Case Report

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The use of Human Amniotic Membrane for Wound Closure after Clubfoot Release: A Case Series

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Abstract

Introduction: The use of the Ponseti technique continues to be the method of choice for the treatment of bot foot, however, in those patients with recurrence due to poor adherence to treatment, syndronics, etc. medial postero release emerges as an alternative. Several coverage techniques are described in post-release residual defects from muscle or fasciocutaneous flaps, skin-free grafting, or open defects that close by the second intention. In recent years the relevance of the use of Human Amniotic Membrane (hAM) as a substitute for dermal matrix has been described. There are two cases of closure of bilateral post-medial post-release wound defect in the recurrence of bot foot with said membrane.

Materials and Methods:

Case 1: A 2-year old boy with Moebius syndrome associated with clubfeet was treated with the Ponseti method at birth. At 2 years of age, the deformity recurred in both feet and he was again treated with serial casting and posteromedial release using the Cincinnati incision. After the procedure, complete skin coverage was not possible and the large defect was treated with hAM.

Case 2: A 10-year-old girl with arthrogryposis had bilateral clubfoot deformities treated with the Ponseti method at birth. Compliance with Ankle-Foot Orthoses (AFOs) was poor and subsequently, the treatment was abandoned. The posteromedial release was performed using the Cincinnati approach with good correction of the deformity; however, there was a severe soft-tissue defect that was treated with hAM.

Case 3: An 8-year-old boy with arthrogryposis and clubfeet. He was treated with the Ponseti method at another institution. He had a severe equinovarus deformity that was corrected with posteromedial release using the Cincinnati approach. Postoperatively, the patient had no residual deformity, but complete skin coverage was not possible, and hAM was used.

Results: All patients are currently with complete coverage, without recurrence of primary pathology.

Conclusion: The use of amniotic membrane could be an option for the closure of posteromedial post-release defects of bot foot.

Keywords: Clubfoot; Human Amniotic Membrane (hAM); Wound healing

Introduction

The treatment of choice for clubfoot is classically addressed through an orthopedic surgery approach [1], first described by Ponsenti in 1963 [2] who reported good short- and long-term results. Currently, this is still the most common method to treat idiopathic club foot.

In patients with conditions, such as neuromuscular diseases or genetic syndromes, clubfeet are generally more rigid and often associated with other abnormalities that may complicate not only the treatment but also the results with increased probabilities for recurrence.

Soft-tissue release has been described as the method of choice in recurrent syndrome-related clubfoot by different authors [3,4]. In most patients undergoing posteromedial release, primary wound closure is possible. However, wound closure is more difficult in patients with severe deformities. In these patients, complete closure with the loss of correction may be an option followed by postoperative corrective serial casting. Another option is to leave the wound open to heal by secondary intention with exposure of the bones, tendons, and neurovascular structures [5].

Different methods have been described to treat the skin defect after clubfoot release ranging from leaving the defect open for a secondary closure intent to using a free skin flap,

rotational flaps, or expanders [6], among others, each with their limitations and not entirely satisfactory.

To our knowledge, no reports have been published on the use of human Amniotic Membrane (hAM) to treat these defects.

hAM has shown to have anti-inflammatory, anti-microbial, and analgesic properties, among others. Additionally, it has little or no immunogenicity and good tissue adherence, it promotes epithelization and is a good substitute for the dermal matrix. These properties make it convenient to use in regenerative medicine. Currently, hAM is widely used to stimulate wound healing in skin lesions and burns and in ophthalmologic and urologic conditions.

The aim of this study was to report our experience with the use of hAM to cover skin defects after the posteromedial release of clubfoot in three cases.

Materials and Methods

Case 1

A 2-year-old boy with Moebius syndrome associated with clubfeet was treated with the Ponseti method at birth. At 2 years of age, the deformity recurred in both feet and he was again treated with serial casting and posteromedial release using the Cincinnati incision. After the procedure, complete skin coverage was not possible and the large defect was treated with hAM. (the time from the initial application of hAM was 6, December 2018).

Case 2

A 10-year-old girl with arthrogryposis had bilateral clubfoot deformities treated with the Ponseti method at birth. Compliance with Ankle-Foot Orthoses (AFOs) was poor and subsequently, the treatment was abandoned. The posteromedial release was performed using the Cincinnati approach with good correction of the deformity; however, there was a severe soft-tissue defect that was treated with hAM. The time from the initial application of hAM was 23, May 2018.

Case 3

An 8-year-old boy with arthrogryposis and clubfeet. He was treated with the Ponseti method at another institution. He had a severe equinovarus deformity that was corrected with posteromedial release using the Cincinnati approach. Postoperatively, the patient had no residual deformity, but complete skin coverage was not possible, and hAM was used (the time from the initial application of hAM was 18, August 2018).

All patients were treated by the same surgeon with the assistance of three advanced fellows at Hospital de Pediatría Juan P. Garrahan in Buenos Aires, Argentina.

All patients underwent posteromedial release through the Cincinnati approach. The patient was placed in a prone position under general anesthesia. After placing the foot in the correct position and confirming adequate vascularization, in all cases a severe soft-tissue coverage defect was observed that was treated with hAM.

hAM is prepared and stored at the Tissue Bank [7], of our hospital. The membrane is retrieved from donated placentas that are collected under sterile circumstances after elective cesarean deliveries. hAM collected from normal vaginal deliveries are excluded because of possible contamination. After collection, the placenta is microbiologically screened to rule out any risk of transmittable infection (bacterial, viral and fungi screening included).

In the primary processing, the hAM is mechanically separated from the placenta and carefully cleaned from any type of residuals and is placed in a nutritive medium with different antibiotics for several days. The membrane is preserved in quarantine until all necessary controls are completed.

In the secondary processing, the membrane is removed from the medium and cut into pieces of different sizes and frozen and stored for up to 5 years at -80ºC.

Prior to use, the hAM is thawed and washed carefully not to tear it. Once outside its double packaging, it is washed for 3 minutes in cold normal saline. At this stage, the tissue undergoes a second microbiological screening.

In our patients, the large defects were covered with hAM under sterile conditions in the same surgical procedure as the posteromedial release. First, the edges of the wound were approached without any skin tension or retraction of the foot to determine the actual size of the defect (**Figure 1**). In our three cases, the defect was located on the posteromedial aspect of the ankle exposing the posterior tibial neurovascular bundle.

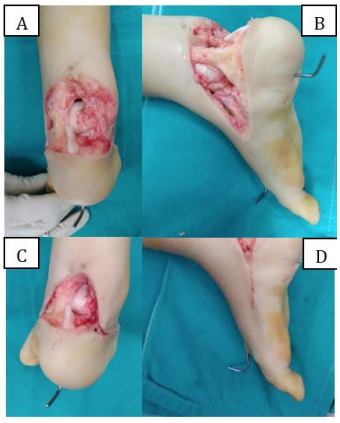

Figure 1: (A) Defect on the posterior aspect of the ankle with exposure of the Achilles tendon after release; (B) Defect on the medial aspect with exposure of the posterior tibial neurovascular bundle; (C) Definitive defect on the posterior aspect after soft-tissue closure; (D) Definitive defect on the medial aspect after soft-tissue closure.

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Once the hAM is prepared for usage, it is placed over the defect. Because of its excellent adhesion to the tissue, sutures are not necessary (**Figure 2**).

The membrane is subsequently covered with nitrofurazone. Finally, after dressing the wound in sterile gauze, a long-leg cast is placed to maintain correction of the foot.

Figure 2: (A) hAM after thawing; (B) hAM placed over the coverage defect.

Postoperative care was according to protocol. Once the patient was discharged, the first control was on postoperative day 5 for the clinical evaluation of the patient. The second control took place on day 10 with the first change of the cast and wound toilet with normal saline and special care not to remove the membrane on which nitrofurazone was again applied.

The third control took place 21 days after the surgery. The cast was changed for the second time and the Kirschner wires were removed. At this stage, the epithelization of the hAM had started (**Figure 3a**) The wound was dressed with sterile gauze and the next long-leg cast is applied.

During the fourth control, six weeks after the surgery, the cast was definitively removed. At this stage, the wound had closed and epithelization was complete or nearly complete **(Figures 3b and 4).**

Figure 3: (A) Epithelization at 21 days postop; (B) Epithelization at 6 weeks postop, after removal of the long-leg cast.

Figure 4: Long term follow up.

Discussion

The primary treatment of clubfoot is still orthopedic; however, there is a large number of clubfeet that require subsequent surgical treatment because of the recurrence of the deformity. Recurrence is more common in patients with associated conditions that make their feet more rigid. In the majority of cases, the skin can be primarily closed after posteromedial release. Nevertheless, in patients with severe deformity primary closure is often not possible and other techniques should be used to cover the defect. Some treating clinicians choose to leave the wound open using dressings and topical treatment. This technique, however, often exposes the neurovascular structures, tendons, and bones, although good results have been described without loss of correction [8].

Regarding skin grafts, autologous grafts are a problem in pediatric patients with the risk of graft failure. In 1996, Napiontek reported good results in nine feet of seven patients with autologous skin grafts transposing the excess skin on the external aspect of the foot to the internal aspect. In the two feet of the oldest child in the series, the grafts failed, but in the seven remaining feet, the wounds healed completely within 6 to 8 weeks [9].

Rockwell et al. described the use of skin allografts from a tissue bank for the closure of skin defects after posteromedial release in 13 feet. Complete epithelization was observed at 6 weeks [10]. For this procedure availability of skin, tissue bank is required. Additionally, unlike hAM, skin grafts require suturing and close follow-up.

Wound coverage with regional fasciocutaneous flaps to protect the bones, tendons and neurovascular structures have been described, as it is the method of choice to restore all the skin layers without leaving contracted scars. This method,

however, heavily depends on the remnant skin surrounding the wound, experience of the surgeon, and the complexity and duration of the surgery and is therefore difficult to perform in our patients due to the underlying diseases [11].

hAM has been used in medicine for more than 100 years [12]. In 1910, Davis was the first to apply it in the treatment of severe burns [13].

Subsequently, hAM has mainly been used in the field of ophthalmology to treat corneal ulcers as well as other eye lesions. In reconstructive urology, the membrane has been used for the treatment of urinary tract wall defects.

hAM properties

Mature hAM has a multilayer translucent biological structure measuring around 15 to 20 cm in diameter with a thickness of 0.02 to 0.03 mm without neuronal, muscular, or vascular structures [14].

The membrane has a polarized structure that separates the external-ectoderm-epithelial layer and the internal-mesoderm-mesenchymal layer [15]. It possesses more than 226 growth factors, cytokines, chemokines, protease inhibitors, and other bioactive agents capable of modulating epithelial growth [16].

hAM has angiogenic and antiangiogenic factors that are useful in ophthalmology to prevent vascularization and fibrosis of the cornea. Additionally, it has antibacterial properties that act as a physical barrier [17]. Its anti-inflammatory effect is crucial for the inhibition of the inflammatory cascade and for generating a suitable environment for the regeneration of simultaneous tissues and analgesics. hAM has low immunogenicity and can, therefore, be used in different tissues. This immunomodulating property also regulates maternal-fetal immune tolerance [13].

In Argentina, the cost of processing 1 cm^2 of hAM is $23.14. However, it is not processed by all tissue banks as it is only obtained from donations of placentas from cesarean section deliveries [3]. The cost of the processing 1 cm^2 of skin, on the other hand, is $15.40 while the procedure for hAM is not much more complicated. In addition, currently, there are difficulties to obtain adequate skin for the graft site because of the widespread use of tattoos [3].

Our study has several limitations. First, it is a report of three cases and no comparisons with other techniques were made regarding time to scarring and complications. Nevertheless, to our knowledge, this is the first report on the use of hAM in clubfoot.

Conclusion

hAM may be considered a good alternative for the treatment of skin defects after the posteromedial release of clubfoot achieving epithelization within 6 to 8 weeks without longer surgical times or loss of postoperative correction. Further studies comparing this method with other available options will confirm its usefulness in these patients.

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