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Treatment of tendinous mallet fingers using a Stack splint versus a dorsal glued splint

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Abstract
The goal of this study was to compare the results of a Stack splint compared to a dorsal glued splint in the treatment of tendinous mallet fingers. Our series included 100 patients, aged 47 years in average, among which 40 are women, with a 9-week follow-up. The first 50 patients (group I) were treated with a dorsal glued splint, and the 50 following patients (group II) were treated with a Stack splint. The average lack of active extension of the distal phalanx was 3.1° in group I and 1.74° in group II. The average pain was rated 0.22/10 in group I and 0.26/10 in group II. There were seven cases of nail dystrophies, 18 cases of macerations and five cases of swan neck deformities in group I. There were six cases of macerations and four cases of swan neck deformities in group II. The dorsal nail-glued splint gives comparable results to the Stack splint with the added advantage of leaving the fingertip free.

Keywords Tendinous mallet finger · Splint · Stack · Dorsal glued splint

Introduction

The treatment of tendinous mallet fingers is usually conservative [1–3]. The Stack splint is the gold standard of conservative treatment [4]. Other types of splints have been described, but none have demonstrated their superiority to the Stack Splint to this day [5]. To avoid the bulk of a Stack splint and free the fingertip, some authors designed a dorsal splint, glued on the nail in order to free the fingertip. They published satisfying results but without a control group [6]. The goal of this study was to compare the results of this dorsal glued splint to the results of the Stack splint.

The main hypothesis of this study was that the lack of active extension after treatment of a tendinous mallet finger with a Stack splint was equivalent with a dorsal glued splint. Secondary hypotheses were that there was no difference in terms of pain, maceration, nail dystrophy and appearance of swan neck deformities.

Materials and methods

The medical files of all patients treated in our department for a tendinous mallet finger between April 2016 and April 2017 were reviewed. We excluded patients under 18 years, pregnant women, mallet thumbs, bony mallet fingers, lesions older than 15 days, patients with a traumatic history on the injured finger, patients with a preexisting nail dystrophy on the injured finger. We included all patients presenting a simple tendinous mallet finger. Our series included 100 patients (among which 40 are women), aged 47 years in average ranging from 21 to 78 years (Tables 1, 2).

All patients were treated with a splint for 9 weeks and followed up every 3 weeks by an occupational therapist. Patients treated between April 2016 and October 2017 (group I) were treated with a dorsal glued splint with 5°–10° of hyperextension of the distal interphalangeal joint (DIP) (Fig. 1). The patients treated between November 2016 and April 2017 (group II) were treated with a non-microperforated Stack splint.

The evaluation of the results consisted after 9 weeks of treatment in the measurement of the lack of active

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Table 1 Characteristics of a series of 50 patients treated for a tendinous mallet finger with a dorsal glued splint

Patient *N*	Age (years)	Gender (M/W)	Dominance (L/R)	Injured side (L/R)	Injured digit (1–5)	Delay (days)
1	25	F	R	L	5	10
2	40	F	R	L	4	7
3	57	F	L	R	5	10
4	49	M	L	L	3	2
5	53	M	R	L	4	4
6	30	M	L	L	5	6
7	53	F	R	R	4	6
8	51	M	R	L	5	1
9	44	M	R	R	5	2
10	68	M	R	R	4	2
11	66	F	L	R	4	2
12	53	M	R	R	3	11
13	73	F	L	L	4	2
14	51	M	L	R	3	1
15	48	F	R	R	4	4
16	40	M	L	L	4	1
17	21	M	R	L	3	1
18	36	F	R	R	3	1
19	57	M	L	L	4	3
20	52	F	R	R	4	12
21	41	F	L	L	4	3
22	54	M	R	L	2	5
23	34	F	R	R	2	13
24	61	F	R	R	5	3
25	61	F	L	L	4	0
27	52	M	L	R	3	1
28	53	M	R	R	3	0
29	25	F	R	L	3	0
30	52	F	R	R	4	0
31	37	F	L	L	3	1
32	77	F	R	L	3	3
33	23	H	L	R	3	1
34	49	F	R	R	4	2
35	65	F	R	R	4	14
36	22	F	R	R	3	8
37	41	M	L	R	5	12
38	48	M	L	L	4	4
39	46	M	R	L	3	7
40	52	F	R	L	5	4
41	36	M	L	L	5	13
42	66	F	R	R	4	4
43	36	M	L	L	5	1
44	57	F	R	R	3	13
45	51	F	R	L	4	3
46	43	F	R	L	3	2
47	39	M	R	L	3	5
48	59	F	R	R	3	1
49	38	M	R	L	2	8
50	44	M	R	L	3	1

Table 2 Characteristics of a series of 50 patients treated for a tendinous mallet finger with a Stack splint

Patient *N*	Age (years)	Gender (M/W)	Dominance (L/R)	Injured side (L/R)	Injured digit (1–5)	Delay (days)
1	30	M	R	R	4	0
2	78	F	R	L	3	0
3	51	F	R	L	3	2
4	73	F	R	L	5	4
5	50	M	L	L	4	0
6	62	M	L	R	3	6
7	43	M	R	L	4	14
8	53	F	R	R	3	14
9	39	M	L	R	5	4
10	62	M	L	R	3	6
11	55	F	R	L	3	6
12	69	F	R	L	4	0
13	64	F	R	L	3	2
14	31	M	R	L	3	1
15	67	M	L	L	4	5
16	63	F	R	R	4	2
17	66	M	L	L	4	3
18	41	M	L	R	4	2
19	63	F	R	R	4	3
20	30	M	R	R	4	5
21	37	M	R	R	5	8
22	45	M	R	R	5	7
23	51	M	R	L	5	0
24	68	M	R	R	3	8
25	66	M	L	L	4	3
26	43	M	R	L	5	4
27	64	M	R	L	5	8
28	50	F	R	L	3	1
29	52	M	R	R	3	2
30	38	M	R	R	4	0
31	69	M	L	L	4	1
32	46	F	L	L	3	0
33	62	M	R	R	3	4
34	66	F	R	R	5	1
35	57	M	R	R	4	1
36	48	M	R	L	4	7
37	55	M	R	R	5	0
38	33	M	R	L	3	5
39	47	M	R	L	4	0
40	20	M	L	L	4	4
41	39	M	R	L	4	10
42	63	F	R	R	4	2
43	44	M	R	R	3	11
44	57	M	R	R	3	2
45	58	F	R	L	3	1
46	53	M	R	R	4	10
47	57	M	R	R	4	14
48	31	M	R	L	5	1
49	54	M	R	L	2	5
50	40	M	L	L	4	1

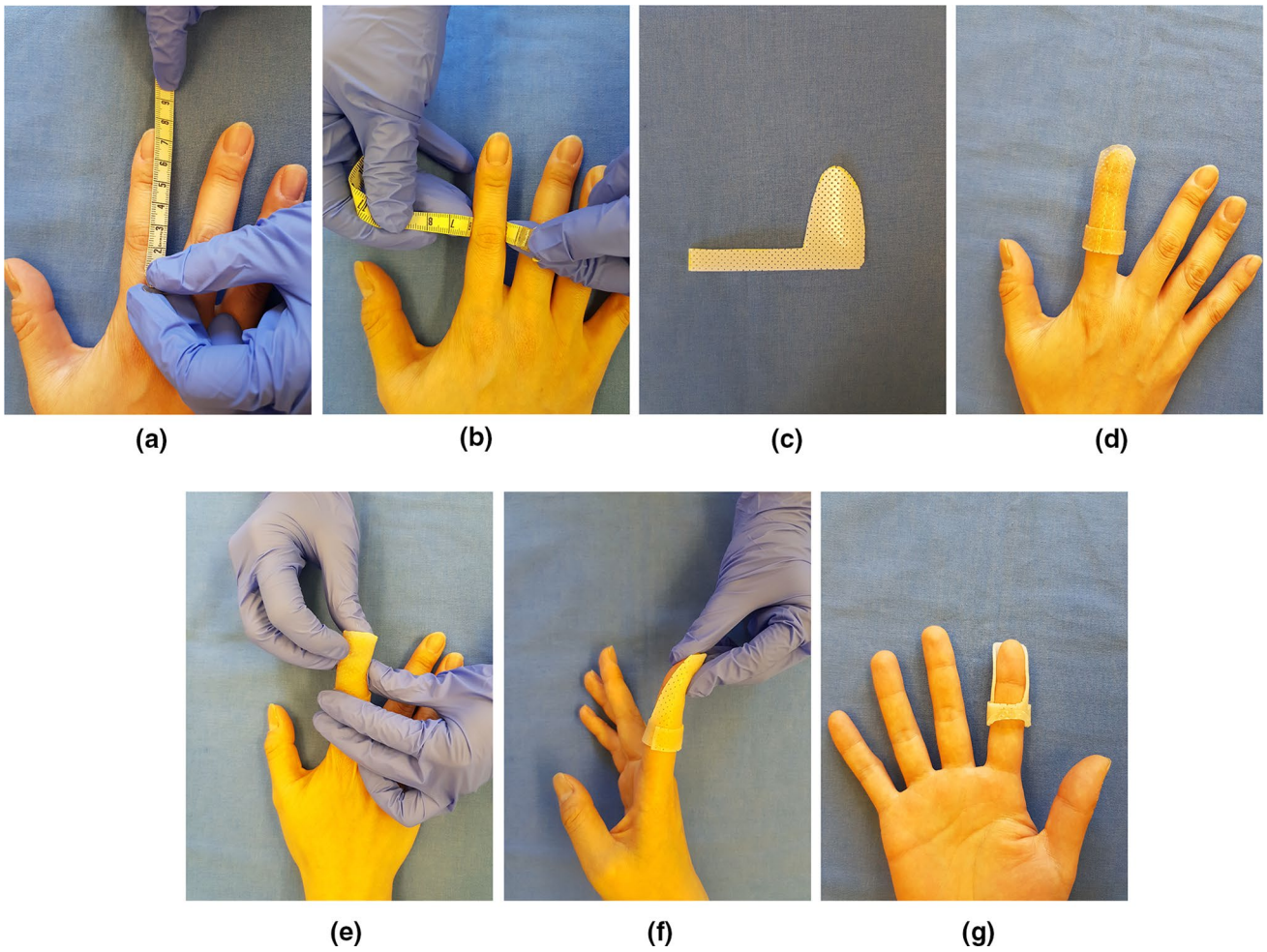

Fig. 1 Making of a glued splint. **a** The digit is measured for the tip of the nail to half of the proximal phalanx, **b** the circumference of the digit is measured at the level of the proximal interphalangeal joint (PIP), **c** the splint is cut from a thermosettable material, **d** after it has been put in warm water, the splint is positioned on the finger, **e** the splint is applied on the finger while it is still soft to fit the anatomy of the digit, **f** the splint is then applied on the nail with 10° of extension of the DIP joint after a drop of glue has been put on it, **g** volar aspect of the finger with the splint in place. Note that then fingertip is free and that the proximal ring of the splint has been bent to allow complete flexion of the PIP

extension of the DIP joint using a goniometer on the dorsal aspect of the DIP, the rating of the pain using a numeric scale ranging from 0 (no pain) to 10 (worst imaginable pain) and looking for complications such as nail dystrophy, maceration and/or swan neck deformity.

After showing that the two groups were comparable, the statistical analysis consisted in using Fisher's exact test to compare the averages of two continuous non-matched quantitative variables (lack of active extension of the DIP joint), one discontinuous variable (pain) and three non-matched qualitative variables (nail dystrophy, maceration, swan neck deformity) between the two groups. The difference was considered as statistically significant when $p < 0.05$.

Results

The analytical results are presented in Fig. 2.

At 9 weeks, the average lack of extension of the DIP joint was 3.1° in group I and 1.74° in group II. The difference was not statistically significant with $p = 0.7595$.

The average pain was 0.22/10 in group I and 0.26/10 in group II. The difference was not statistically significant with $p = 0.8897$.

We noted seven cases of nail dystrophies in group I and no case in group II. The difference was statistically significant with $p = 0.01248$.

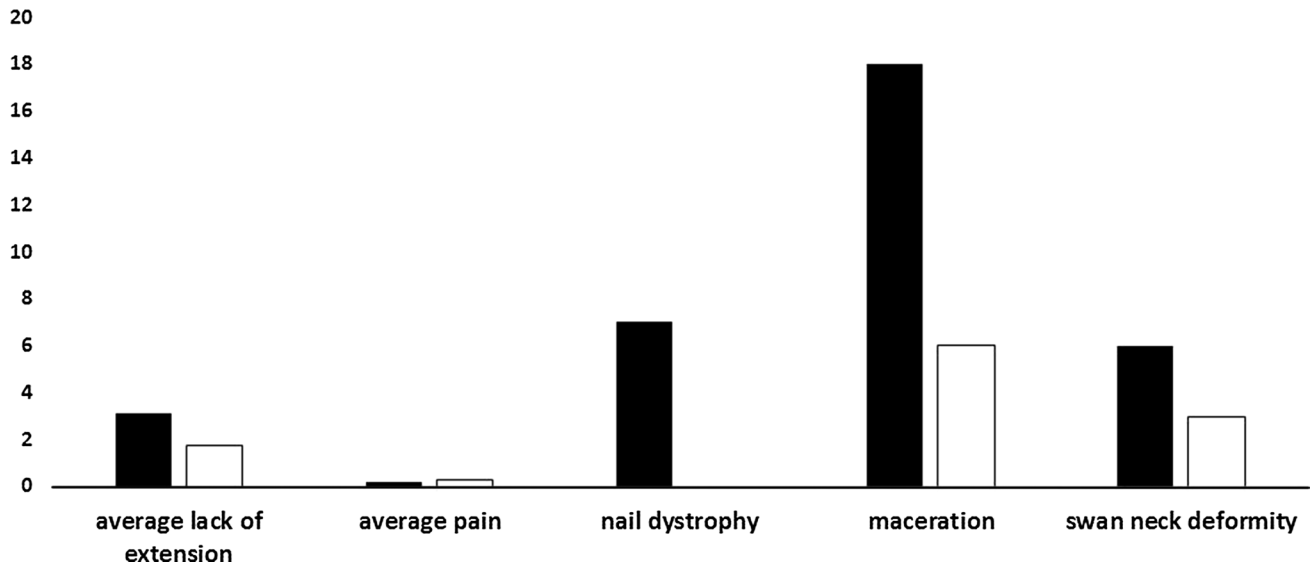

Fig. 2 Results at 9 weeks of a series of 100 cases of tendinous mallet fingers treated with a Stack splint (white bars) versus dorsal glued splint (black bars)

We noted 18 cases of maceration in group I and six cases in group II. The difference was statistically significant with $p = 0.004958$.

We noted five cases of swan neck deformities in group I and four cases in group II. The difference was not statistically significant with $p = 0.487$.

Discussion

The methods of evaluation of treatments of tendinous mallet fingers rely on the clinical and/or radiological measurement of the remaining lack of active extension of the DIP joint and on the rate of complications.

There is no consensus on the way of measuring the lack of extension of the DIP joint. A clinical method and a radiological method can be found in the literature. Some authors use a goniometer, but do not indicate if the measure is made on the dorsal or lateral aspect of the DIP joint [7]. We measure the lack of extension on the dorsal aspect of the DIP joint, as the measure on the lateral aspect can lack precision [3]. Other authors make the measurement on a lateral view X-rays, arguing that the dorsal edema that can be encountered on the DIP joint overestimates the lack of extension measured clinically [8]. Regardless of the method used, the Crawford classification consists in grouping the results in four intervals of remaining lack of active extension. The result is considered as excellent between 0 and 10°, good between 10 and 25°, acceptable over 25° and poor in case of persistent pain [9]. It is no longer used, and the studies selected by a recent meta-analysis used the remaining lack of active extension measured in degrees [5]. In our series, the remaining lack of extension was inferior to 5° in both groups, and the result can be considered as excellent.

Some publications have shown a difference of remaining lack of active extension depending on the type of splint used [5, 10]. The microperforated Stack splint gives better results than the non-microperforated Stack splint. The reason is the absence of maceration with the microperforated material, increasing the observance of the treatment [10]. Those results go against our own series where group II (with a Stack splint) has a very low rate of maceration. No publication reports a higher rate of swan neck deformities depending on the type of splint used. In our series, the rate of swan neck deformities was very low.

Other publications have shown that if the measure of the remaining lack of extension of the DIP joint was not discriminating, the rate of complications made a difference [5, 8]. Among these complications, we noted skin lesions such as maceration, irritation, dorsal ulceration sometimes requiring the use of antibiotics [8] and nail dystrophies. Dorsal aluminum splints have a lower complication rate (6.66%) than the Stack splint (33%) for some authors [11]. Meanwhile, other authors report higher rates of complications with the aluminum splint (11.5%) compared to the Stack splint (8.33%) [8]. For some authors, dorsal thermoformed splints have lower rates of complications (20%) compared to the Stack splint (46%) [12]. In our series, the dorsal glued splint was subject to more cases of maceration and nail dystrophies. These results need to be tempered by the fact that these complications are transitory.

The position of immobilization could play a part in the remaining lack of active extension, and some authors recommend immobilizing the DIP joint in slight hyperextension

[13]. Stack splints immobilize the DIP joint in rectitude, and no publication has yet proved the benefit of immobilizing the DIP joint hyperextension. Our series has shown that the hyperextension had no influence on the lack of extension as there was no significant difference between the two groups at the end of the treatment.

The observance of the treatment could play a part in the remaining lack of extension [14, 15], and some authors recommend frequent consults to verify that the splint is worn correctly [16]. Other authors on another hand recommend using splints requiring less surveillance [10, 12]. In our series, the follow-up was identical for both groups, and we cannot reach a conclusion.

Regarding the length of the treatment, most authors recommend that a splint should be worn for 8–9 weeks. Many recommend wearing the splint at night for an additional 2 weeks [17]. A level-1 prospective series has demonstrated the absence of benefit of wearing the splint at night at the end of the treatment [7] and this is why we stopped our treatment at 9 weeks.

Depending on the series, the evaluation of the results was done at 9 weeks and up to 18 months [5, 18, 19]. Most studies evaluate the results at the end of the treatment, and longer follow-ups have not shown a worsening of the results compared to the end of the treatment [10]. Finally, it is difficult to follow up patients for an extended period of time after the end of the treatment, and it is therefore legitimate to evaluate the results at the end of the 9th week.

Among the theoretical advantages of the dorsal glued splint, we note that it is made from a microperforated material to avoid maceration [20], the material used is also thermosettable and enables the DIP joint to be positioned at 5°–10° of hyperextension [21], the ergonomy is improved as the fingertip remains free, and the anatomy of the patient is respected as it is custom made. Our results show that the glued splint did not give better results in hyperextension compared to an immobilization in rectitude. On the other hand, the available sizes of Stack splints can sometimes be unsuitable to the anatomy of the patients. The main advantage of the glued splint is the almost normal use of the finger as the fingertip remains free [6].

Among the theoretical disadvantages of the glued splint, we note the need for a workshop and qualified staff to manufacture them. Among the practical disadvantages, our study has shown that it led to complications such as nail dystrophy and maceration, but with a lower rate compared to other series in the literature.

The main hypothesis of this study was verified as the active lack of extension was equivalent between the Stack splint and the dorsal glued splint in the treatment of tendinous mallet fingers. Among the secondary hypotheses, two were verified as we found no difference between the two groups in terms of pain and swan neck deformities and two were not verified as we found significant differences in terms of maceration and nail dystrophy in the two groups.

All in all, the dorsal glued splint gives equivalent results to the Stack splint with the added advantage of leaving the fingertip free.

Compliance with ethical standards

Conflict of interest Philippe Liverneaux has conflicts of interest with Newclip Technics, Argomedical, Biomodex, Zimmer Biomet. None of the other authors have conflicts of interest.

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