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A Comparative Study Between Newly Developed Wave-form and Traditional Straight-form Splints

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Purpose: Widely used fiberglass splints are made from straight-form material. These prove difficult to mold at joints and form wrinkles, causing complications such as pain, pressure sores, and peripheral nerve palsy. We compared the usefulness of wave-form splints with straight-form splints and the level of satisfaction of these designs from care providers and wearers.

Methods: Eighty-nine (n=89) emergency physicians and orthopedic surgeons participated in this study. The subjects (acting as care providers and mock patients) used wave-form and straight-form material to construct and wear short leg splints, long arm splints, and sugar tong splints. The clinicians were surveyed on their satisfaction as providers and wearers. All questions were measured on scores from 0 and 10(10=maximum score). After splints were removed, subjects were surveyed on the extent of splint wrinkling with scores from 1 to 3(3=maximum wrinkling).

Results: Provider satisfaction scores for wave-form splints versus straight-form splints in short leg splint applications were 7.76±1.30 vs 6.74±1.25 (*p*=0.000). Provider satisfaction scores for wave-form splints versus straight-form splints in long arm splint applications were 7.73±1.33 and 6.73±1.59 (*p*=0.004), respectively. The subjects felt more comfortable wearing wave-form splints, compared to straight-form splints (7.79±1.49 vs. 6.79±1.58, respectively; *p*=0.004) and more satisfied (8.03±1.35 vs. 7.18±1.33, respectively; *p*=0.003). The frequencies of wrinkle occurrence in wave-form and straight-form splints were 29.7% and 42.2%, respectively (*p*=0.02).

Conclusion: Wave-form splints may be more practical for molding and wearing than traditional straight-form splints.

Key Words: Splints, Immobilization, Fiberglass casts, Complications

Introduction

Splints are used in the management of many acute musculoskeletal injuries seen in the emergency setting. When properly made, these devices confer symptomatic relief, mechanical support and sometimes constitute definitive therapy for fractures and soft tissue injuries of the extremities[1-3)].

Prefabricated splints using layers of fiberglass between polypropylene paddings are now common adopted in the emergency department. Fiberglass splints are time-efficient, taking only 3 minutes to set. In addition, fiberglass splints are stornger and lighter than plaster splints[4)]. However, Fiberglass splints are made from straight-form material and thus lack the versatility and custom fit qualities of self-made plaster splints (Fig. 1)[5,6)]. This is difficult to mold at joints and form wrinkles which may cause complications, such as pain, pressure sore and peripheral nerve palsy[7)].

Fiberglass wave-form splints are developed to facilitate molding at joints (Fig. 2). We compared the usefulness and satisfaction of healthcare providers and wearers on wave-form splints made with straight-form splints, and studied whether splints molding causes wrinkling and folding.

Materials and Methods

1. Study design

Eighty-nine (n=89) emergency physicians and orthopedic surgeons participated in the workshops held over

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three sessions to learn and practice wave-form splints.

In the first workshop, 38 subjects participated and used 6 inched wave-form and straight-form material in turn to make short leg splints on each other as providers and as mock patients. Subjects wearing the short leg splints were asked to stand and walk for 1 hour. In the second workshop, 37 subjects participated and used 4 inched wave-form and straight-form material in turn to make long arm splints on each other as providers and as mock patients. Subjects wearing the long arm splints were asked to engage in minimal activity for 1 hour. In the third workshop, 14 subjects participated and used 4 inched wave-form and straight-form material in turn to make sugar tong splints on each other as providers and as mock patients. The subjects wearing sugar tong splints were asked to engage in minimal activity for 1 hour.

After each workshop, we questioned the participants and surveyed the molded splints

2. Outcome measure

The clinicians were surveyed on their overall satisfaction and the usefulness of the splints as providers. The clinicians were then questioned about comfort, immobilization effec-

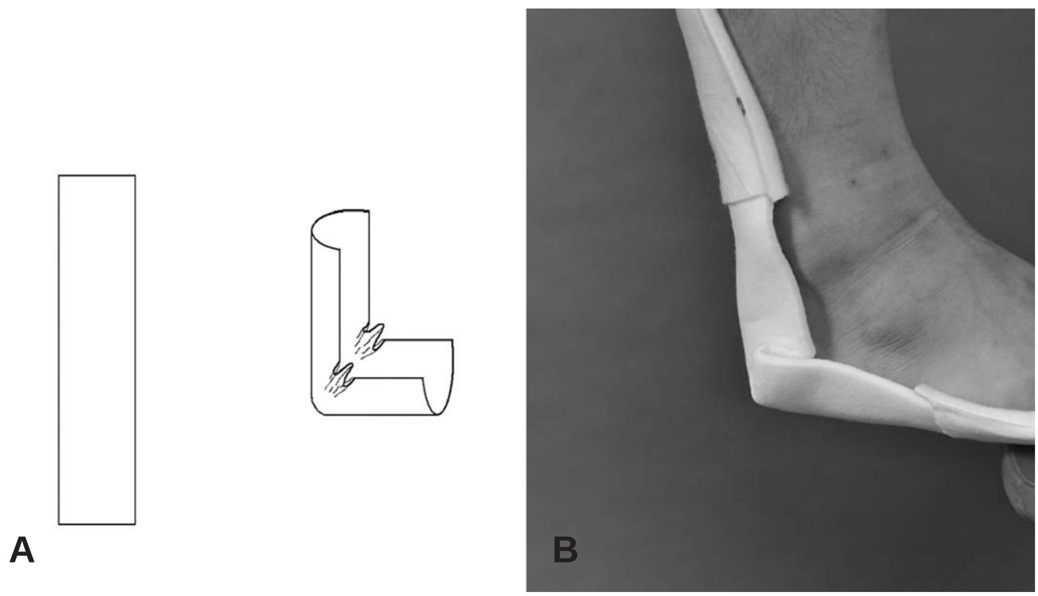

Fig. 1. Traditional straight-form splints. (**A**) Schematic diagrm, (**B**) photograph (short leg spint).

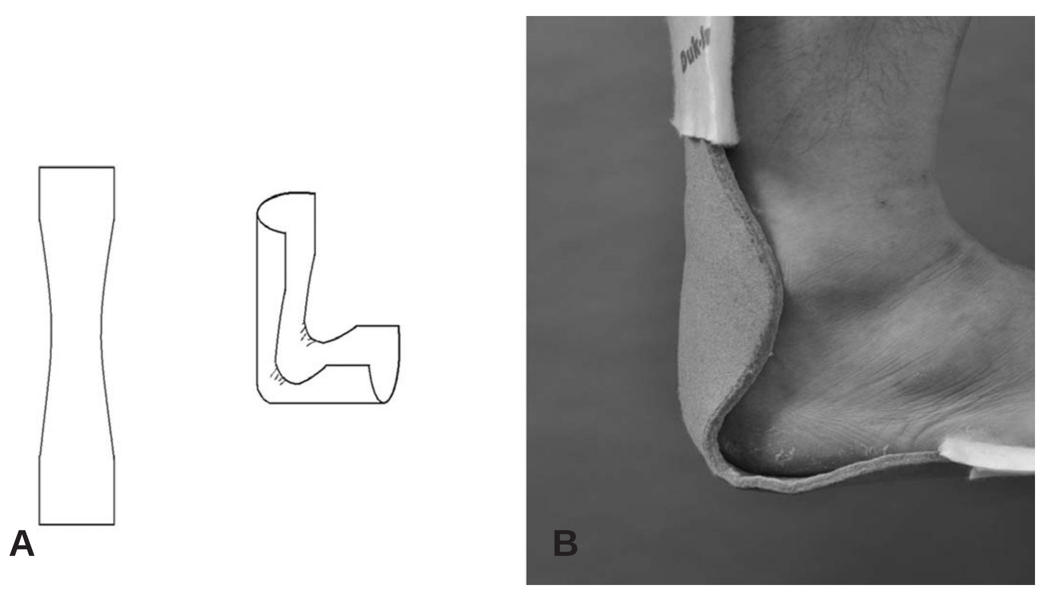

Fig. 2. Newly developed wave-fom splints. (**A**) Schematic diagrm, (**B**) photograph (short leg splint).

tiveness, and their overall satisfaction as wearers of each splint after splint removal. Answers to questions scored between 0 and 10 score, with 10 as the maximum score.

After removing the splints, the subjects were surveyed on the extent of splint wrinkling with score between 1 and 3, with 3 being the maximum wrinkling and folding. No wrinkling would score 1, wrinkling only would score 2 and both wrinkling and folding would score 3.

3. Statistical analysis

Continuous variables are described as mean±SD and were compared using the Mann-Whitney U test. Independent variables were compared using the Chi square test. Analysis was performed using SPSS Version 15. A p-value of less than 0.05 ($p<0.05$) was considered to be statistically significant.

Results

Povider satisfaction scores in the short leg splints application were 7.76±1.30 for wave-form and 6.74±1.25 for straight-form splints (p=0.000), and usefulness scores were 7.53±1.37 and 7.00±1.25 (p=0.082), respectively for wave-form and straight-form splints. For long arm splint application, provider satisfaction scores were 7.73±1.33 and 6.73±1.59 (p=0.004), and the usefulness scores were 7.81±1.31 and 6.65±1.18 (p=0.000), respectively for wave-form and straight-form splints. For sugar tong splint application, provider satisfaction scores were 7.57±1.60 and 7.36±1.28 (p=0.734), and the usefulness scores were 7.71±1.20 and 7.26±1.15 (p=0.982), respectively for wave-form and straight-form splints (Table 1).

Wearing wave-form and straight-form short leg splints, the subjects felt more comfortable (7.79±1.49 vs. 6.79±1.58; p=0.004) and more satisfied (8.03±1.35 vs. 7.18±1.33; p=0.003) with wave-form splints compared to straight-form splints. For long arm splints, the subjects experienced more comfort (7.84±1.37 vs. 6.89±1.41; p=0.006) and satisfaction (7.74±1.39 vs. 6.78±1.34; p=0.003) with wave-form splints, compared with straight-form splints (Table 2). For sugar tong splints,

Table 1. Satisfaction and usefulness of splint molding

		Satisfaction	Usefulness
Short leg splint (n=36)	wave-form splint	7.76±1.30	7.53±1.37
	straight-form splint	6.74±1.25	7±1.25
	p-value	*0.000	0.082
Long arm splint (n=37)	wave-form splint	7.73±1.33	7.81±1.31
	straight-form splint	6.73±1.59	6.65±1.18
	p-value	*0.004	*0.000
Sugar tong splint (n=14)	wave-form splint	7.57±1.60	7.71±1.20
	straight-form splint	7.36±1.28	7.64±1.15
	p-value	0.734	0.982

* $p<0.05$

Table 2. Comfort, satisfaction and immobilization of splint wearing

		Comfort	Satisfaction	Immobilization
Short leg splint (n=36)	wave-form splint	7.79±1.49	8.03±1.35	7.00±1.49
	straight-form splint	6.76±1.58	7.18±1.33	7.50±1.35
	p-value	*0.004	*0.003	0.111
Long arm splint (n=37)	wave-form splint	7.84±1.37	7.74±1.39	7.29±1.43
	straight-form splint	6.89±1.41	6.78±1.34	7.05±1.29
	p-value	*0.006	*0.003	0.566
Sugar tong splint (n=14)	wave-form splint	8.07±1.00	8.07±1.07	7.79±1.19
	straight-form splint	7.57±0.85	7.57±0.85	7.71±0.99
	p-value	0.246	0.285	0.874

* $p<0.05$

comfort and satisfaction with wave-form splints and straight-form splints were respectively 8.07±1.00 vs. 7.57±0.85 (p=0.246) and 8.07±1.07 vs. 7.57±0.85 (p=0.285), but did not demonstrate significant differences (Table 2).

Neither splinting materials showed significant difference in mobilization effectiveness in short leg, long arm and sugar tong splinting techniques.

For short leg splints, there was no significant difference in the frequency of wrinkle occurrence between wave-form and straight-form splints: 91.6% and 94.4% (p=0.291), respectively. However, in long arm and sugar tong splints there was significant difference. Wrinkle occurrence in wave-form and straight-form splints for long arm splints were respectively 29.7% and 42.2% (p=0.026); for sugar tong splints, it was respectively 40.0% and 80.0% (p=0.036) (Table 3).

Discussion

Splints are frequently applied in the emergency department and in the pimary care settling for temporary immobilization of fractures and dislocations, and for definitive treatment of soft tissue injury[1-3]. However, traditional prefabricated splints are made from straight-form material and so lack some of that the versatility and custom fit qualities of self made plaster splints[5]. When soft tissue injury, fracture and dislocation occur in the elbow and ankle, applying splint molding without causing wrikling and folding remain challenging.

We initially hypothesized that patient satisfaction and the usefulness of splint molding would rely on the types of splints and immobilization angle of articulation.

In short leg splint applied to immobilize ankles at 90 degrees, wave-form splints moldings were more satisfatory than straight-form splints moldings, and wave-form splints wearings were more comfortable and satisfactory than straight-form splints wearings. However, both wave-form and strait-form splints showed a higher rate of occurence of wrinkling and folding (Table 3). We suggested that ankle joint immobilization were difficult wheather wave-form splints or straight-form splints

In long arm splints applied to immobilize elbows at 90 degrees, wave-form splints moldings were more satisfatory and useful than straight-form splints moldings and more comfortable and satisfactory than straight-form splints. The frequency of wrinkles and foldings occurence were lower in wave-form splints than in straight-form splints. We suggested that because elbow immobilization is required at 90 degrees, clinicians using traditional straight-form splints made efforts to mold wrinkling and folding toward the outer surface. However, clinicians using wave-form splints found it easier to mold in the elbow due to lower rate of wrikling and folding formation in splint molding.

In sugar tong splints, molding and wearing showed no significant difference in provider satisfaction and usefulness, and comfort and satisfaction as wearer. However, the frequency of wrinkles and folding occurence were lower in wave-form splints than in straight-form splints. We suggested that because sugar tong splints molding is cover up and down the forearm and immobilize wrist plantar flexion (15 degree) and ulnar deviation, angle bending the splints in wrist is lower than other splints. Therefore, both straight-form splints and wave-form splints were easy use to molding and wearing, on the other hand, molded straight-form splints had more wrin-

Table 3. Wrinkling and folding of splint

	No wrinkling (%)	Wrinkling (%)	Folding (%)	p-value
short leg splint (n=36)				
wave-form splint	3 (8.3)	6 (16.7)	27 (75.0)	
straight-form splint	2 (5.5)	2 (5.5)	32 (89.0)	0.291
long arm splint (n=37)				
wave-form splint	26 (70.3)	9 (24.3)	2 (5.4)	
straight-form splint	19 (51.4)	7 (18.9)	11 (29.7)	*0.026
sugar tong splint (n=14)				
wave-form splint	10 (71.4)	0 (0)	4 (28.6)	
straight-form splint	3 (21.4)	1 (7.2)	10 (71.4)	*0.025

* $p<0.05$

kling and folding than wave-form splints.

Immobilization is the mainstay of fracture therapy. It remains difficult to generate scientifically meaningful data in support of the use of splinting for the management of soft tissue injuries[8]. However, immobilization is traditionally important in the management of acute musculoskeletal injury. Therefore, splints material is firm to maintain joint immobillization. The splinting materials investigated in this study showed no significant difference in immobilization effectiveness for all splinting techniques in short leg, long arm and sugar tong.

The limitation of this study was that level of comfort and satisfaction , immobilization effectiveness were subjective evaluation wearing and applying splints. Additionally, This study investigated the level of satisfaction and comfort experienced by mock patients wearing splints for one hour. However, patients present with fracture, dislocation and soft tissue injury expereince swelling and tenderness and they usually require splints for more than 1week. And so, we could not survyed pressure sore, peripheral nerve palsy ocasionally wearing splints for long time. As such, a prospective study that includes genuine orthopedic patients is required to validate the findings of this study.

Conclusion

For the surveyed care providers, the wave-form splints were found to be more useful and satisfactory than the traditional straight-form splint for molding short leg and long arm splints. For the wearers of short leg and long arm splints, wave-form splints were found to be more comfortable and satisfactory when compared to straight-form splints. There was no difference in their immobilization effectiveness. Given these findings, the newly developed wave-form splints should be considered to be adopted by healthcare providers, given its superiority in utility, satisfaction and comfort over traditional straight-form splints

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