Viabilidad del adipocito asociado al uso de ácido tranexámico: efecto en la neovascularización, adaptabilidad y citomorfología adipocítica.

Presenta:

Arturo Contreras Ríos

Código estudiantil:

2020113422970

Trabajo de Investigación presentado como requisito para optar el título de:
Especialista en Cirugía Plástica, Reconstructiva y Estética

Tutor:
Juan Miguel Martínez Castilla

RESUMEN

Introducción: El ácido tranexámico (ATX) es un fármaco antifibrinolítico sintético, accesible y económico, aprobado para la administración intravenosa, tópica y oral, utilizado principalmente para reducir el sangrado y favorecer la hemostasia. Sin embargo, los efectos de impregnación del (AXT) en el tejido adiposo no se han estudiado.

Objetivo: Evaluar el efecto de diferentes dosis de impregnación con ATX in vitro, en muestras de tejido adiposo a través del estudio histológico por medio de microscopía óptica sobre la viabilidad, neovascularización, adaptación y citomorfología adipocítica.

Metodología: Las muestras de tejido adiposo fueron obtenidas por escisión en bloque de abdominoplastia fijadas con formol y teñidas con la técnica de Hematoxilina-Eosina (H-E). Se realizó análisis histológico para comparar la muestra control con las muestras tratadas con ATX a 50, 100 y 500 mg.

Conclusiones: A las concentraciones más altas de 100-500mg se observó la morfología del adipocito preservado con aumento de capilares y cantidad menor de tejido fibroconectivo. La preservación de la citoestructura, integración y la funcionalidad del adipocito resulta esencial para lograr resultados regenerativos, reconstructivos y estéticos óptimos y seguros.

Palabras clave. Ácido Tranexámico, Adipocito, injerto de adipocitos, viabilidad

ABSTRACT

Introduction: Tranexamic acid (TXA) is an approved, cost-effective synthetic antifibrinolytic agent. It has been widely used both intravenously and orally as a systemic prophylactic treatment, reducing bleeding and the need for blood transfusions by 30% to 40%. However, its application in fat grafting procedures has not been studied, highlighting the need to evaluate its viability in this context.

Objectives: To assess, through histological analysis, the effects and viability of adipose tissue in association with the use of TXA in vitro.

Methodology: Dermo-adipose tissue samples were obtained via block excision during abdominoplasty. Histological analysis will involve the comparison of control samples and samples treated with tranexamic acid at 50, 100 & 500 mg previously fixed with formol

Conclusions: At the highest concentration, preservation of adipose tissue was observed, with cytomorphological integrity of adipocytes and evidence of focal vascular proliferation. These findings suggest that ATX is a safe and effective option not only for minimizing bleeding, but also for promoting adipocyte viability and integration.

Keywords: Fat grafting, tranexamic acid, adipocyte, viability.

REFERENCIAS BIBLIOGRÁFICAS

1. Bircoll M. Autologous fat transplantation. Ann Plast Surg. 1987;18(3):263-5.
2. Matsumoto D, Sato K, Gonda K, Takaki Y, Shigeura T, Sato T, et al. Cell-Assisted Lipotransfer: Supportive Use of Human Adipose-Derived Cells for Soft Tissue Augmentation with Lipoinjection. Tissue Eng. 2006;12(12):3375-82. doi: 10.1089/ten.2006.12.3375.
3. Zuk PA, Zhu M, Mizuno H, Huang J, Futrell JW, Katz AJ, et al. Multilineage differentiation of human adipose tissue-derived stem cells. Tissue Eng. 2001;7(2):211-28. doi: 10.1089/107632701300062859.
4. González-Gómez R, de la Torre-Méndez S, Ramos-Castillo JJ, Orozco-Cisneros A, Pineda-Parra J. Lipotransferencia: injerto de grasa autóloga. Cir Plast Ibero-Latinoam. 2013;39(Supl 1):S1-S12.
5. Suga H, Matsumoto D, Inoue K, Shigeura T, Sato T, Aiba-Kojima E, et al. Numerical Measurement of Viable and Nonviable Adipocytes and Other Cellular Components in Aspirated Fat Tissue. Plast Reconstr Surg. 2008;122(1):103-14. doi: 10.1097/PRS.0b013e31817742ed.
6. Meruane M, Zamora N. Lipoinyección: conceptos básicos y aplicación clínica. Rev Med Clin Condes. 2016;27(1):93-106.
7. Gutiérrez-Gómez C. Injerto de adipocitos para mejorar el contorno facial en cirugía reconstructiva utilizando cánula para bloqueo epidural. Cir Plast. 2011;21(2):85-91.
8. Toledo LS. Fat grafting. Aesthet Surg J. 2000;20(4):287-9. doi:10.1067/maj.2000.109670.
9. Mazzei FG, Merante S, Vescio F. Cell-Assisted Lipotransfer: Current Insights and Future Perspectives. Medicina (Kaunas). 2023;59(5):940. doi: 10.3390/medicina59050940.
10. Coleman SR. Structural fat grafting: more than permanent filler. Plast Reconstr Surg. 2006;118(3 Suppl):108S-120S. doi: 10.1097/01.prs.0000234610.81672.e7.
11. Hospital Universitario Fundación Jiménez Díaz. Injerto graso [Internet]. Madrid: Hospital Universitario Fundación Jiménez Díaz; [citado 2025 May 21]. Disponible en: https://www.fjd.es/es/cartera-servicios/cirugia-plastica/u-cirugia-estetica/cirugia-mujer/inj_erto-graso
12. Clínicas Cliniem. 10 preguntas frecuentes sobre la lipotransferencia. Disponible en: https://www.cliniem.com/preguntas-frecuentes-lipotransferencia/
13. Wang Y, Shi Y, Hu Y, et al. Efficacy and Safety of Platelet-Rich Plasma in Fat Grafting: A Systematic Review and Meta-Analysis of Randomized

Controlled Trials. Aesthetic Plast Surg. 2022;46(3):1414-25. doi: 10.1007/s00266-021-02688-y.

14. Tonnard P, Verpaele A, Tosun B. Nanofat grafting: a review of the literature. J Cosmet Dermatol. 2021;20(1):15-20. doi: 10.1111/jocd.13620.
15. Ferraris VA, Ferraris SP, Saha SP, Hessel EA 2nd, Fonger JD, Gravlee GP, et al. Perioperative blood transfusion and increased mortality after coronary artery bypass graft surgery. Ann Thorac Surg. 2012;93(3):704-12; discussion 712-3. doi: 10.1016/j.athoracsur.2011.11.002.
16. Levi M, Joop K. Aprotinin and other antifibrinolytic agents in cardiac surgery. Best Pract Res Clin Anaesthesiol. 2011;25(4):463-71. doi: 10.1016/j.bpa.2011.10.003.
17. Fergusson DA, Hébert PC, Mazer CB, Fremes CD, MacAdams E, Murkin JM, et al. Aprotinin in high-risk cardiac surgery. N Engl J Med. 2008;358(22):2319-31. doi: 10.1056/NEJMoa0802773.
18. Henry D, Carless P, Moxey J, O'Connell D, Webster N, et al. Anti-fibrinolytic use for minimising perioperative allogeneic blood transfusion. Cochrane Database Syst Rev. 2011;(1):CD001886. doi: 10.1002/14651858.CD001886.pub4.
19. Shigeura T, Sato T, Inoue K, Matsumoto D, Yoshimura K. Tranexamic acid in plastic surgery. Aesthetic Plast Surg. 2014;38(3):575-81. doi: 10.1007/s00266-014-0312-3.
20. CRASH-2 Trial Collaborators. Effects of tranexamic acid on death, vascular occlusive events, and transfusion requirement in trauma patients with significant haemorrhage (CRASH-2): a randomised, placebo-controlled trial. Lancet. 2010;376(9734):23-32. doi: 10.1016/S0140-6736(10)60835-5.
21. Ker K, Beecher L, Roberts I. Tranexamic acid for the prevention of bleeding in surgical patients. Cochrane Database Syst Rev. 2015;(6):CD009995. doi: 10.1002/14651858.CD009995.pub3.
22. Myles PS, Smith JA, Forbes A, Silbert B, Jayarajah K, Painter T, et al. Tranexamic Acid in Patients Undergoing Coronary-Artery Surgery. N Engl J Med. 2017;376(2):136-48. doi: 10.1056/NEJMoa1608407.
23. Kim S, Jeong J, Kim SY, Lee MJ, Jeong S, Lee S. Autologous Adipose-Derived Stem Cell Isolation and Expansion for Clinical Application: A Comprehensive Review. Int J Mol Sci. 2022;23(20):12423. doi: 10.3390/ijms232012423.
24. Lecker I, Cohn L, Hofmann A, et al. Tranexamic Acid-Associated Seizures: A Systematic Review and Meta-Analysis. J Neurosurg Anesthesiol. 2021;33(2):159-71. doi: 10.1097/ANA.0000000000000720.
25. Keyl C, Heimann A, Strobel M, et al. The effects of tranexamic acid on the central nervous system: a systematic review. Anaesthesia. 2020;75(8):1078-87. doi: 10.1111/anae.15064.

26. Price C, Smith C, Rock P, et al. Risk factors for tranexamic acid-associated seizures after cardiac surgery. Br J Anaesth. 2020;125(3):363-71. doi: 10.1016/j.bja.2020.03.047.
27. Faraoni D, Mater C, D'Amico G, et al. Tranexamic acid: a narrative review of dosing regimens, adverse effects, and outcomes. Eur J Anaesthesiol. 2020;37(12):1001-10. doi: 10.1097/EJA.0000000000001309.
28. Andersson L, Nilsson IM, Colleen S, Granstrand B, Melander B. Role of the fibrinolytic system in fibrinogen and bleeding and the effect of tranexamic acid. Scand J Urol Nephrol. 1968;2(2):117-24. doi: 10.3109/00365596809160533.
29. Horrow JC, Van Riper DF, Strong MD, et al. The dose-response relationship of tranexamic acid in cardiac surgery. Anesthesiology. 1995;82(5):1107-13. doi: 10.1097/00000542-199505000-00005.
30. Koster A, Grabitz RG, Friedel N, et al. The effects of two different dosages of tranexamic acid on blood loss and transfusion requirements in patients undergoing cardiac surgery. Anesth Analg. 2002;94(4):798-802. doi: 10.1097/00000539-200204000-00009.
31. Guo S, Wu Y, Tang K, et al. Optimal dosage and administration route of tranexamic acid for bleeding in various surgeries: a systematic review and meta-analysis of randomized controlled trials. J Clin Anesth. 2022;80:110753. doi: 10.1016/j.jclinane.2022.110753.
32. Eikebrokk K, Hagelund L, Kristoffersen AJ, et al. Topical tranexamic acid: Cytotoxicity and effects on wound re-epithelialization. Wound Repair Regen. 2021;29(2):290-9. doi: 10.1111/wrr.12879.
33. Loo J, MacGillivray R, Baker J, et al. Topical tranexamic acid reduces blood loss in abdominoplasty: A prospective, randomized, controlled trial. Plast Reconstr Surg. 2020;145(2):418-26. doi: 10.1097/PRS.0000000000006456.
34. Dinsmore RC, Choi J, Cohen SR. The use of tranexamic acid in pediatric craniosynostosis surgery: a meta-analysis. J Neurosurg Pediatr. 2016;18(3):346-52. doi: 10.3171/2016.2.PEDS15638.
35. Karslioglu K, Ulas EB, Tumer G, et al. The effect of topical tranexamic acid on flap survival in rat random pattern flap model. Microsurgery. 2022;42(1):47-52. doi: 10.1002/micr.30829.
36. Klein JA. Tumescent technique for local anesthesia improves safety in liposuction. Plast Reconstr Surg. 1990;85(4):654-5. doi: 10.1097/00006534-199004000-00028.
37. Sarwer DB, Gibbons LM, Cash TF, et al. The psychology of cosmetic surgery: a review of the literature. Plast Reconstr Surg. 2005;116(7):1924-38. doi: 10.1097/01.prs.0000188616.48625.e4. American Society of Plastic Surgeons. Position Statement: Patient Safety in Liposuction [Internet]. Arlington Heights (IL): American Society of Plastic Surgeons; 2019. Disponible en:

https://www.plasticsurgery.org/for-medicalprofessionals/policies-and-advocacy/position- statements/patient-safety-in-liposuction

38. Al-Sharafi B, Al-Dossari O, Al-Sayed A, et al. Tranexamic acid in liposuction: a systematic review. J Plast Reconstr Aesthet Surg. 2022;75(2):778-83. doi: 10.1016/j.bjps.2021.09.030.
39. El-Mohsen MA, El-Kashty OA. Assessment of hemoglobin level changes after mega-liposuction: A prospective cohort study. J Cosmet Dermatol. 2020;19(11):2844-50. doi: 10.1111/jocd.13620.
40. Trimas SJ, Ezzat W, El-Sharafi B. The use of tranexamic acid in tumescent solution for cervicofacial rhytidectomy: a randomized controlled trial. Aesthetic Plast Surg. 2023;47(1):158-65. doi: 10.1007/s00266-022-03120-w.
41. Yu M, Liu H, Yin L, et al. Tranexamic acid promotes bone formation and inhibits osteoclastogenesis by modulating macrophage polarization. Sci Rep. 2020;10(1):15989. doi: 10.1038/s41598-020-72944-x.
42. Wagenbrenner M, Kiefer R, Schmal H, et al. Effects of tranexamic acid on chondrocytes and osteogenically differentiated human mesenchymal stromal cells in vitro. J Orthop Surg Res. 2021;16(1):379. doi: 10.1186/s13018-021-02511-9.
43. Konishi Y, Maruo K, Nishiike R, et al. Intra-articular tranexamic acid is associated with reduced blood loss in total knee arthroplasty: a retrospective study. J Orthop Sci. 2018;23(4):681-4. doi: 10.1016/j.jos.2018.03.003.
44. Kim TK, Kim JM, Jang SM, et al. The effect of intra-articular injection of tranexamic acid on blood loss after total knee arthroplasty: a randomized controlled trial. J Arthroplasty. 2010;25(4):948-52. doi: 10.1016/j.arth.2009.08.010.
45. Patel S, Bawa K, Banyard DA, et al. Tranexamic acid does not alter viability or differentiation of adipose-derived stem cells in fat grafts. Plast Reconstr Surg Glob Open. 2023;11(1):e4758. doi: 10.1097/GOX.0000000000004758.
46. Wang T, Yang K, Deng Y, et al. Macrophage polarization: A key factor in fat grafting. Exp Ther Med. 2020;20(1):1-8. doi: 10.3892/etm.2020.8659.
47. Han S, He L, Yu Y, et al. Macrophage polarization in adipose tissue regeneration. Front Immunol. 2022;13:845348. doi: 10.3389/fimmu.2022.845348.
48. Sica A, Mantovani A. Macrophage plasticity and polarization: in vivo veritas. J Clin Invest. 2012;122(3):787-95. doi: 10.1172/JCI59643.
49. Lumeng CN, Bodzin SG, Saltiel AR. Obesity induces a phenotypic switch in adipose tissue macrophages. J Clin Invest. 2007;117(1):175-84. doi: 10.1172/JCI29881.
50. Spiller KL, Campbell L, Reddy A, et al. The role of macrophage activation in adipose tissue inflammation and remodeling in response to obesity. Biomaterials. 2014;35(4):1123-33. doi: 10.1016/j.biomaterials.2013.10.024.

51. Zhang P, Gan Y, Du M, et al. M2 macrophages promote angiogenesis and adipogénesis in fat grafting. J Tissue Eng Regen Med. 2019;13(4):678-88. doi: 10.1002/term.2818.
52. Raoufi, A., Soleimani Samarkhazan, H., Nouri, S. *et al.* Macrófagos en la enfermedad de injerto contra huésped (EICH): doble función como herramientas y dianas terapéuticas. *Clin Exp Med* 25 , 73 (2025). doi.org/10.1007/s10238-025-01588-0
53. Cinti S, Mitchel G, Barbatelli G, Murano I, Ceresi E, Faloia E, et al. Adipocyte death defines macrophage localization and function in adipose tissue of obese mice and humans. J Lipid Res. 2005;46(11):2347-55. doi: 10.1194/jlr.M500294-JLR200.
54. Gabriel Martínez-Santibañez, Kae Won Cho, Carey N. Lumeng. Chapter Two - Imaging White Adipose Tissue with Confocal Microscopy. En: Macdougald OA, editor. Methods in Enzymology. Academic Press; 2014. p. 17-30. (Volume 537). doi: 10.1016/B978-0-12-411619-1.00002-1.
55. Shih L, Davis MJ, Winocour SJ. The Science of Fat Grafting. Semin Plast Surg. 2020 Feb;34(1):5-10. doi: 10.1055/s-0039-3402073
56. Patel S, DeSouza T, Furrukh AJ, Joo A, Corvera S, Lalikos J. Investigating the Influence of Tranexamic Acid on Adipocyte Differentiation in an In Vitro Model.
57. Plast Reconstr Surg Glob Open. 2025 Apr 24;13(Suppl 1):3- doi: 10.1097/01.GOX.0001111980.12667.a1