ALLOSOURCE®

ALLOMEND® ACELLULAR DERMAL MATRIX BASIC SCIENCE SUMMARY

AlloSource, Centennial, CO

AlloMend® Acellular Dermal Matrix Basic Science Summary

INTRODUCTION

This paper presents a summary of scientific studies completed to evaluate various properties of AlloMend Acellular Dermal Matrix (ADM) human tissue (AlloSource®, Centennial, CO). This compilation of data can be considered when choosing to use AlloMend for applications such as: general reconstruction, tendon augmentation, rotator cuff repair and reconstruction, abdominal wall reconstruction/hernia repair, and pelvic organ prolapse repair, among others.[1] AlloSource's comprehensive scientific evidence papers can be found at allosource.org/products/allomend.

The following physical properties of AlloMend are addressed in this paper:

- Surface Area Coverage and Fluid Egress Properties[1]
- Incorporation and Biocompatibility Results[2]
- Suture Retention Strength[3]
- Ultimate Tensile Strength[4]
- Growth Factor Content[5]

SURFACE AREA COVERAGE AND FLUID EGRESS PROPERTIES

Acellular dermal matrix tissue can either be meshed (i.e., cutting slits) or perforated (i.e., stamping small holes). The surface area resulting from these patterns differs due to the additional surface area exposed inside slits or holes. Meshing, as compared to perforating, does not remove tissue, thus increasing the surface area allowing for greater contact area between the tissue and the surgical site. This may lead to more rapid vascularization and faster patient recovery.[6] In addition, meshing or perforating tissue is beneficial to enhance anatomical conformability.

AlloSource evaluated the surface area of three patterns (**Figure 1**):

- Perforated Pattern #1 – representative of commonly used commercial allograft
- Perforated Pattern #2 – representative of a double perforation density pattern (not represented in Figure #1)
- Meshed Pattern #3 – AlloMend ADM, in a 1:1 configuration

Results showed that meshing increased tissue surface area by 97.5%, whereas the perforated tissue patterns increased surface area by less than 1%.

In applications where fluid egress (or flow through the tissue) is desired, meshing or perforating ADM tissue is beneficial to potentially reduce the risk of seroma, which has been shown in some clinical studies to slow vascular ingrowth and postpone integration of the allograft.[7,8]

AlloSource compared the fluid egress properties of perforated ADM tissue (Patterns #1 and #2) to standard meshed AlloMend ADM tissue (Pattern #3).[1] The same three patterns were evaluated, as mentioned previously with the surface area testing.

Meshed tissue had an average drain time, correlating to fluid egress of 5.3 times faster than perforated Pattern #1 and 3.3 times the drain time of Pattern #2 (**Table 1**). Thus, a meshed ADM appears to significantly improve the fluid egress properties compared to perforated tissue.

PATTERN	AVERAGE TIME	STANDARD DEVIATION	95% CONFIDENCE INTERVAL
Perforated #1	10.369 seconds	1.598 seconds	(9.189, 11.549)
Perforated #2	6.504 seconds	1.273 seconds	(5.324, 7.683)
Meshed #3	1.974 seconds	1.157 seconds	(0.795, 3.154)

Table 1: *Drain time for meshed and perforated ADM*

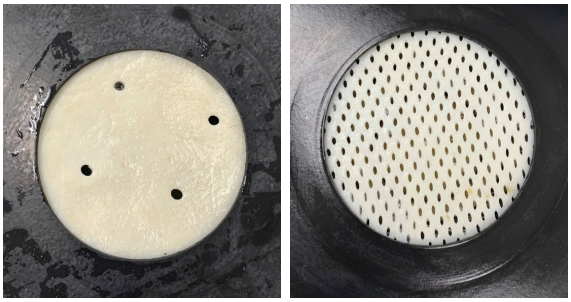


Figure 1. *Photos of perforated pattern #1 (left) and meshed Pattern #3 (right). Note – perforated pattern #2 had twice the perforation density of pattern #1.*

INCORPORATION AND BIOCOMPATIBILITY RESULTS

AlloMend undergoes decellularization through a proprietary process called DermaTrue™. The DermaTrue Decellularization Process renders the tissue acellular (including the removal of cellular debris, such as DNA, RNA and antigens, contributing to a low host immunogenic response. Detergents or enzymes are not used as part of the decellularization process. The process is non-cytotoxic and retains the tissue's biomechanical properties. **Figures 2** and **3** show AlloMend ADM implantation at two and 12 weeks, respectively, in an animal model. Results showed tissue incorporation and blood vessel infiltration. There was no tissue rejection or infection noted, thus demonstrating biocompatibility. In addition, there was no discernible impact on metabolism and animal development, subsequent to implantation.[2]

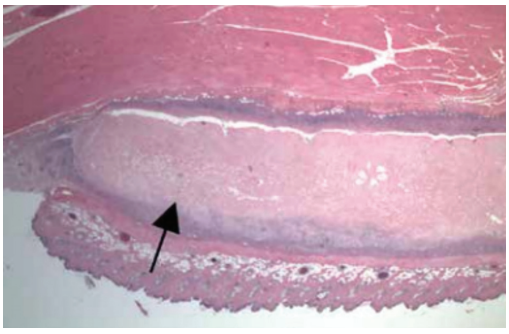


Figure 2. *Allograft Implantation (arrow) at two weeks*

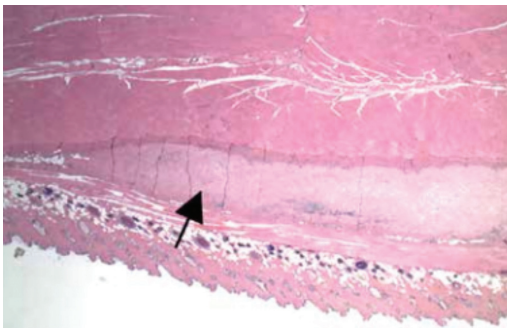


Figure 3. *Demonstrates tissue incorporation and blood vessel infiltration (arrow) at 12 weeks*

SUTURE RETENTION STRENGTH

Suture retention strength is the maximum suture pull force that a tissue can withstand before the suture tears through the tissue. Testing was conducted on four AlloMend ADM non-meshed tissue thickness configurations: 0.5–1.0 mm, 1.0–2.0 mm, 2.0–3.0 mm and 3.0–4.0 mm (measured 1.0 cm from the tissue's edge). Results were expressed in Newtons per millimeter (N/mm).[3]

Suture retention strength was shown to correlate with allograft thickness (**Table 2**). Various brands of 2-0 sutures exhibit mechanical strength between 69 and 125 N.[9] The AlloMend ADM non-meshed 1.0–2.0 mm thickness allograft exhibited a pullout strength between 61 and 123 N, which means that the tissue can be expected to be as strong as a FiberWire® 2-0 suture.[3]

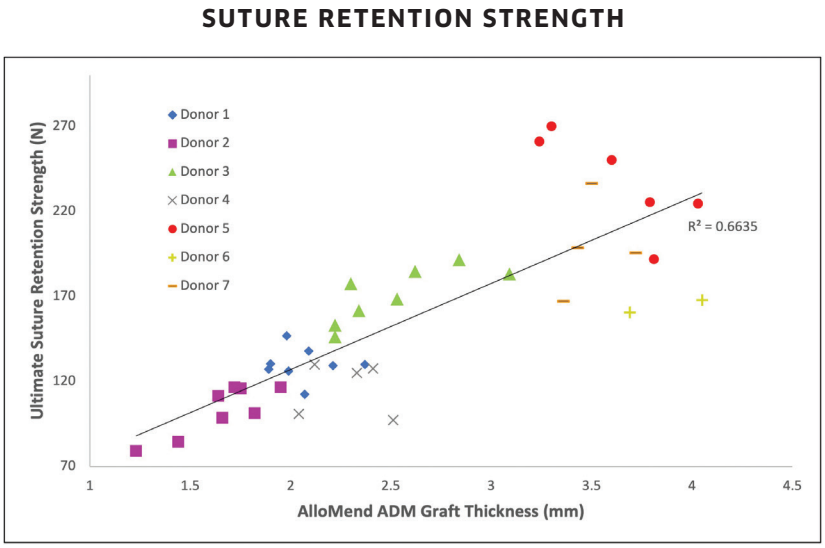
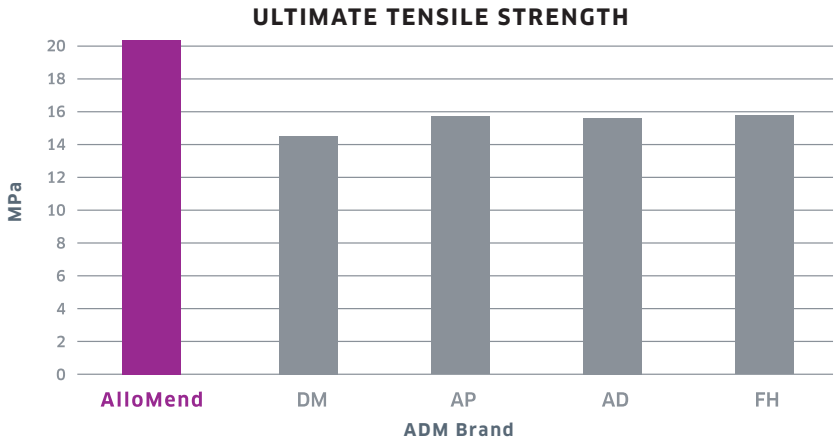


Table 2. *Relationship between allograft thickness and suture pullout*

ULTIMATE TENSILE STRENGTH

The ultimate tensile strength (UTS) of a biomaterial is the maximum stress or strain it can withstand while being stretched or pulled to the point of breaking or failing.[4] Ultimate tensile strength is measured in megapascals (MPa). One MPa is the equivalent of one Newton per square millimeter (N/mm^2) of tissue.

AlloMend ADM non-meshed allografts exhibited an UTS of 20.7 MPa ± 2.2. AlloMend surpassed published UTS data for other ADM products as shown in **Table 3**.



DM: DermaMatrix Acellular Dermis (Synthes)

AP: AlloPatch HD Acellular Human Dermis (MTF)

AD: AlloDerm Freeze-Dried Acellular Dermal Matrix Graft (LifeCell)

FH: FlexHD Acellular Hydrated Dermis (Ethicon)

Table 3. *Comparison of ADM products' ultimate tensile strength (based on published data on file)*

GROWTH FACTOR CONTENT

AlloMend was evaluated for the presence of four growth factors that have been shown to play an important role in the healing process: bFGF, PDGFbb, TGF-β, and BMP2. The presence of these native growth factors was found to be retained in the AlloMend ADM product.[5] Growth factors have been shown, in some studies, to help with the coordination of cellular incorporation, proper bone attachment and proper differentiation of cells. In addition, growth factors can prevent inflammation and necrosis at the implantation site.[10,11]

Table 4 outlines the major growth factors shown to be present in AlloMend ADM, using ELISA assay testing, as well as the potential function of each growth factor as shown in the literature.

	Potential Function of Growth Factor as Noted in the Literature*
Fibroblast Growth Factor (bFGF)[9,10,11]	Has been shown to promote angiogenesis, granulation, and epithelialization via host endothelial cell, fibroblast, and keratinocyte migration. This can assist with inducing tissue remodeling, wound healing, and neovascularization.
Platelet Derived Growth Factor (PDGFbb)[10,11,12,13]	Has been shown to attract macrophages and fibroblasts to the injury site which may reduce inflammation and enhance the cascade of tissue repair. Promotes collagen and proteoglycan synthesis which may reduce scarring.
Transforming Growth Factor (TGF-β)[11,13,14]	TGF-β is involved in many aspects of the healing process and works in conjunction with other growth factors such as PDGF to promote collagen production. It has also been shown to promote angiogenesis and may prevent inflammation due to the recruitment of macrophages to the injury site.
Bone Morphogenic Protein 2 (BMP2)[15,16]	BMP2 has shown involvement in various phases of wound repair including immune response modulation. It has also shown potential in bone, tendon-like tissue, and epithelial repair.

Table 4: *AlloMend ADM growth factors and function of each growth factor*

**AlloMend is a 361 human cell, tissue, and cellular and tissue-based product (HCT/P). Growth factors retained are from the native dermis. Growth factors were not quantified or evaluated for clinical effectiveness in this study.*

CONCLUSION

AlloMend Acellular Dermal Matrix was evaluated for various attributes: surface area, fluid egress, incorporation and biocompatibility, suture retention strength, ultimate tensile strength and growth factors. The results demonstrate that AlloMend ADM retains native properties, such as strength and growth factors post decellularization, which allow for biocompatibility of the implant which may be beneficial for a variety of clinical applications.

REFERENCES

1. Blume L, Sakthivel R. The biomechanical properties of meshed AlloMend acellular dermal matrix: fluid egress and surface area. AlloSource White Paper. 2019;00149-LIT [001].
2. Stilwell R, Delaney R. The biomechanics of AlloMend acellular dermal matrix: biocompatibility study. AlloSource White Paper. 2018;00088-LIT [001].
3. Stilwell R, Delaney R, Castillo L. The biomechanics of AlloMend acellular dermal matrix: Suture retention strength. AlloSource White Paper. 2020;00078-LIT [002].
4. Steven PJ, Stilwell R, Castillo L. The biomechanics of AlloMend acellular dermal matrix: Ultimate tensile strength. AlloSource White Paper. 2020;00048-LIT [002].
5. Delaney, R, Stilwell R. The Biologic Properties of AlloMend Acellular Dermal Matrix: Growth Factor Study. AlloSource White Paper. 2016;00104-LIT [001].
6. Nissen NN, Polverini PJ, Gamelli RL, DiPietro LA. Basic fibroblast growth factor mediates angiogenicactivity in early surgical wounds. *Surgery*. 1996;119(4):457 – 65
7. Caputo GG, Franchini Z, Maritan M, Pozza ED, et al. Daily serum collection after acellular dermal matrix-assisted breast reconstruction. *Arch Plast Surg*. 2015;42:321 – 26.
8. Brzezienski MA, Jarrell JA 4th, Mooty RC, Brzezinski MA, et al. Classification and management of seromas in immediate breast reconstruction using the tissue expander and acellular dermal matrix technique. *Ann Plast Surg*. 2013;70:488 – 492.
9. Gerber C, Schneeberger AG, Beck M, Schlegel U. Mechanical strength of repairs of the rotator cuff. *J Bone Joint Surg*. 1994;76(3):371 – 80.
10. Wang HJ, Wan HL, Yang TS, Wang DS, et al. Acceleration of skin graft healing by growth factors. *Burns*. 1996;22(1):10 – 14.
11. Ching YH, Sutton TL, Pierpont YN, Robson MC, et al. The use of growth factors and other humoral agents to accelerate and enhance burn wound healing. *Eplasty*. 2011;11:e41.
12. Akita S, Akino K, Hirano A. Basic fibroblast growth factor in scarless wound healing. *Adv Wound Care (New Rochelle)*. 2013;2(2):44 – 49.
13. Pakyari M, Farrokhi A, Maharlooei MK, Ghahary A. Critical role of transforming growth factor beta in different phases of wound healing. *Advances in Wound Care*. 2013;2(5):215 – 225
14. Heldin CH, Westermark B. Mechanism of action and in vivo role of platelet-derived growth factor. *Physiol Rev*. 1999;79(4):1283 – 1316.
15. Klatte-Schulz F, Pauly S, Scheibel M, Greiner S, et al. Characteristics and stimulation potential with BMP-2 and BMP-7 of tenocyte-like cells isolated from the rotator cuff of female donors. *PLoS One*. 2013;8(6):e67209.
16. Moura J, da Silva L, Cruz MT, Carvalho E. Molecular and cellular mechanisms of bone morphogenetic proteins and activins in the skin: potential benefits for wound healing. *Arch Dermatol Res*. 2013;305(7):557 – 69.

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