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Application of a New Vascular Graft in Replacing Diseased Blood Vessels: The Amniotic Membrane and its Stem Cells

Mahsa Khayat-Khoei*

Department of Obstetrics and Gynecology, University of Texas Health Science Center at Houston, Houston, TX, USA

As we age, the risk of developing vascular disease increases which requires replacement of the damaged vessel for which several different treatment approaches exist. Even though autologous graft is still the mainstay of therapy, alternative methods such as allografts or prosthetic grafts are used for the patients who do not have suitable vessel that can be used for grafting. There are several problems with using these alternative methods such as high immunogenicity of allogenic grafts [1] and the low capacity of prosthetic grafts to remodel and fit in the human tissue as well as risks of infection, stenosis and thrombosis [2]. These shortcomings have led to a continuous research in the field aimed at seeking alternatives.

Among the new therapeutic methods that have recently been evaluated, the Amniotic Membrane has reported to show unique capacities that can make it a perfect candidate for vascular grafting. This biologic membrane has several specifics that we aim to summarize in this report.

The human placenta has been used for centuries in regenerative medicine and wound healing procedures and recently it is proven that the Amniotic Membrane might be the key contributor of the medical benefits the placenta has [3]. The Amniotic Membrane (AM) is part of the human placenta located closest to the fetus and has special characteristics that make this membrane suitable for use in vascular tissue engineering. The AM consists of a single layer of Amniotic Epithelial Stem Cells (AESCs) on a thick basement membrane, and Amniotic Mesenchymal Stem Cells (AMSCs) in an avascular stroma [4] Collagen types III, IV, and V and noncollagenous glycoproteins, including nidogen, laminin, and fibronectin shape the thick basement membrane of the AM. Presence of these factors in the basement membrane of the AM, turns this membrane into a scaffold that can allow seeding and growth of many types of cells, such as epithelial progenitor and endothelial cells that are critical for stopping intrinsic thrombogenicity and creating a successful vascular graft [5]. The importance is in the AM native ability to allow seeding of endothelial cells which can halt thrombogenicity. This is a phenomenon that we cannot see in prosthetic graft implantation [2]. Compared to synthetic materials that need adhesive coating to allow attachment of endothelial cells to the graft lumen, the AM has no need to be coated with an adhesive and can natively support cell adhesion.

Attached to the thick basement membrane, the Amniotic Membrane has two different types of pluripotent stem cells that have shown to contribute to unique properties of this membrane. The AESC have pro-apoptotic and anti-angiogenic capacities that can be applicable in controlling cancer, making the AM a non-tumorigenic tissue and therefore safe for grafting as a vascular substitute [6-8]. The Amniotic Membrane has immunoregulatory, pro-apoptotic and anti-angiogenic [6,7] as well as anti-fibrosis, anti-microbial, and low immunogenicity properties [9] and provides an anatomically, physiologically and immunologically privileged space for the growing fetus. The anti microbial capacities of the AM is due to the AESCs ability to produce beta-defensins, the major group of antimicrobial peptides expressed at mucosal surfaces by epithelial cells [10]. Furthermore secretory leukocyte proteinase inhibitor and elafin are produced by the AM to protect it from infection and inflammation [11].

The anti-inflammatory properties of the AM can help in overcoming one of the main pathologic features of graft rejection which is the Inflammatory changes following activation and infiltration of monocytes [12]. In a study done by Peirovi et al, the AM was used as graft in the external jugular vein of sheep and no sign of inflammation was reported [13]. The anti-inflammatory properties of the AM can be attributable to the markedly suppression of highly potent pro-inflammatory cytokines (interleukin-1 alpha and interleukin-1 beta) by the AM stromal matrix as well as production of natural inhibitors of matrix metalloproteases (MMPs) by the AM [14]. MMPs are expressed by infiltrating polymorphonuclear cells and macrophages and have inflammatory effects even in cancers [15].

In summary, the AM is an immune-privileged tissue with very low risk of rejection and is a potent source of natural antimicrobial and anti-inflammatory agents that can help in limiting infection and other major side effects after grafting. Considering the AM capacity in native vascular graft endothelialization to limit thrombogenicity, and the fact that it is a biologic tissue readily available at a lower cost than prosthetic grafts, we can conclude that the AM can be a superior alternative to synthetic grafts for treating vascular diseases.

References

1. Swartz DD, Russell JA, Andreadis ST (2005) Engineering of fibrin-based functional and implantable small-diameter blood vessels. Am J Physiol Heart Circ Physiol 288: 451- 460.
2. Seifalian AM, Tiwari A, Hamilton G, Salacinski HJ (2002) Improving the clinical patency of prosthetic vascular and coronary bypass grafts: the role of seeding and tissue engineering. Artif Organs 26: 307-320.
3. Silini AR, Cargnoni A, Magatti M, Pianta S, Parolini O (2015) The long path of human placenta,and its derivatives, in regenerative medicine. Front Bioeng Biotechnol 3: 162.
4. Niknejad H, Paeini-Vayghan G, Tehrani FA, Khayat-Khoei M, Peirovi H (2013) Side dependent effects of the human amnion on angiogenesis. Placenta 34: 340-350.
5. Niknejad H, Peirovi H, Jorjani M, Ahmadiani A, Ghanavi J, Seifalian, et al. (2008) Properties of the amniotic membrane for potential use in tissue engineering. Eur Cell Mater 29: 88-99.
6. Khayat-Khoei M (2015) Role of Stem Cells in the Anti-tumor Effects of the Human Amniotic Membrane. J Cytol Histol 6: e117.
7. Niknejad H, Khayat-Khoei M, Peirovi H, Abolghasemi H (2014) Human amniotic epithelial cells induce apoptosis of cancer cells: a new antitumor therapeutic strategy. Cytotherapy.16: 33–40.

***Corresponding author:** Mahsa Khayat-Khoei, Department of Obstetrics and Gynecology, University of Texas Health Science Center at Houston, Houston, USA, Tel: 1 713-500-4472; E-mail: mahsa.khoei@dr.com

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8. Islam R, Asaduzzaman SM, Rahman MS, Rahman S (2015) Properties and Therapeutic Potential of Human Amniotic Membrane. Asian Journal of Dermatology 7: 1-12.

9. Seo JH, Kim Y, Kim J (2008) Properties of the amniotic membrane may be applicable in cancer therapy. Med Hypotheses 70: 812-840.

10. King AE, Paltoo A, Kelly RW, Sallenave JM, Bocking AD (2007) Expression of natural antimicrobials by human placenta and fetal membranes. Placenta 28: 161-169.

11. King AE, Critchley HO, Sallenave JM, Kelly RW (2003) Elafin in human endometrium: an antiprotease and antimicrobial molecule expressed during menstruation. J Clin Endocrinol Metab. 88 : 4426-4431.

12. Tatewaki H, Egashira K, Kimura S, Nishida T, Morita S, et al. (2007) Blockade of monocyte chemoattractant protein-1 by adenoviral gene transfer inhibits experimental vein graft neointimal formation. J Vasc Surg 45: 1236-1243.

13. Peirovi H, Rezvani N, Hajinasrollah M, Mohammadi SS, Niknejad H (2012) Implantation of amniotic membrane as a vascular substitute in the external jugular vein of juvenile sheep. J Vasc Surg 56: 1098-1104.

14. Hao Y, Ma MD, Hwang DG, Kim WS, Zhang F (2000) Identification of antiangiogenic and antiinflammatory proteins in human amniotic membrane. Cornea 19: 348-352.

15. Niknejad H, Khayat-Khoei M, Peirovi H (2012) Inhibition of MMPs might increase anticancer properties of amniotic epithelial cells. Med Hypotheses 78: 690-691.