

Use of hyaluronic acid-derived dermal substitute for skin reconstruction in giant omphalocele

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The management of neonates with giant omphalocele remains a challenging endeavor. Multiple management strategies have been devised and several repair techniques have been described. However, no single procedure can be considered a standard. Among silo, skin flap, and primary closure, none have been successful in treating all patients. Here we present two cases in which we used Hyalomatrix to prepare for skin grafting to repair giant omphaloceles. *Ann Pediatr Surg* 10:87–91 © 2014 Annals of Pediatric Surgery.

Introduction

Omphalocele is labeled as giant when the diameter of the abdominal wall defect is larger than 5 cm and when the sac contains the liver [1]. The prognosis of giant omphalocele (GO) depends on the presence of other associated major structural and/or chromosomal abnormalities, which are now detected antenatally [2–19].

The treatment of GO is difficult, primarily because of the disproportion between the large volume of the omphalocele and the small volume of the abdominal cavity. The management of GO presents a major challenge to pediatric surgeons.

We report two cases of GO that required delayed closure. In both cases, Hyalomatrix was used to prepare for skin grafting to repair GO [1,2].

Several studies have reported the use of Hyalomatrix for skin reconstruction in partial deep dermal burns, in scalp reconstruction, and in skin reconstruction at other sites [20–22].

Patients and methods

Our study included two cases of GO: one was 10 cm in diameter and the other was 18 cm in diameter at the time of surgery.

First case

The case was a full-term, male baby born by lower segment cesarean section on 9 March 2010. The baby had a GO of 10 × 10 cm in size that was associated with congenital feet anomalies (congenital talipes equines) and microcephaly, which was diagnosed later on as craniosynostosis.

A silo bag was applied immediately after birth and the bowels were then gradually reduced by squeezing the bag; this was carried out daily for 10 days. It only resulted in partial reduction of the bowels. Hence, the child was taken back to the operation theater on 22 March 2010. The silo bag was removed and a Gortex mesh (Gore Medical Co., USA) was applied.

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Postoperatively, the patient had heavy pseudomonas infection in the wound, which mandated change of the mesh; this was performed on 19 April 2010. This time a dual mesh was applied.

On 3 May 2010, the mesh was removed and wound debridement was performed followed by application of Hyalomatrix (Anika therapeutics, Abano teme, Italy); the Hyalomatrix was left on the wound for 2 weeks.

On 17 May 2010, skin graft was performed. The skin was meshed 1:1.5.

On 27 May 2010, patient was discharged from hospital after complete healing of the wound. He has ventral hernia, which awaits repair (Figs 1–6).

Second case

The case was a 32-week-old preterm male baby, delivered by lower segment cesarean section on 6 October 2010 due to breech presentation. The baby was a twin to a normal male baby.

Omphalocele was diagnosed during antenatal care.

After initial resuscitation, the child was taken for surgery; intraoperative evaluation showed that the patient has very small abdominal cavity, very thin recti muscles, and very thin muscles of the diaphragm with deficient areas that partly exposed the lungs. The omphalocele was huge containing liver, colon, and stomach.

A silo bag was sutured to the edges of the fascia after repair of the diaphragmatic defects.

Daily squeezing of the silo bag failed to reduce the bowels completely; hence, the silo bag was removed and a Gortex mesh was applied on 18 October 2011.

The mesh was changed on 27 October 2011; on 30 November 2011, Hyalomatrix was applied after removal of the Gortex mesh and conservative debridement of the granulation tissue that was formed as a reaction to the Gortex application.

Fig. 1



First case after birth.

Fig. 2



After application of silo bag.

On 21 December 2011, the patient was taken to the operation theater and removal of the outer silastic layer of the Hyalomatrix was performed; the dermis-like layer was already formed on the defect of $18 \times 18 \text{ cm}$ (324 cm^2) in size. The patient's thigh circumference was 100 cm^2 (about 1/3 the size of the defect); hence, meshing 1:3 was performed for the skin grafts. The skin graft was applied over the defect and a tie-over dressing was performed using silver dressing (Aquacell Silver; Conva Tec., UK). The skin graft survived well.

Extubation of the child was carried out 1 week post-operatively, but he kept on desiderating and needed reintubation and assisted ventilation.

On 17 February 2012, the patient suffered a cardiac arrest. Resuscitation was not successful and the patient died. The primary reason for death was respiratory failure (Figs 7–15).

Fig. 3



After removal of the Gortex mesh.

Fig. 4



Application of Hyalomatrix.

Fig. 5



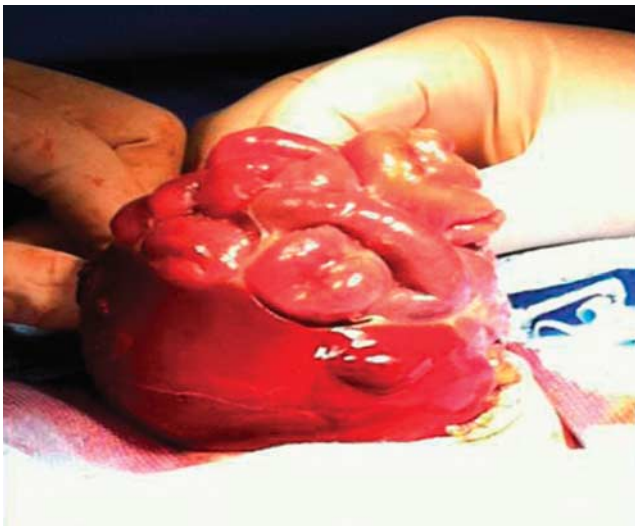
Skin graft after removal of the outer layer of the Hyalomatrix.

Fig. 6



The patient at 2-year follow-up.

Fig. 7



Just after birth with a giant omphalocele.

Discussion

Yamagishi *et al.* [14] reported the management of one case of ruptured GO that was first treated with application of a silo bag for 3 weeks followed by application of vicryl mesh for 2 weeks, and finally meshed split thickness skin graft was applied. After 2 weeks, the skin was fully reconstructed. The child died at the age of 8 months because of respiratory insufficiency. Yamagishi *et al.* [14] considered their steps of management as a standard protocol for the treatment of GO and gastroschisis.

In our study, we used silo bag for 3 weeks, followed by application of Gortex mesh for 2 weeks then application of Hyalomatrix, and finally meshed split thickness skin graft.

What is Hyalomatrix?

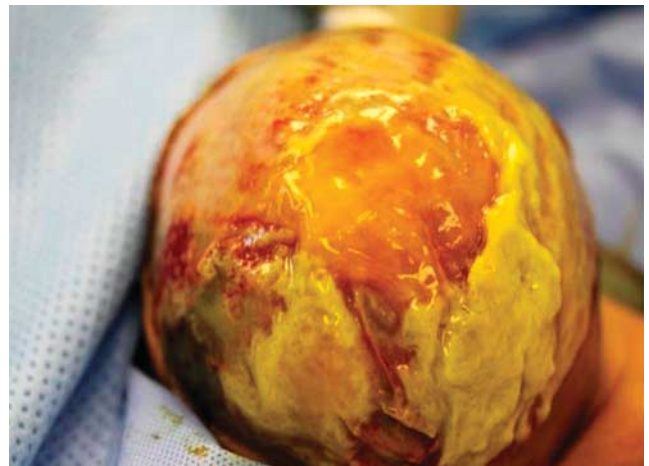
The main role of hyaluronic acid in wound healing is as follows:

Fig. 8



Application of a Gortex mesh.

Fig. 9



After removal of the Gortex mesh, heavy exudates covering granulation tissue.

Fig. 10



After debridement of the wound.

Fig. 11



Application of Hyalomatrix.

Fig. 12



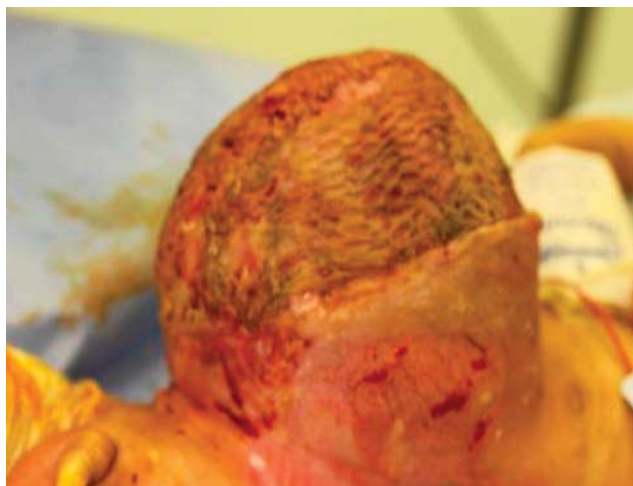
After removal of the outer layer of Hyalomatrix, dermis-like layer is formed.

Fig. 13



Meshed skin graft 1 : 3.

Fig. 14



Early postskin graft.

Fig. 15



Final picture showing full-skin reconstruction.

- (1) stimulation of the migration of phagocytotic cells;
- (2) stimulation of the proliferation of fibroblasts and keratinocytes; and
- (3) promotion of angiogenesis [20].

Esterification of hyaluronic acid with benzyl alcohol is used to obtain Hyaff – an ester of hyaluronic acid used in Hyalomatrix production [21].

When Hyaff comes into contact with exudates, it jellifies and creates an environment favorable to wound healing and to the orderly deposition of collagenous fibers [22].

Hyalomatrix is a skin substitute composed of two layers:

- (1) The inner layer is a three-dimensional dermis-like matrix consisting of fibers of a hyaluronic acid ester called Hyaff. It is in the form of scaffold, which lies under the outer layer.

- (2) The outer layer is a flexible and transparent elastomeric film that operates as a semipermeable barrier to external agents. The transparency of the elastomeric film makes it possible to monitor the evolution of the underlying wound without removing the medication.

Conclusion

We used our technique in two patients:

- (1) The first patient is still alive at more than 2 years of follow-up, and he was operated upon for craniosynostosis. Now, he is ready for abdominal wall reconstruction and hernia closure.
- (2) The second patient died at an age older than 3 months because of respiratory failure.

From our experience with the above-mentioned two cases, we reached a conclusion that, for operative treatment of major omphalocele and to avoid abdominal compartment syndrome, we can consider the steps used in these two cases (silo followed by application of Gortex mesh, which will initiate formation of granulation tissue, followed by application of one of the dermal substitute (Hyalomatrix) that will initiate a dermis-like layer on which thin split thickness skin graft is applied as a last stage) as another alternative of treatment of these very complex cases that will end in full-skin reconstruction.

The resulting ventral hernia could be corrected at a later time when the abdominal cavity is fully developed.

The morbidity and mortality of the GO depends mainly on the other chromosomal anomalies and associated syndromes, mainly related to pulmonary hypoplasia.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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