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Original article

Polypropylene prosthesis for the treatment of fingertip injuries. Description of surgical technique and results☆

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ABSTRACT

Objective: Report the results of treatment of fingertip injuries and describe this reproducible and low cost surgical technique, which utilizes a polypropylene prosthesis that temporarily replaces the nail and is placed on the area of injury, providing protection and encouragement for healing by secondary intention.

Method: This study evaluated 22 patients with traumatic injuries of the fingertips in the period from January 2012 to December 2015. All procedures were performed by the same surgeon. The mean postoperative follow-up was 13 months, with a minimum follow-up of six months. For all statistical inferences, a *p*-value of 0.05 was considered. The software used was SPSS version 21.0 for Windows.

Results: There were no cases of complications related to the polypropylene device. There was no significant difference between static two-point discrimination and age, between discrimination and time between injury and surgery, or between discrimination and time to follow-up. The authors used a table of scores that includes three factors proposed by Jefferson for a better evaluation of the results. 72.7% (16 cases) of patients had good results, 22.7% (five cases) fair results, and only 4.5% (one case) poor result.

Conclusion: This study presented a new technique for finger tip lesions, simple and easily reproducible, with satisfactory results and low complication rates.

☆ Study conducted at the Santa Casa de Misericórdia de Vitória, Departamento de Ortopedia e Traumatologia, Vitória, ES, Brazil.

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Uso da prótese de polipropileno para o tratamento das lesões em ponta de dedo. Descrição de técnica cirúrgica e resultados

Palavras-chave:
Falanges dos dedos da mão
Traumatismos dos dedos
Adulto

RESUMO

Objetivo: Relatar os resultados do tratamento das lesões de ponta de dedo, bem como descrever a técnica cirúrgica, reprodutível e de baixo custo, que usa uma prótese de polipropileno que substitui temporariamente a unha e é colocada sobre a área da lesão, promove proteção e estímulo para a sua cicatrização por segunda intenção.

Método: Foram avaliados 22 pacientes portadores de lesões traumáticas da polpa digital de janeiro de 2012 a dezembro de 2015. Todos os procedimentos foram feitos pelo mesmo cirurgião. O tempo médio de seguimento pós-operatório foi de 13 meses, com um seguimento mínimo de seis meses. Para toda a inferência estatística, considerou-se um valor de p de 0,05. O *software* usado foi o SPSS for Windows, versão 21.0.

Resultados: Não foi observado caso de complicação referente ao dispositivo de polipropileno. Não foi observada diferença estatística significante entre sensibilidade estática entre dois pontos (DE2P) e idade, entre sensibilidade e tempo entre lesão e data da cirurgia nem entre sensibilidade e tempo de seguimento. Adotou-se uma tabela de escores que incluiu três fatores propostos por Jefferson para melhor avaliação dos resultados; 72,7% (16 casos) dos pacientes tiveram resultados bons, 22,7% (cinco) regulares e apenas 4,5% (um) apresentou resultado ruim.

Conclusão: O presente estudo apresentou uma nova técnica, simples e facilmente reprodutível, para as lesões das pontas de dedos com resultados satisfatórios e baixa taxa de complicações.

Introduction

Injuries to the fingertips, defined as the distal portion of the finger where the flexor and extensor tendons are inserted, are responsible for one of the main causes of emergency room visits in public and private hospitals.[1]

These injuries, when untreated or poorly managed, often lead to irreparable sequelae and limitations, causing a great loss to the economically active population, especially when they involve the thumb and/or index finger.[2]

In the literature, numerous techniques have been described for the treatment of fingertip injuries, in order to maintain maximum length, with functional coverage and adequate sensitivity. Different factors should be considered when choosing one surgical technique over another, especially the type of injury and factors related to the patient, surgeon, and institution.[2–5] However, many techniques are not reproducible elsewhere, due to their cost and the population studied.

This article is aimed at reporting the results of the treatment of fingertip injuries, as well as to describe a reproducible, low-cost surgical technique that uses a polypropylene prosthesis that temporarily replaces the nail and is placed over the area of the injury, by protecting and stimulating its healing by second intention.

Material and methods

Twenty-two patients with traumatic injuries of the digital pulp were studied from January 2012 to December 2015. All procedures were performed by the same surgeon. The study was approved by the Ethics Committee of the institution and the patients signed the Informed Consent Form to participate.

Initially, a descriptive analysis of the studied variables was performed. Due to the non-normality of the data, non-parametric tests were used for inferential analyses. The Mann–Whitney or the Kruskal–Wallis test was used for the evaluation between score and age, time between injury and surgery, and follow-up time. For the analysis between subjective evaluation and age, time between injury and surgery, and follow-up time, the Mann–Whitney test was used. Spearman's correlation test was used to evaluate correlation between sensitivity and age, time from injury to surgery, and follow-up time.

The inclusion criteria were patients with acute trauma (compression, avulsion) in any finger of the hand. Exclusion criteria were infections; prior surgeries on the injured finger; tumors; severe osteoarthritis of the joint; systemic diseases, such as psoriasis, lupus erythematosus, Raynaud's disease, iron deficiency anemia, and hemochromatosis, and heart or lung disease.

Patients' age ranged from 16 to 67 years (mean of 40); 20 (90.9%) patients were male. The extent of pulpal loss was determined immediately after adequate debridement in all injuries; it was measured in square centimeters with the aid of a sterile ruler. Table 1 presents the descriptive analysis of all the numerical variables contained in the database.

After healing, the fine sensitivity in the injury area was assessed. The two-point discrimination test (2PD; Weber test)

Table 1 – Descriptive analysis of numerical variables.

	N	Mean	SD	Median	Min	Max
Age (years)	22	40.27	14.7	39	16	67
2PD (mm)	22	2.86	0.68	3	2	4
Time from injury to surgery (days)	22	5.38	7.17	2	0.5	28
Follow-up (months)	22	13.05	7.14	12	6	36

2PD, dynamic sensitivity between two points.

and the Semmes–Weinstein monofilament testing were used to check sensitivity.

The mean postoperative follow-up time was 13 months (minimum of six months).

For all statistical inference, a *p*-value of 0.05 was considered significant. SPSS for Windows version 21.0 was used for all analyses.

Description of the technique

A digital blockade with lidocaine was initially made. In trauma with injuries to the nail bed, the bed was repaired with 6.0 absorbable suture or 7.0 or 8.0 microsurgical nonabsorbable suture; the bed was then protected with a polypropylene prosthesis obtained through a small portion of flexible silicone (polypropylene) cut away from a saline plastic bag, which temporarily replaces the nail. This material is easily obtainable in operating rooms.

After the material was cut in the exact shape of the open area of the wound, it was fixed under the nail fold and sutured at the healthy edges of the lesion. For that, a U-suture was made with a good distance between the entrance and exit sites of the suture to avoid skin ischemia. This same suture can be used to attach the plastic prosthesis to the lateral nail fold. Simple sutures are sufficient to attach the plastic to the entire skin border, so that the prosthesis is perfectly accommodated without pressing on to the wound.

The dressing is made with sterile gauze and micropore paper tape. The first dressing is changed only after five or seven days. During this first period of time, liquid exudate forms, discretely moistening the dressing. After the first week, there is no more exudate, but rather fibrin tissue formation that will be gradually replaced by granulation tissue, which will fill the entire lost area and restore the original shape of

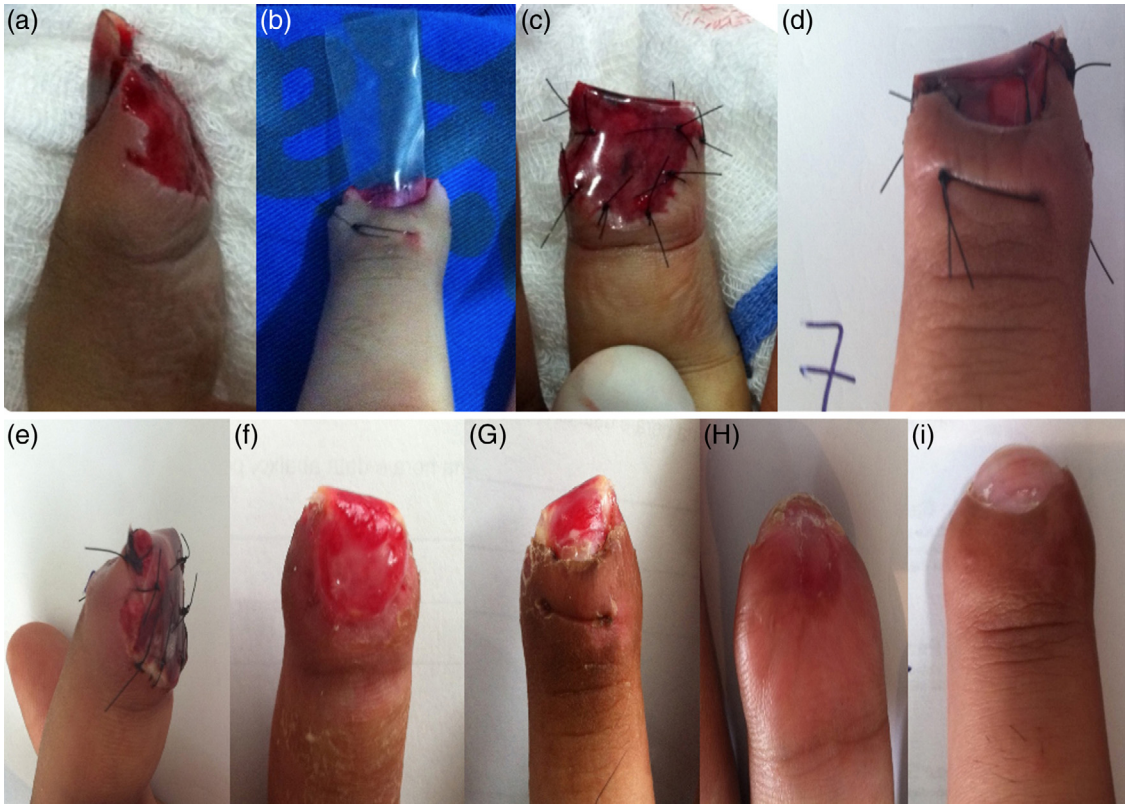

Fig. 1 – Clinical case 1: female patient, 49 years old. Trauma by crushing the ring finger; (a) oblique volar wound with great loss of substance and difficult flap planning; (b) plastic fixed with U-suture. Note the small nail bed; (c) attaching the plastic to the edges of the wound; (d and e): aspect after one week; (f and g) plastic removed after 45 days; (h and i): aspect after 70 days.

Fig. 2 – Clinical case 2: female patient, 34 years old. Trauma by crushing the middle finger; (a) aspect of the dorsum of the finger with complex nail bed lesion; (b) oblique volar injury (difficult flap use); (c) plastic trimmed into a U-shape; (d) intraoperative aspect; (e and f): late postoperative aspect. Presence of a viable nail.

the digital pulp. Thus it is observed that the greater the bone loss of the phalanx, the smaller the final length of the finger. However, the shape and appearance of the residual segment are very close to the original. Figs. 1–3 illustrate clinical cases in which the described technique was used.

After the first week, the dressings are changed daily; only 70% alcohol is used, and the wound is covered with gauze and micropore paper tape. The prosthesis is removed after six weeks.

Results

No complications were observed regarding the use of a polypropylene device obtained from a saline plastic bag.

The variable time between injury and surgery presented values with different measurement units, some in days and others in hours (<24 h). Thus, in order to analyze this variable, it was converted from <24 h to 12 h.

The score table proposed by Jefferson,[6] which included three factors (Table 2), was used for better evaluation of the results. The following variables were considered: nail growth (0 = no growth; 1 = partial growth with plate arrest; and 2 = normal growth), nail size (0 ≤ 50%; 1 = between 50% and 75%; and 2 ≥ 75% of the size of the nail on the opposite side); and the shape of the nail (0 = significant deformation in the vertical plane; 1 = minor deformation in the vertical

Table 2 – Esthetic and functional classification according to the sum of the results.

Nail growth	0 = no growth; 1 = partial growth with arrest; 2 = normal growth
Nail size	0 ≤ 50%; 1 = between 50% and 75%; 2 = 75% of the size of the nail on the opposite side
Nail shape	0 = significant deformity in the vertical plane; 1 = small deformity in the vertical plane; 2 = no deformity
Total score 6	The results were obtained by additing up, and the scores were classified as good (5–6), regular (3–4), or poor (<3)

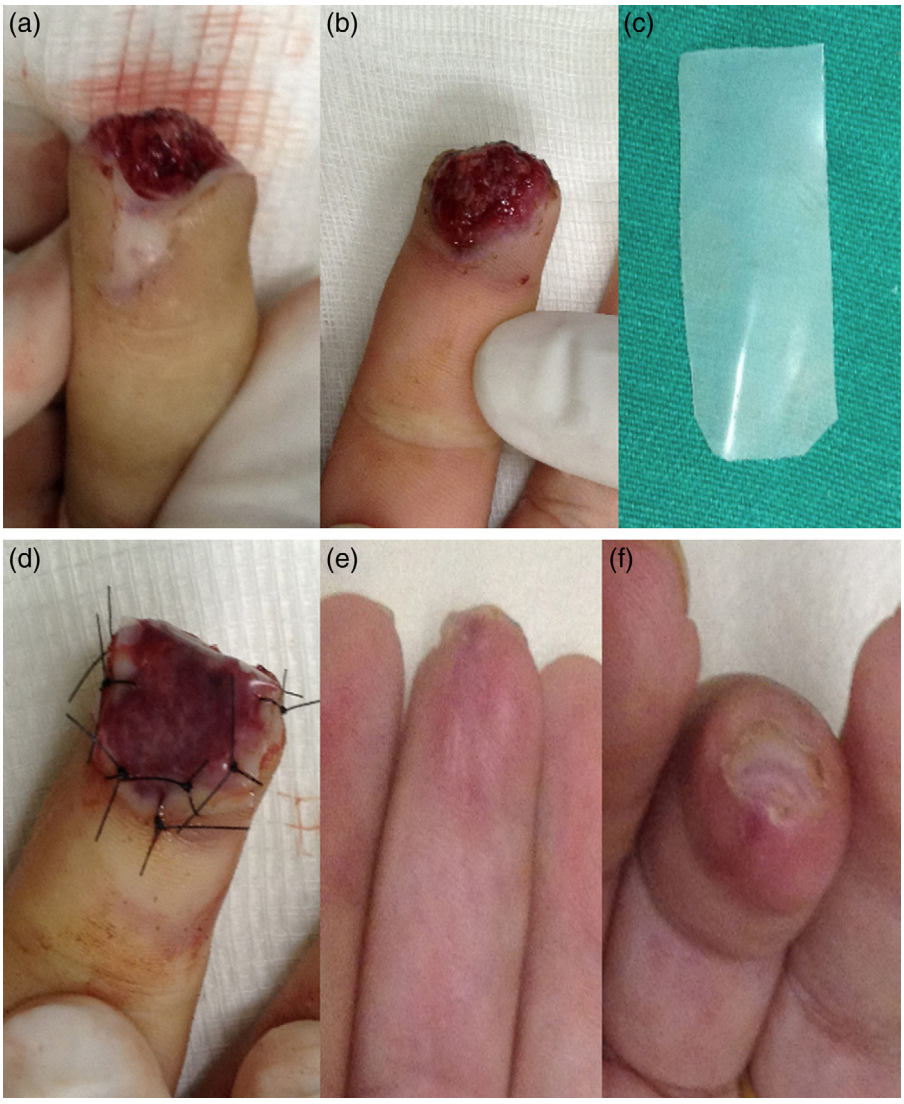

Fig. 3 – Clinical case 3: male patient, 38 years old. Injury to the radial border of the thumb; (a and b) thumb with extensive oblique lesion from its radial border (difficult flap planning); (c and d) aspect of plastic covering large open area; (e and f): epithelization aspect, one week after removal of the plastic. The thumb acquires a rounded shape.

plane; and 2 = no deformity), compared with the opposite side. The results were obtained by adding up the scores, and they were classified as good (5–6), regular (3–4), and poor (<3); 72.7% (16 cases) of the patients presented good results, 22.7% (five) regular, and only 4.5% (one) presented a poor result.

Table 3 presents the descriptive information of the qualitative/categorical variables.

Table 4 presents the results of inferential analysis by the Kruskal–Wallis method to assess whether there was a difference between score and age, time between surgery and injury, and follow-up time. No significant differences were observed between score and age, between score and time between injury and surgery, nor between score and follow-up time. The variables age, time between injury and surgery, and follow-up time do not seem to have any influence on the score obtained.

Table 5 presents an analysis between the subjective evaluation with age, time between surgery and injury, and follow-up time. No significant differences were observed between subjective evaluation and age, between subjective evaluation and time between injury and surgery, nor between subjective evaluation and follow-up time. The variables age, time between injury, and surgery and follow-up time appeared to have no influence on the subjective evaluation result.

Table 6 presents the results of the Mann–Whitney method of inferential analysis in evaluating whether there was a dynamic sensitivity difference between two points (2PD) and age, time between surgery and injury, and follow-up time. No significant differences were observed between sensitivity (2PD) and age, between sensitivity and time between injury and surgery, nor between sensitivity and follow-up time. The variables age, time between injury, and surgery

Table 3 – Descriptive analysis of qualitative variables.

	Frequency (*n*)	%
Gender		
Male	20	90.9
Female	2	9.1
Side		
Right	9	40.9
Left	13	59.1
Finger		
Ring	5	22.7
Index	6	27.3
Middle	6	27.3
Little	2	9.1
Thumb	3	13.6
Cause		
Car accident	1	4.5
Crushing	10	45.5
Explosion	1	4.5
Power drill	1	4.5
Polishing machine	1	4.5
Saw	3	13.6
Firearm projectile	1	4.5
Direct trauma	2	9.1
Chain trauma	1	4.5
Door trauma	1	4.5
Infection		
Yes	2	9.1
No	20	90.9
2PD		
Normal	17	77.3
Satisfactory	5	22.7
Neuroma		
No	21	95.5
Yes	1	4.5
Growth		
1	2	9.1
2	20	90.9
Size		
0	2	9.1
1	3	13.6
2	17	77.3
Shape		
0	2	9.1
1	12	54.5
2	8	36.4
Subjective evaluation		
Good	12	54.5
Excellent	10	45.5

and follow-up time do not seem to have any influence on sensitivity.

Table 7 presents the results between sensitivity (2PD) and age, time between injury and surgery, and follow-up time. No significant correlation was observed between sensitivity (2PD) and age, time between injury and surgery and follow-up time. A negative correlation was observed between 2PD and time between injury and surgery, i.e., the higher the 2PD value, the shorter the time between injury and surgery or vice versa.

Discussion

In traumatic fingertip injuries, the nail may be avulsed or damaged in a way that its preservation is rendered impossible in reconstruction procedures. In these cases, a temporary substitute can be used to protect the nail bed and the matrix until a new nail grows. An ideal replacement should be sterile, inexpensive, easily accessible, and sturdy enough to protect the fingertip from painful stimuli.

In recent decades, numerous devices have been used for this purpose.[7] A nail-shaped silicone blade was described by Zook.[8,9] However, due to the weakness of the blade, a displacement of the fold may occur if the suture is improperly positioned. Specific splints (INRO nail splint) have been described by Ogunro[10] for the treatment of nail injuries, but their cost hinders the applicability in other medical centers. Simpler substitutes, such as a portion of an X-ray film or the suture-kit envelope itself, have been used (Cohen, Dumontier). Other authors reported the use of silicone-based nasogastric tube materials or plastic syringes.[5,7] These materials are readily available and can be molded into splints for the nail bed. However, the material of the nasogastric tube is not as resistant as acrylic or metal; its durability and ability to protect the nail bed against external forces are also lower. In turn, metal or acrylic splints can cause additional injuries due to their rigidity. In the present study, a polypropylene prosthesis was used; it had features that protected the nail bed against painful stimuli and external forces, and at the same time was not so rigid as to cause residual deformities.

Transverse injuries of the distal third of the distal phalanx are usually treated with Kutler or Atasoy V-Y advancement flaps.[6,11,12] The great challenge is volar oblique injuries, which affect a large extension of the digital pulp and, unlike transverse injuries, do not allow local skin advance. For more complex cases, countless flap techniques have been described in the literature; however, there is no consensus on what would be the best for each type of injury. These flap techniques are technically difficult, and require specific skills and training. Furthermore, all techniques require a donor area of cutaneous tissue, which may come from a non traumatized region of the injured finger or another less important finger, as in the renowned Littler's flap.[4] Other areas of the hand, both volar and dorsal, may also function as donors for pedicled or random flaps. Microsurgical flaps have also been mentioned in the literature, and require even more skill and training by the specialist; moreover, they are poorly reproducible by most surgeons. The technique described in the present study is indicated to cover different types of fingertip injuries, engaging or not the nail bed.

Although grafts are a treatment option, they are not well suited for fingertip coverage, since they do not provide sensitivity and do not withstand friction, causing frequent injuries in the grafted area. The best type of healing is that performed by the body itself, called secondary intention, since it is able to restore the original properties of that segment of the finger, particularly the sensitivity, anatomical shape, and even fingerprint. This technique, which the authors described in the present study and support, provides adequate stimulation and protection so that the body can heal fingertip injuries,

Table 4 – Analysis between score and age, time between injury and surgery, and follow-up time.

	Score				*p*-Value
	≤3 M (± SD)	4 M (± SD)	5 M (± SD)	6 M (± SD)	
Age (years)	58.5 (± 9.19)	28.5 (± 3.82)	40.2 (± 14.0)	41.8 (± 14.2)	0.1
Time from injury to surgery (days)	10.7 (± 14.42)	3.5 (± 3.71)	6.0 (± 9.00)	4.0 (± 3.78)	0.97
Follow-up (months)	6.5 (± 0.7)	19.4 (± 11.3)	12.4 (± 5.51)	12.0 (± 5.38)	0.16

Kruskal–Wallis test.

Table 5 – Analysis between subjective evaluation and age, time between injury and surgery, and follow-up time.

	Evaluation Good M (± SD)	Subjective Excellent M (± SD)	*p*-Value
Age (years)	44.8 (± 13.4)	34.4 (± 13.4)	0.09
Time from injury to surgery (days)	4.2 (± 7.6)	6.7 (± 6.6)	0.22
Follow-up (months)	13.4 (± 5.5)	12.6 (± 9.0)	0.49

Mann–Whitney test.

Table 6 – Analysis between sensitivity and age, time between injury and surgery, and follow-up time.

	Sensitivity		*p*-Value
	Normal M (± SD)	Satisfactory M (± SD)	
Age (years)	41.88 (± 13.4)	34.81 (± 16.3)	0.35
Time from injury to surgery (days)	6.35 (± 9.92)	2.00 (± 1.0)	0.64
Follow-up (months)	12.24 (± 7.7)	15.8 (± 3.4)	0.12

Mann–Whitney test.

Table 7 – Correlation between sensitivity and age, time between injury and surgery, and follow-up time.

	r	*p*-Value
2PD *vs.* age	0.23	0.98
2PD *vs.* time between injury and surgery	−0.006	0.3
2PD *vs.* follow-up time	0.21	0.32

r, Spearman's correlation coefficient.

whether transverse or oblique. During the 45 days of use of the prosthesis, the body appears to react to the presence of polypropylene, producing granulation tissue in an accelerated and coordinated way, quickly re-establishing the anatomical shape of the finger. Moreover, the prosthesis protects the open area of the lesion and avoids adherence of the dressing and bleeding during the change of dressings. The authors have even observed the return of the fingerprint on the remaining digital segment.

Infections are well-described complications after finger surgery, especially in contaminated lesions or those associated with compound fractures.[2] The risk of infection increases by 13% in contaminated wounds and 40% in those severely contaminated. The most frequently observed infectious agents are *Staphylococcus aureus*, *Streptococcus*, and pseudomonas.[2] In the present study, no cases of infection were observed. The authors believe this fact may have improved patients' satisfaction regarding esthetic appearance or residual finger deformity.

Conclusion

The present study presented a new, simple, and easily reproducible technique for fingertip injuries, with satisfactory results and a low rate of complications.

Conflicts of interest

The authors declare no conflicts of interest.

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