Functional Outcomes of 24-Hour Thumb Immobilization in Healthy Volunteers: Prospective Comparative Study

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J Wrist Surg 2017;6:201–205.

Abstract

Background Immobilization is often needed for the treatment of wrist and hand injuries. The current best method of immobilization for several types of injuries has yet to be elucidated with little being reported on the functional differences of each type of immobilization.

Purpose The purpose of this study is to compare the functional outcome between healthy young volunteers with a 24-hour short arm cast (SAC) versus thumb spica cast (TSC) immobilization.

Methods A total of 50 healthy volunteers completed a baseline typing assessment and a Patient-Reported Outcomes Measurement Information System (PROMIS) upper extremity functional scoring assessment. Participants in group 1 were randomly initially assigned to a TSC of their dominant hand followed by an SAC, whereas participants in group 2 were randomly initially assigned to a TSC of their nondominant hand followed by an SAC. The volunteers completed the typing assessment and PROMIS assessment at the end of the 24-hour casting period.

Results A total of 50 participants were enrolled in the study with 25 in group 1 and 25 in group 2. There was a 24.3-point difference between the average PROMIS score for participants with SAC compared with participants with TSC (93 vs. 68.7; $p = 0.0001$). There was a significant difference between the typing speed and accuracy of participants with SAC compared with participants with TSC ($p = 0.0001$).

Conclusion There is a significant difference in functionality of a TSC immobilization versus an SAC immobilization according to the PROMIS functional outcome score and typing speed in a 24-hour casting period. SAC immobilization should be considered to have a possible similar effect in pathologic conditions instead of TSC immobilization given these findings even though a 24-hour period is not enough to provide adequate long-term conclusions.

Level of Evidence I, prospective comparative study.

Keywords

- cast immobilization
- short arm cast
- thumb spica cast
- wrist immobilization

received

August 17, 2016

accepted after revision

December 16, 2016

published online

January 23, 2017

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 Tel: +1(212) 584-4662.

DOI <https://doi.org/10.1055/s-0037-1598025>.
 ISSN 2163-3916.

Internal fixation is becoming a more prevalent treatment option for orthopaedic injuries and fracture management. Immobilization with cast or splints used to be more commonplace prior to more modern treatment options and fixation methods. Immobilization has risks and complications associated with it, including stiffness and pressure sores.¹

The scaphoid is the most commonly fractured bone in the wrist and often occurs secondary to forceful wrist hyperextension after a fall.² Scaphoid fractures have a high incidence of nonunion, especially when the fracture is displaced or involves the proximal pole.^{3,4} There are multiple factors that increase the risk of nonunion, including fracture displacement, delay in diagnosis, and inadequate protection or immobilization.⁵ A nondisplaced scaphoid waist fracture is usually treated with a below-elbow cast, most often immobilizing the thumb (thumb spica cast [TSC]).⁶ However, there is little agreement on the type of immobilization, specifically whether the thumb needs to be immobilized in the cast. Surgical treatment is recommended for scaphoid fractures that have more than 2 mL of displacement.⁷ The total casting time ranges from 6 to 12 weeks for nondisplaced scaphoid waist fractures.⁸ Bujize et al have shown that a short arm cast (SAC) without the thumb immobilized may increase union rates compared with a TSC for nondisplaced scaphoid fractures.⁶

Compared with SAC, the TSC may decrease hand functionality and overall quality of life for the patient during the time the cast must be worn. Most surgeons in the United States immobilize the thumb when treating a patient with a scaphoid fracture.⁹ However, in Europe, an SAC without immobilization of the thumb is used by most surgeons.^{10,11}

The aim of this study is to test the functionality of various casting methods. The hypothesis of the study is that there is a significant difference in the hand functionality and activities of daily living of patients casted with TSC versus SAC for a 24-hour period. Because of the common occurrence of scaphoid fractures and the potential for significant improvement in patient quality of life during treatment, it is critical to address whether SAC provides better hand functionality than TSC.

Materials and Methods

This was a multicenter study comparing SAC versus TSC immobilization. Each respective institutional review board approved the study, and volunteers gave written informed consent. The study included healthy male and female volunteers 18 years or older who were recruited through a general request for volunteers. Exclusion criteria were any injury, deformity, or pathology of the upper extremities.

After patients provided informed consent, a web-based application (Randomness and Integrity Services Ltd., Dublin, Ireland) was used to randomize the participants. Participants were assigned randomly to receive casting of their dominant hand or their nondominant hand. Participants in group 1 were initially assigned to a TSC of their dominant hand followed by an SAC, whereas participants in group 2 were initially assigned to a TSC of their nondominant hand fol-

lowed by an SAC. The casts were each maintained for 24 hours.

Casting instructions for the TSC was to immobilize the wrist in neutral and the thumb in palmar abduction leaving the interphalangeal joint free. The cast extended to the proximal forearm but did not cross the elbow joint. Casting instructions for the SAC was to immobilize the wrist in neutral while leaving the trapeziometacarpal and thumb metacarpophalangeal joints free. Volunteers were advised to have their cast changed or removed if they developed discomfort, irritation, or got their cast wet.

A total of 50 participants were included in the study with 25 in each group. A power analysis was done to determine the minimum number of participants needed in each group to see a statistical difference. After 24 hours of casting, each patient was instructed to fill out a standardized survey (Upper Extremity Function—Fine Motor, Adult), provided by the Patient-Reported Outcomes Measurement Information System (PROMIS). The survey asks patients to rate their level of difficulty in performing various upper extremity functions common to daily life, such as writing or opening containers. The PROMIS score is on a 0–100 scale with 100 indicating no functional deficit. As an extra measure of upper extremity fine motor function, an online standardized typing test (SpeedTypingOnline) was administered to all patients along with the survey. The typing test requires the patient to type for 1 minute and records parameters such as typing speed (word per minute) and accuracy. All participants filled out the PROMIS survey and underwent the typing test prior to casting (control). Each participant underwent this cycle of testing twice, once for each cast.

Primary outcome variables studied included PROMIS survey scores, typing speed, and typing accuracy. The secondary outcome variable investigated was the effect of casting on nondominant versus dominant hands. Statistical analysis was performed using JMP Pro 10 Software (SAS Inc, Cary, NC). As the data were not normally distributed, nonparametric tests were used for statistical analysis. Wilcoxon Signed Rank (Kruskal-Wallis) and Mann-Whitney U tests were used to analyze the effect of TSC, SAC, and hand dominance on PROMIS scores, typing speed, and typing accuracy. A *p* value of < 0.05 was used for statistical significance.

Results

A total of 50 participants were enrolled in the study with 25 in group 1 and 25 in group 2. Clinical characteristics and demographics for each study group were comparable. The average precasting PROMIS score was 100. The PROMIS scores for the two groups after 24 hours of casting are shown in ►Table 1. There was a 24.3-point difference between the average PROMIS score for all the participants with SAC compared with all the participants with TSC (93 vs. 68.7; *p* = 0.0001). When comparing the participants with dominant hand SAC with those with dominant hand TSC (89.12 vs. 52.2; *p* = 0.0001), the average difference was 36.92 points. The average PROMIS score difference was lower, but still

Table 1 PROMIS scores

Type of cast	No. of casts	Average PROMIS	Mean Difference	p Value
SAC	50	93	24.3	0.0001
TSC	50	68.7		
Dom SAC (group 1)	25	89.12	36.92	0.0001
Dom TSC (group 1)	25	52.2		
Non-Dom SAC (group 2)	25	96.88	11.68	0.0001
Non-Dom TSC (group 2)	25	85.2		

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; SAC, short arm cast; TSC, thumb spica cast.

significant, when comparing nondominant arm SAC with nondominant arm TSC (96.88 vs. 85.2; $p = 0.0001$).

Tasks that were most difficult for the TSC participants involved fine dexterity such as putting on clothes (esp. buttons), opening doorknobs, and opening bottles or jars. The results of the typing test between the two groups are shown in ► **Tables 2** and **3**. There was a significant difference between the typing speed and accuracy of participants with SAC compared with those with TSC ($p = 0.0001$). This differ-

ence was seen when dominant arm SAC was compared with dominant arm TSC, and also when nondominant arm SAC was compared with nondominant arm TSC ($p = 0.0001$).

► **Table 4** shows that there were differences in the PROMIS scores and typing test results when comparing participants who had undergone casting of dominant hand versus nondominant hand. There was a significant difference when comparing PROMIS scores of participants who had undergone dominant arm SAC compared with nondominant arm SAC

Table 2 Typing accuracy

Type of cast	No. of casts	Average accuracy (%)	Difference (%)	p Value
SAC	50	94.56	1.56	0.0001
TSC	50	93		
Dom SAC (group 1)	25	94.36	1.56	0.0001
Dom TSC (group 1)	25	92.8		
Non-Dom SAC (group 2)	25	94.76	1.56	0.0001
Non-Dom TSC (group 2)	25	93.2		

Abbreviations: SAC, short arm cast; TSC, thumb spica cast.

Table 3 Typing speed

Type of cast	No. of casts	Average typing speed (wpm)	Difference (wpm)	p Value
SAC	50	49.38	10.54	0.0001
TSC	50	38.84		
Dom SAC (group 1)	25	47.52	11.72	0.0001
Dom TSC (group 1)	25	38.16		
Non-Dom SAC (group 2)	25	51.24	9.36	0.0001
Non-Dom TSC (group 2)	25	39.52		

Abbreviations: SAC, short arm cast; TSC, thumb spica cast.

Table 4 Hand dominance

Type of cast	No. of casts	Mean PROMIS	p Value	Typing accuracy (%)	p Value	Typing speed (wpm)	p Value
Dom SAC	25	89.12	0.0001	94.36	0.5070	47.52	0.2642
Non-Dom SAC	25	96.88		94.76		51.24	
Dom TSC	25	52.2	0.0001	92.8	0.4696	38.16	0.7559
Non-Dom TSC	25	85.2		93.2		39.52	

Abbreviations: SAC, short arm cast; TSC, thumb spica cast.

and dominant arm TSC compared with nondominant arm TSC ($p = 0.0001$). The difference between typing accuracy and typing speed when comparing casting of dominant arm with nondominant arm was not found to be significant.

Discussion

Many recent studies have shown that there is little to no advantage in immobilizing the thumb for nondisplaced scaphoid fractures.^{6,12} Our study tested the hypothesis that there is no difference in hand functionality and activities of daily living of patients casted for a 24-hour period with TSC versus SAC. This study shows that there is a decrease in patient functionality and satisfaction when being immobilized for a 24-hour period in a TSC compared with an SAC. Significantly more limitations are seen with TSC treatment. The SAC may allow the patient to have a better quality of life and significantly better function in their daily activities.

Prior studies have shown that prolonged cast immobilization has several potential pitfalls.^{13–15} It may lead to problems such as joint stiffness, muscle atrophy, cartilage degradation, ligament weakening, and osteoporosis.^{13–15} This must be weighed against the bony healing gained with the immobilization.^{14–16} In an effort to reduce arthrofibrosis, operative fixation of scaphoid fractures has been recommended for early range of motion.¹⁷ In addition, proponents of surgical fixation for scaphoid fractures cite faster return to work and decreased indirect costs from time off work.¹⁷ By leaving the thumb free for early motion, it is possible that patients may need less therapy after completing their cast treatment. Hypothetically, this may allow patients to return to regular activities and work faster while potentially reducing patients' indirect costs. However, many physicians are skeptical of keeping the thumb free when casting scaphoid fractures for fear of nonunion.

There are several weaknesses to our study. First, patients did not have an upper extremity injury, which could limit true functionality secondary to decreased use from pain. Second, 24 hours of immobilization may fail to capture the long-term effects of cast treatment and the sequelae that occur afterward. There were several strengths to the study, which included the large number of participants and the prospective randomized multicenter design. PROMIS scores, typing speed, and typing accuracy provide a real objective measurement of casting detriment. This allows extrapolation beyond scaphoid fractures to any situation where one may consider the use of a TSC versus an SAC. This study should be interpreted with caution

because we only immobilized healthy participants for 24 hours, and therefore the results cannot be used as a generalization for longer-term immobilization.

Physicians should be aware that casting in general is not completely benign and that functionality is more limited with TSC immobilization. Because recent research has shown treatment outcomes are the same or better with SAC, consideration should be made to excluding the thumb when possible to improve patient functionality and satisfaction.

Note

This study was conducted at the Tufts Medical Center, Boston, Massachusetts.

Conflict of Interest

None.

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