

The Ideal Scaffold for Treating Full-Thickness Wounds of the Lower Extremity

Bryon McKenna, DPM^a, N. Jake Summers, DPM^{b,*}

KEYWORDS

• Amnion • Amniotic membrane • Full-thickness • Scaffold • Wounds

KEY POINTS

- Amnion-chorion tissue is an ideal scaffold for lower extremity wounds given the growth factors and protein matrix that are present.
- Use of these products is not a new concept, it was first published in the early twentieth century; however, there have been significant improvements in the safety and packaging of the tissue.
- Research has shown that using amnion in nonhealing wounds significantly improves the rate of healing and chance of complete healing.
- More research is needed comparing the different types of tissue or products.

INTRODUCTION

Amniotic tissue has been in use for chronic wounds, skin transplants, and burns since the early twentieth century when Drs Sabella,¹ Davis,² and Stern³ first published on transplanting fresh amniotic tissue immediately following birth to chronic wounds and burns with pronounced response. Drs Stern and Sabella worked together performing their research; however, they published their data separately. They both harvested tissue immediately following a birth, harvesting amniotic tissue from the umbilical cord directly adjacent to the fetal tissue. They began applying the harvested amniotic tissue to wounds to aid in healing and both advocated for a wax dressing to keep the tissue in place on the wound after application. Early studies showed improved wound healing, reduced pain,⁴⁻⁶ reduced fluid loss,^{7,8} and reduced infection rates.^{9,10} Initial utilization was performed in acute and burn wounds; however, in the late twentieth century, amniotic tissue was shown to be beneficial for treating chronic,

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^a Department of Surgery, Mount Auburn Hospital, 330 Mount Auburn Street, Cambridge, MA 02138, USA; ^b Dartmouth-Hitchcock, Foot and Ankle/Podiatry, 25 South River Road, Bedford, NH 03110, USA

* Corresponding author.

E-mail address: n.jake.summers@hitchcock.org

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nonhealing wounds.^{11,12} The utilization and application of amniotic tissue to wounds is not a new concept; however, the availability and new applications of the products have significantly improved in recent years. The advancements are a result of new processing procedures that have allowed companies the ability to preserve the products, allowing greater availability to physicians and their patients, as well as new research evaluating the use of amniotic tissue for new purposes.

BIOCHEMICAL PROPERTIES

Harvested fetal tissue is divided into 2 components: chorionic tissue (outer layer) and amniotic tissue (inner layer). The amniotic layer is the focus of this article and has been the primary focus of most research in this area. The amniotic layer is unique in that it does not contain any blood vessels, muscle fibers, lymphatic tissues, or nerves. The function of the amniotic tissue in fetal development is to regulate the amniotic fluid and the rest of the fetal environment.¹³ The amnion is divided into 5 unique layers: epithelium, basement membrane, compact layer, fibroblast layer, and spongy (intermediate) layer.¹⁴ The basement membrane is composed of collagens III and IV and glycoproteins, including laminin, nidogen, and fibronectin, and is noted to be a thin layer immediately deep to the epithelium.¹⁵ The compact layer forms the main fibrous support of the amnion, composed of collagens I and III, forming bundles, and collagens V and VI, forming filamentous connections to the basement membrane.¹⁵ The thickest layer is the fibroblast layer and is composed of nonfibrillar meshwork of collagen III and proteoglycans and glycoproteins¹⁴ (Table 1).

In the 1980s and 1990s, surgeons observed that fetuses that had undergone surgical procedures were born without scar formation or inflammation.¹⁶ This discovery led to an influx of research about amniotic tissue and the potential use for wounds and other injuries. Research has shown that amnion has an increased concentration of certain factors that propagate wound healing without scar formation and limit inflammation without inhibiting it completely. It is important to realize that the inflammatory phase of healing is a critical step; however, preventing chronic inflammation or overactivity of the inflammatory cascade is critical for wound healing. Hao and colleagues¹⁷ evaluated the concentration of certain cytokines in amnion tissue,

Amnion Layer	Components
Epithelium	Epithelium
Basement membrane	Collagen III and IV Glycoproteins laminin, nidogen, and fibronectin
Compact layer	Collagen I and III Collagen V and VI
Fibroblast layer	Collagen III Proteoglycans Glycoproteins
Spongy (intermediate) layer	

Each layer plays a unique role important to the purpose of the amnion in the fetal development. The chorion is connected to the amnion at the spongy (intermediate) layer and is significantly thicker than the amnion.

Data from John T. Human amniotic membrane transplantation: past, present and future. *Ophthalmol Clin North Am* 2003;16:43–65; and Niknejad H, Peirovi H, Jorjani M, et al. Properties of the amniotic membrane for potential use in tissue engineering. *Eur Cell Mater* 2008;15:88–99.

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