



# Reconstruction of Distal Finger Amputations in Children with Composite Autograft and Semi-Occlusive Dressing

## *Reconstrucción en amputaciones distales de dedos en niños con injerto compuesto y vendaje semioclusivo*

Manuel Alfonso Méndez<sup>1</sup>  Daniela Aguirre<sup>2</sup>  Magdalena Méndez<sup>3</sup> 

<sup>1</sup> Department of Orthopedics and Traumatology, Pontificia Universidad Católica de Chile, Santiago, Chile

<sup>2</sup> Department of Orthopedics and Traumatology, Clínica Las Condes, Región Metropolitana, Chile

<sup>3</sup> School of Medicine, Pontificia Universidad Católica de Chile, Santiago, Chile

Address for correspondence Manuel Alfonso Méndez, MD, Pontificia Universidad Católica de Chile, Diagonal Paraguay 362, Edificio Académico, Piso 3. Santiago, Chile  
(e-mail: mendzbecerram64@gmail.com).

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### Abstract

The reconstruction of finger tip amputation in children is challenging. There are many procedures described to treat this injury, none of which present optimal results. Repositioning of the amputated segment as an autograft or with microsurgical techniques seems to offer the best outcome. It enables the preservation of otherwise irreplaceable structures, such as the nail bed and the hyponychium, thus enabling children to maintain an anatomically and functionally normal finger pulp. We present a series of three pediatric patients treated with a new technique, which combines composite autograft and semi-occlusive dressing (CASOD). The results observed so far have been promising.

### Keywords

- ▶ finger tip amputation
- ▶ children
- ▶ reconstruction

### Resumen

La reconstrucción de una amputación distal de dedo en un niño es un desafío. Los procedimientos propuestos son muchos, y los resultados no han sido buenos. La reconstrucción con reposición del segmento a modo de injerto compuesto, o con técnicas microquirúrgicas, parece ofrecer la mejor de las posibilidades, pues se conservan estructuras irremplazables, como el lecho ungueal y el hiponiquio, lo que permite que los niños mantengan un pulpejo anatómico y con función normal. Presentamos una serie de tres pacientes pediátricos tratados con una nueva técnica, que combina la reposición del segmento, como un injerto compuesto, y el uso de curación semioclusiva (*composite autograft and semi-occlusive dressing*, CASOD, en inglés). Hemos observado buenos resultados.

### Palabras clave

- ▶ amputación distal de dedos
- ▶ niños
- ▶ reconstrucción

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## Introduction

Distal finger amputation is that which occurs distal to the insertion of the deep flexor tendon, and constitutes a difficult situation to treat in children. It is also true that this is primarily an esthetic problem, and it is highly probable that it does not cause functional problems of the hand.

The mechanism of injury is almost always associated with catching the finger in a door.

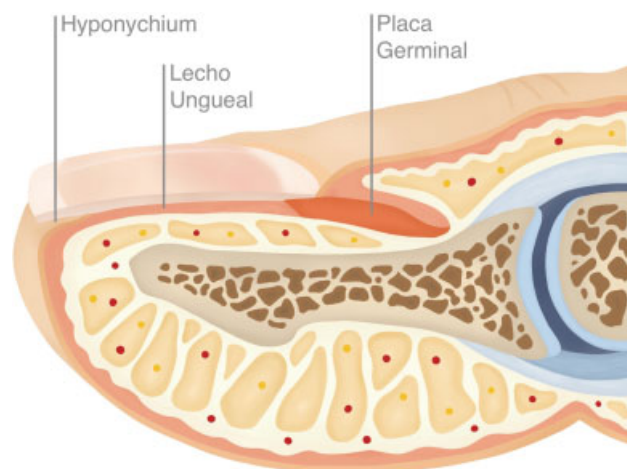
Regarding distal amputation of a finger, many have been the treatment alternatives described for the general population. Management with a semi-occlusive bandage has been considered,<sup>1</sup> as well as replacement management as a composite graft,<sup>2</sup> reconstruction with a nail apparatus graft plus a finger pulp flap,<sup>3</sup> and reimplantation with the use of microsurgical techniques.<sup>4</sup> However, the overall results in the pediatric population remain unsatisfactory.

In the case of reimplantation with microsurgical techniques, the conditions are not favorable due to the reduced diameter of the vessels, and a great amount of training is required. Attempting only to replace amputated segments as a composite graft frequently leads to fingertip deformities.<sup>5</sup> In the case of semi-occlusive bandages as an isolated technique, it never succeeds in regenerating the hyponychium.

We affirm that, in the reconstruction of these amputations, one of the critical steps is to preserve the nail bed and the hyponychium (►Fig. 1), which are irreplaceable tissues. It is true that the length of the fingertip pulp and the esthetic aspect of the finger can be achieved with an advancement or axial flap. But the conservation of the nail bed and of the hyponychium is the key to preserving the anatomy of the tip, avoiding the parrot beak deformity, hence allowing an adequate clamp and reducing the presence of wounds and infections.

Consequently, the objective of the treatment of these lesions should be to preserve the length of the finger, to provide a soft, non-painful fingertip pulp, with an adequate cosmetic appearance, and to enable an adequate distal flexion of the finger.

Considering the different proposals observed in the history of these injuries, we want to present a new alternative



**Fig. 1** Scheme of the hyponychium and nail bed.

for the treatment of distal amputations of the fingers in the pediatric population, performing reconstruction with segment replacement, as a composite graft, combining it with a semi-occlusive bandage.

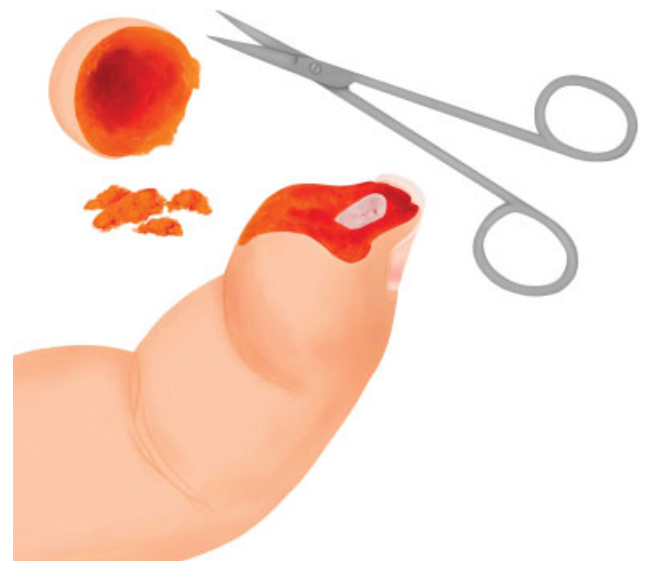
## Procedure

In the ward, under sedation and nerve block, the injured finger and the amputated fragment are cleaned with saline solution and chlorhexidine; if there is a bone component, it is not removed (►Fig. 2).

A partial resection of the fatty tissue of the amputated pulp is performed to reduce the thickness of the tissue that will be replaced (►Fig. 3). In the event that there is a bone component in the amputated part, it is fixed with a hypodermic needle, and, finally, skin stitches are placed as an approximation suture (►Fig. 4). Then, a transparent film dressing (Tegaderm Film, 3M, Saint Paul, MN, US) is placed (►Fig. 5), taking care to completely seal the finger to prevent



**Fig. 2** Scheme of a fleshy amputation.



**Fig. 3** Removal of part of the fatty tissue from the finger pulp.



**Fig. 4** Sutured composite graft.

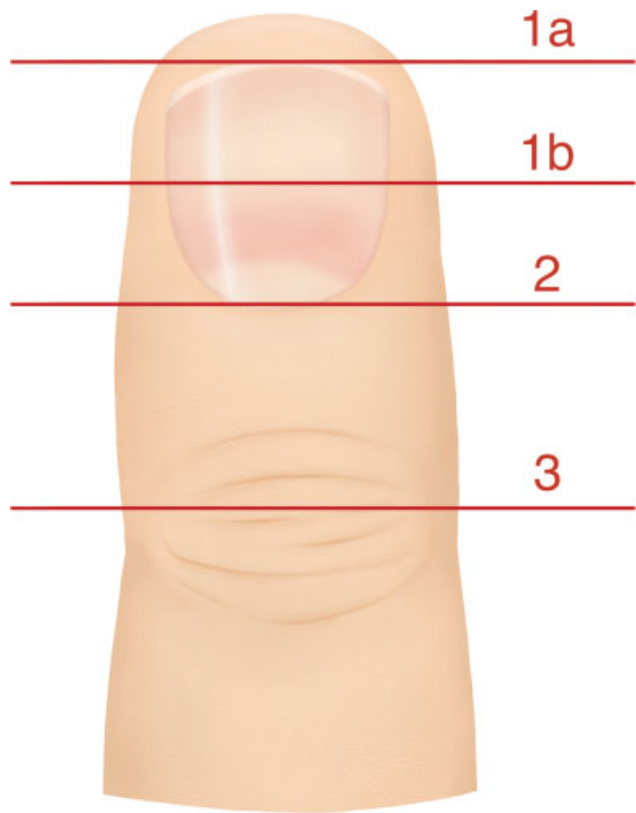


**Fig. 5** Placement of transparent film.

the leakage of liquids. After this, we must assure that the transparent film bandage enables us to observe that the finger capillary is adequately filled. The film dressing seal is removed at six weeks. The patient should be seen once a week to verify the correct sealing of the finger, the eventual presence of infections, and to warn the parents about the bad odor that may derive from the treatment. During the six weeks, the film dressing is not removed, it is only reinforced.

**Case 1**

An 18-month-old girl, with entrapment of the right ring finger in one of the hinges of a toy, who suffered an amputation of the fingertip, without bone compromise, level 1a according to the modified classification of Ishikawa et al.<sup>6</sup> (► **Fig. 6**). Her finger underwent cleaning, debridement, and composite graft reconstruction of the amputated fragment,



**Fig. 6** Modified classification of Ishikawa et al.<sup>6</sup>



**Fig. 7** Amputation of the pulp of the right ring finger with bone involvement.

and it was covered with semi-occlusive healing for six weeks. The patient presented an ad integrum recovery from the injury, without complications (► **Fig. 7, 8, 9, 10, 11**).

**Case 2**

A 9-year-old boy with an entrapment of the right index finger in the frame of a door, who suffered an amputation of the fingertip with compromise of the tuft of the distal phalanx, level 1b in the modified classification of Ishikawa et al.<sup>6</sup> He had his finger cleaned and reconstructed with composite graft, the bone fragment was fixed with a needle, and the lesion was covered with a semi-occlusive dressing (► **Fig. 12, 13, 14**).





**Fig. 8** Reconstruction of the finger pulp with composite graft.



**Fig. 9** Placement of transparent film dressing.



**Fig. 10** Control at thirteen months.

### Case 3

A 10-year-old girl, who trapped her right middle finger in a door, ended up with a level-1b fingertip amputation in the modified classification of Ishikawa et al.<sup>6</sup> We performed finger cleaning and reconstruction with a composite graft, bone fixation, and semi-occlusive dressing. The dressing was removed at six weeks (► Fig. 15, 16).



**Fig. 11** Fingertip pulp without nail deformation.



**Fig. 12** Amputation of the pulp of the right forefinger.



**Fig. 13** Reconstruction of the composite graft with the placement of a hypodermic needle to fix the bone fragment.



**Fig. 14** Appearance of the pulp at twelve months.



**Fig. 15** Amputation of the pulp of the right middle finger.

## Discussion

In the pediatric population, attempts to reconstruct a fingertip amputation have not been successful, and there is no definite proposal. Butler et al.<sup>5</sup> presented a series of 97 cases of fingertip reconstruction with the composite graft replacement technique. Only 10% had complete graft survival, and 34% partial survival. Imaizumi et al.<sup>7</sup> presented a series of 17



**Fig. 16** Appearance of the pulp at twelve months.

reconstructions of distal finger amputations in children; of these, 10 were with composite graft replacement, and 5 of them survived.

Johnson and Giele<sup>3</sup> presented a series of eight patients who underwent reconstruction with a perionychium (nail bed) graft and the use of a local flap. The four children in the series showed complete fingertip survival, with a good esthetic result.

Technically, the reconstruction of these amputations with the use of anastomosis with microsurgical techniques is a challenge, due to the reduced diameter of the vessels. Wen et al.<sup>8</sup> described a series of 21 reimplantations in the pediatric population, with 95% of implant survival. In the hands of trained teams, this technique seems to be a good solution, but it is difficult to find them in our reality, and other aspects must also be considered, such as the surgical time and the days of hospitalization that are required. Hsu et al.,<sup>4</sup> in their series of 5 fingertip reimplantations, took an average of 245 minutes per surgery, followed by 5 days of hospitalization. Imaizumi et al.<sup>7</sup> reported 137 minutes of surgery, with 6.7 days of hospitalization.

When a wound occurs, in this case, the distal amputation of a finger, the classic healing process that is activated is produced by the contraction of the edges and an epidermization of the scar tissue.<sup>9,10</sup> The semi-occlusive dressing strategy offers conditions for a different healing process to occur. Hoigné et al.<sup>1</sup> stated in their article that, in cases of distal amputation of a finger (in which the segment is not replaced), semi-occlusive dressing enables ~ 90% of the original tissue to regenerate, and they called this process "regenerative healing", in which the conditions for an inflammatory process similar to that which occurs in the embryological stages of development can be recreated,<sup>11</sup> and, in this case, regeneration would be facilitated by the "stem cells" that are found in the nail bed.<sup>12</sup> For all this to occur, the participation of the exudate that is produced has a crucial role.<sup>13</sup>

It is easy to think that in this process of amputation and tissue replacement a process of cell death occurs. And we also see that an *ad integrum* healing process of the amputated part occurs in our treatment strategy approach.

With the proposed combination of reconstruction with a composite graft and use of a semi-occlusive bandage, it is



impressive that either there was never cell death, or there was, but, by some mechanism, these cells were replaced, and we think that they repopulated an area with preserved tissue structure. It is something similar to what happens with other biological processes, such as the repopulation of neural cell tissue, in which, in the face of tissue loss, nerve grafts provide a tissue exoskeleton that leads to cell repopulation,<sup>14</sup> or as it occurs with a bone allograft, in which structural bone tissue provides support for bone cell colonization and consolidation to occur.<sup>15,16</sup>

However, we propose that, when placing the composite graft, part of the finger pulp tissue is removed, to reduce its thickness and ensure a smaller area of ischemia.

Regarding the level of amputation, there are records that indicate that, the more proximal the amputation, the higher the possibility of necrosis<sup>3</sup> (levels according to the modified scale of Ishikawa et al.<sup>6</sup>), but our series of three patients does not enable us to conclude success in relation to the level of amputation.

Age has also been described as a factor that favors the survival of the composite graft; the younger the patient, the better survival.<sup>5</sup> Our series of 3 cases is scattered, and shows an 18-month-old, a 9-year-old, and a 10-year-old patient. This factor did not affect the result.

We believe that, to achieve good esthetic and functional results in the reconstruction of distal amputations of the fingers in the pediatric population, the preservation of the nail bed and the hyponychium is a fact of great importance. This is achieved only with the anatomical preservation of the aforementioned structures, either by microsurgical procedures, or by a replacing the segment, such as with a composite graft.

In the series described in the present article, the outcome was children with a painless fingertip and able to perform the pinch movement.

The proposed technique offers another possibility in the treatment of these lesions in the pediatric population, without requiring microsurgical techniques. Thus, it opens the possibility of considering a simple and easy-to-reproduce technique.

This procedure requires more cases for validation.

#### Conflict of Interests

The authors have no conflict of interests to declare.

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