักดิ์ ลิ่มทองแท่ง, ธนวัฒน์ พิมลสิริผล, ทศศาสตร์ หาญรุ่งโรจน์, ภานุพันธุ์ ทรงเจริญ

ภูมิหลัง: *การใช้อุปกรณ์ดามนิ้วเป็นการรักษาที่พบได้บ่อยสำหรับการรักษาการบาดเจ็บบริเวณปลายนิ้วมือ เนื่องจากสามารถทำได้ง่ายและมีอุปกรณ์ให้เลือกใช้หลากหลายชนิด เพื่อให้เหมาะสมกับผู้ป่วยและสามารถทนการรักษาได้นานโดยไม่มีผลแทรกซ้อน อุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไปสามารถพบได้ในทุกโรงพยาบาลและมีราคาถูก แต่มีการศึกษาเปรียบเทียบพบว่าการใช้อุปกรณ์ดามนิ้วมือที่ทำจากพลาสติกดัดเข้ารูปกับผู้ป่วยเฉพาะรายอาจทำให้ผู้ป่วยทนการรักษาได้ดีกว่า แต่อุปกรณ์ดามนิ้วชนิดนี้ยังมีราคาแพงและไม่แพร่หลายโดยเฉพาะในโรงพยาบาลขนาดเล็ก ดังนั้นคณะผู้นิพนธ์จึงได้คิดวิธีการดัดแปลงอุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไป เพื่อให้เหมาะสมกับผู้ป่วยแต่ละคนมากขึ้น*

วัตถุประสงค์: *เพื่อเปรียบเทียบความพอดีของอุปกรณ์ดามนิ้วแบบเฉพาะบุคคลกับอุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไป*

วัสดุและวิธีการ: *ทำการสุ่มอาสาสมัครทั้งหมดจำนวน 60 คน ออกเป็นสองกลุ่มเท่าๆกัน คือกลุ่มอุปกรณ์ดามนิ้วแบบเฉพาะบุคคลกับกลุ่มอุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไป จากนั้นทำการดามปลายนิ้วนางมือข้างที่ไม่ถนัดของอาสาสมัครไว้เป็นเวลา 1 สัปดาห์ จากนั้นวัดตำแหน่งของอุปกรณ์ดามนิ้วเปรียบเทียบกับตำแหน่งที่ขีดไว้ตอนเริ่มต้น*

ผลการศึกษา: *พบว่าอุปกรณ์ดามนิ้วแบบเฉพาะบุคคลมีการเคลื่อนตัวในด้านข้างและการบิดน้อยกว่าอุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไปอย่างมีนัยสำคัญทางสถิติ (ค่าเฉลี่ยการเคลื่อนตัวด้านข้าง 0.86 มม. กับ 2.23 มม. ค่า $p < 0.001$, ค่าเฉลี่ยมุมการบิดตัว 1.1 องศา กับ 2.23 องศา ค่า $p < 0.001$) แต่ผลอื่นๆไม่พบว่ามีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติทั้งการเคลื่อนตัวตามแนวแกนของนิ้ว ความพึงพอใจต่อการรักษา และ จำนวนอาสาสมัครที่ขอออกจากการศึกษาก่อนกำหนด ไม่พบผลข้างเคียงจากการใช้อุปกรณ์ดามนิ้วในการศึกษานี้*

สรุป: *อุปกรณ์ดามนิ้วแบบที่ดัดแปลงสำหรับเฉพาะบุคคลสามารถเพิ่มความกระชับกับนิ้วของอาสาสมัครได้เมื่อเปรียบเทียบกับอุปกรณ์ดามนิ้วอลูมิเนียมแบบทั่วไป แต่ในด้านความพึงพอใจและความทนต่อการรักษาไม่พบว่ามีความแตกต่างกันระหว่างกลุ่ม*