DOI: http://dx.doi.org/10.22267/rus.192103.165



Universidad y Salud ARTÍCULO DE REVISIÓN

**Grupos sanguíneos y su relación con los niveles plasmáticos del Factor**

**de von Willebrand**

Blood groups and their relationship with plasma levels of von Willebrand Factor

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Fecha de recepción: Noviembre 23 - 2017 Fecha de revisión: Julio 12 - 2018 Fecha de aceptación: Agosto 9 - 2019

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| *Márquez-Benítez Y, Lancheros-Silva AM, Díaz-Chaves E. Grupos sanguíneos y su relación con los niveles plasmáticos de factor Von Willebrand. Univ. Salud. 2019;21(3):277-287. DOI: http://dx.doi.org/10.22267/rus.192103.165* |

**Resumen**

**Introducción:** El tipo de grupo sanguíneo entre otros factores, influye en los niveles plasmáticos del Factor de von Willebrand (FvW), su actividad biológica podría incidir en el desarrollo de eventos trombóticos y hemorrágicos. **Objetivo:** Describir las características y los mecanismos de reacciones postrasduccionales del grupo sanguíneo que permiten la variación en la concentración plasmática del FvW. **Materiales y métodos:** Revisión teórico descriptiva de tipo documental. Las bases de datos consultadas fueron *Medline, Lilacs, ScienceDirect, Scopus, SciELO, Proquest, Ovid y Pubmed.* Como criterio de selección se incluyeron artículos en idioma inglés y español a partir del año 2010 y algunos anteriores como referente histórico. **Resultados:** Se describieron los principales mecanismos e investigaciones que evidencian la influencia del tipo de grupo sanguíneo ABO en los niveles plasmáticos del FvW, así como la estructura y función de dicha proteína. **Conclusiones**: Las concentraciones plasmáticas del FvW pueden depender del tipo de grupo sanguíneo, la edad, sexo, embarazo, ciclo menstrual, variación de proteínas y factores bioquímicos e inmunológicos. Se podría tener en cuenta el tipo de grupo sanguíneo de los pacientes como un posible factor predictor a futuro de complicaciones clínicas tanto trombóticas como hemorrágicas.

**Palabras clave**: Factor de von Willebrand; antígenos de grupos sanguíneos; proteína ADAMTS13; trombofilia. (Fuente: DeCS, Bireme).

**Abstract**

**Introduction:** The type of blood group among other factors influences the plasma levels of von Willebrand Factor (FvW) and its biological activity could influence the development of thrombotic and hemorrhagic events. **Objective:** To describe the characteristics and mechanisms of post-translational reactions of the blood group that generate variation in the plasma concentration of FvW. **Materials and methods:** A descriptive theoretical review of documentary type. The databases consulted were *Medline, Lilacs, ScienceDirect, Scopus, SciELO, Proquest, Ovid and Pubmed.* As a selection criterion, articles in English and Spanish were included beginning in 2010 and some previous ones as historical reference. **Results:** The main mechanisms and investigations that show the influence of the ABO blood group type on the plasma levels of FvW, as well as the structure and function of this protein were described. **Conclusions:** FvW plasma concentrations may depend on the type of blood group, age, sex, pregnancy, menstrual cycle, protein variation and biochemical and immunological factors. The type of blood group of patients could be considered as a possible future predictor of both thrombotic and hemorrhagic clinical complications.

**Key words:** von Willebrand factor; blood group antigens; ADAMTS13 protein; thrombophilia. (Source: DeCS, Bireme).

**Referencias**

1. Cossio-Andia E, Solis S, Jhunior A, Castellon-Bautista N, Davalos-Pacheco M, Jarro-Mena RL. Tipificación del grupo sanguíneo ABO y el factor Rh en la población de Totora-Cochabamba gestión 2012. Rev Cient Cienc Med. 2013;16(1):25-27.

2. Guyton AC, Hall JE. Tratado de Fisiología Médica. 12ª ed. Madrid: Elsevier; 2011.

3. Cruz-Bermúdez HF, Moreno-Collazo JE, Forero SE. Caracterización de donantes voluntarios de sangre por grupo sanguíneo ABO y Rh que asistieron a un banco de sangre de la ciudad de Tunja-Colombia. Arch Med [Internet]. 2012 [citado 2017 Sep 06]; 2(2):185-189. Disponible en: http://revistasum.umanizales.edu.co/ojs/index.php/archivosmedicina/article/view/7

4. Lenting P, Casari C, Christophe O, Denis C. von Willebrand factor: the old, the new and the unknown. J Thromb Haemost [Internet]. 2012 [citado 2017 Sep 06];10(12):2428-37. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/jth.12008

5. Kahr MK, Franke D, Brun R, Wisser J, Zimmermann R, Haslinger C. Blood group O: A novel risk factor for increased postpartum blood loss?. Haemophilia [Internet]. 2018 May [citado 2017 Oct 10];1-6. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/hae.13537

6. Hussein E, Teruya J. Evaluating the impact of the ABO blood group on the clinical outcome of thrombotic thrombocytopenic purpura associated with severe ADAMTS13 deficiency. Vox Sang [Internet]. 2017 Jul [citado 2017 Oct 11];112(5):434-442. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/vox.12511

7. Bejerano-Pérez N, García-Bejerano D, Pimentel-Figueroa CA. Discrepancias en el agrupamiento del sistema de grupos sanguíneos ABO. Rev Ciencias Médicas [Internet]. 2016 Feb [citado 2018 Abr 08];20(1). Disponible en: http://scielo.sld.cu/scielo.php?script=sci\_arttext&pid=S1561-31942016000100026&lng=es.6)

8. Chang-Monteagudo A, Bencomo-Hernández AA, Morera-Barrios LM, Ustáriz-García C, de la Guardia-Peña O. Evolución de la nomenclatura de los factores del sistema de antígenos leucocitarios humanos. Rev Cubana Hematol Inmunol Hemoter [Internet]. 2014 Ene - Mar [citado 2017 Oct 16];30(1):11-20. Disponible en: http://scielo.sld.cu/scielo.php?script=sci\_arttext&pid=S0864-02892014000100003

9. Bueno ML. Cromosomas, vehículos en la organización y transmisión de los caracteres. Acta Biol Colomb [Internet]. 2011 [citado 2017 Oct 16];16(3):43-60. Disponible en: http://www.redalyc.org/articulo.oa?id=319027888003

10. Matta-Camacho NE. Sistema inmune y genética: un abordaje diferente a la diversidad de anticuerpos. Acta Biol Colomb [Internet]. 2011 Sep [citado 2018 Abr 08];16(3):177-188. Disponible en: https://revistas.unal.edu.co/index.php/actabiol/article/view/19284/27967

11. Smith NL, Chen MH, Dehghan A, Strachan DP, Basu S, Soranzo N, et al. Control Consortium, Novel associations of multiple genetic loci with plasma levels of factor VII, factor VIII, and von Willebrand factor: the CHARGE (Cohorts for Heart and Aging Research in Genome Epidemiology) consortium. Circulation [Internet]. 2010 [citado 2017 Nov 03];121(12):1382-1392. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2861278/

12. Terraube V, O’donnell J, Jenkins PV. Factor VIII and von Willebrand factor interaction: biological, clinical and therapeutic importance. Haemophilia [Internet]. 2010 [citado 2017 Nov 03];16(1):3-13. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2516.2009.02005.x

13. Lillicrap D. von Willebrand disease: advances in pathogenetic understanding, diagnosis, and therapy. Blood [Internet]. 2013 [citado 2017 Nov 04];122(23):3735-40. Disponible en: http://www.bloodjournal.org/content/early/2013/09/24/blood-2013-06-498303.short?sso-checked=true

14. Lenting PJ, Christophe OD, Denis CV. Von Willebrand factor biosynthesis, secretion, and clearance: connecting the far ends. Blood [Internet]. 2015 [citado 2017 Nov 09];125(13): 2019-2028. Disponible en: http://www.bloodjournal.org/content/early/2015/02/23/blood-2014-06-528406

15. Batlle J, Pérez-Rodríguez A, Corrales I, López-Fernández M, Rodríguez-Trillo Á, Lourés E, et al. Molecular and clinical profile of von Willebrand disease in Spain (PCM-EVW-ES): Proposal for a new diagnostic paradigm. Thromb Haemost [Internet]. 2016 [citado 2017 Nov 14];115(1):40-50. Disponible en: https://www.thieme-connect.com/products/ejournals/abstract/10.1160/TH15-04-0282

16. Haberichter DL. von Willebrand factor propeptide: biology and clinical utility. Blood [Internet]. 2015 [citado 2017 Nov 16];126:1753-1761. Disponible en: http://www.bloodjournal.org/content/early/2015/07/27/blood-2015-04-512731.1

17. Eikenboom J, Federici AB, Dirven RJ, Castaman G, Rodeghiero F, Budde U, et al. VWF propeptide and ratios between VWF, VWF propeptide, and FVIII in the characterization of type 1 von Willebrand disease. Blood [Internet]. 2013 [citado 2017 Nov 18];121(12):2336-9. Disponible en: http://www.bloodjournal.org/content/early/2013/01/24/blood-2012-09-455089.short?sso-checked=true

18. De Jong A, Eikenboom J. Developments in the diagnostic procedures for von Willebrand disease. J Thromb Haemost [Internet]. 2016 [citado 2018 Abril 7];14:449-460. Disponible en: https://www.ncbi.nlm.nih.gov/pubmed/2671418116)

19. Veyradier A, Boisseau P, Fressinaud E, Caron C, Ternisien C, Giraud M, et al. A laboratory phenotype/genotype correlation of 1167 French patients from 670 families with von Willebrand disease: a new epidemiologic picture. Medicine [Internet]. 2016 [citado 2017 Nov 18];95(11):e3038. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4839904/

20. Canis K, McKinnon TA, Nowak A, Haslam SM, Panico M, Morris HR, et al. Mapping the N-glycome of human von Willebrand factor. Biochem J [Internet]. 2012 [citado 2017 Nov 18];447(2):217-28. Disponible en: http://www.biochemj.org/content/447/2/217

21. Casonato, A, Daidone, V, Padrini R. Assessment of von Willebrand factor propeptide improves the diagnosis of von Willebrand disease. Semin Thromb Hemost [Internet]. 2011 [citado 2017 Nov 20];37(05):456-463. Disponible en: https://www.thieme-connect.com/products/ejournals/abstract/10.1055/s-0031-1281029

22. Madabhushi SR, Shang C, Dayananda KM, Rittenhouse-Olson K, Murphy M, Ryan TE, et al. Von Willebrand factor (VWF) propeptide binding to VWF D′ D3 domain attenuates platelet activation and adhesion. Blood [Internet]. 2012 [citado 2017 Nov 28];119(20):4769-4778. Disponible en: http://www.bloodjournal.org/content/early/2012/03/27/blood-2011-10-387548

23. Woods AI, Blanco AN, Kempfer AC, Paiva J, Bermejo EI, Sánchez Luceros A, et al. Factor de von Willebrand y Enfermedad de von Willebrand: nuevos enfoques diagnósticos. Acta Bioquím Clín Latinoam [Internet]. 2016 [citado 2017 Dic 02];50(2):273-89. Disponible en: http://www.scielo.org.ar/pdf/abcl/v50n2/v50n2a12.pdf

24. Casari C, Lenting P, Wohner N, Christophe O, Denis C. Clearance of von Willebrand factor. J Thromb Haemost [Internet]. 2013 [citado 2017 Dic 02];11(s1):202-11. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/jth.12226

25. De Wee EM, Sanders YV, Mauser-Bunschoten EP, van der Bom JG, Degenaar-Dujardin ME, Eikenboom J, et al. Determinants of bleeding phenotype in adult patients with moderate or severe von Willebrand disease. Thromb Haemost [Internet]. 2012 [citado 2017 Dic 03];108(4):683. Disponible en: https://insights.ovid.com/thrombosis-haemostasis/jthrh/2011/07/002/determinants-bleeding-phenotype-patients-moderate/618/00149457

26. Davies JA, Hathaway LS, Collins PW, Bowen DJ. Von Willebrand factor: demographics of plasma protein level in a large blood donor cohort from South Wales in the United Kingdom. Haemophilia [Internet]. 2012 [citado 2017 Dic 09];18(3):e60-e87. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2516.2012.02782.x

27. Miller C, Haff E, Platt S, Rawlins P, Drews C, Dilley A, et al. Measurement of von Willebrand factor activity: relative effects of ABO blood type and race. J Thromb Haemost [Internet]. 2003 [citado 2017 Dic 09];1(10):2191-7. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1046/j.1538-7836.2003.00367.x

28. Laffan MA, Lester W, O'Donnell JS, Will A, Tait RC, Goodeve A, et al. The diagnosis and management of von Willebrand disease: a United Kingdom Haemophilia Centre Doctors Organization guideline approved by the British Committee for Standards in Haematology. Br J Haematol [Internet]. 2014 [citado 2018 Abril 8];167:453-465. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4283483/

29. Woods AI, Sánchez-Luceros A, Meschengieser SS, Kempfer AC, Blanco AN, Lazzari MA, ed. Diagnosis and management of von Willebrand disease in a single institution of Argentina. Semin Thromb Hemost [Internet]. 2011 [citado 2017 Dic 10];37(5):568-75. Disponible en: https://www.researchgate.net/profile/Adriana\_Woods/publication/51816373\_Diagnosis\_and\_Management\_of\_von\_Willebrand\_Disease\_in\_a\_Single\_Institution\_of\_Argentina/links/5a4d21c5a6fdcc3e99d158d2/Diagnosis-and-Management-of-von-Willebrand-Disease-in-a-Single-Institution-of-Argentina.pdf

30. Padilla-Romo MGZ, Jaloma-Cruz AR. Algoritmo diagnóstico para la enfermedad de von Willebrand (EVW) en población mexicana. Gac Méd Méx [Internet]. 2015 [citado 2018 Ene 13];151(6):828-33. Disponible en: https://www.anmm.org.mx/GMM/2015/n3/GMM\_151\_2015\_3\_399-402.pdf

31. Favaloro EJ. Diagnosis and classification of von Willebrand disease: a review of the differential utility of various functional von Willebrand factor assays. Blood Coagul Fibrinolysis [Internet]. 2011 [citado 2018 Ene 28];22(7):553-64. Disponible en: https://journals.lww.com/bloodcoagulation/Fulltext/2011/10000/Diagnosis\_and\_classification\_of\_von\_Willebrand.1.aspx

32. Hernández-Zamora E, Zavala-Hernández C, Quintana-González S, Reyes-Maldonado E. Enfermedad de von Willebrand, biología molecular y diagnóstico. Cirugía y Cirujanos [Internet]. 2015 [citado 2018 Feb 03];83(3):255-64. Disponible en: https://www.sciencedirect.com/science/article/pii/S0009741115000687

33. Kano T, Kondo K, Hamako J, Matsushita F, Sakai K, Matsui T. Effects of plasma glycosyltransferase on the ABO(H) blood group antigens of human von Willebrand factor. Int J Hematol [Internet]. 2018 Apr [citado 2018 Feb 18];108(2):139-144. Disponible en: https://link.springer.com/article/10.1007/s12185-018-2452-0

34. Franchini M, Makris M. Non-O blood group: an important genetic risk factor for venous thromboembolism. Blood Transfus [Internet]. 2013 [citado 2018 Ene 17];11:164-5. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3626462/pdf/blt-11-164.pdf

35. Brehm MA. Von Willebrand factor processing. Hamostaseologie. 2016 Nov 21;37(1):59-72.

36. Solecka BA, Weise C, Laffan MA, Kannicht C. Site-specific analysis of von Willebrand factor O- glycosylation. J Thromb Haemost [Internet]. 2016 Abr 1 [citado 2018 Ene 15];14(4):733-46. Disponible en: http://onlinelibrary.wiley.com/doi/10.1111/jth.13260/full

37. McGrath RT, van den Biggelaar M, Byrne B, O’Sullivan JM, Rawley O, O’Kennedy R, et al. Altered glycosylation of platelet-derived von Willebrand factor confers resistance to ADAMTS13 proteolysis. Blood [Internet]. 2013 Dic 12 [citado 2018 Ene 17];122(25):4107-10. Disponible en: http://www.bloodjournal.org/content/122/25/4107.long

38. Mckinnon TAJ, Goode EC, Birdsey GM, Nowak AA, Chan ACK, Lane DA, et al. Specific N-linked glycosylation sites modulate synthesis and secretion of von Willebrand factor. Blood [Internet]. 2011 [citado 2017 Dec 17];116(4):640-8. Disponible en: http://www.bloodjournal.org/content/bloodjournal/116/4/640.full.pdf

39. Lynch CJ, Lane DA. N-linked glycan stabilization of the VWF A2 domain. Blood [Internet]. 2016 Mar 31 [citado 2018 Ene 17];127(13):1711-8. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4817312/

40. Eikenboom J, Federici AB, Dirven RJ, Castaman G, Rodeghiero F, Budde U, et al. VWF propeptide and ratios between VWF, VWF propeptide, and FVIII in the characterization of type 1 von Willebrand disease. Blood [Internet]. 2013 Mar 21 [citado 2018 Ene 20];121(12):2336-9. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4191434/

41. Sanders Y V, Groeneveld D, Meijer K, Fijnvandraat K, Cnossen MH, Van Der Bom JG, et al. von Willebrand factor propeptide and the phenotypic classification of von Willebrand disease. Blood [Internet]. 2015 [citado 2018 Ene 17];125(19):3006-13. Disponible en: http://www.bloodjournal.org/content/bloodjournal/125/19/3006.full.pdf

42. Ozel AB, McGee B, Siemieniak D, Jacobi PM, Haberichter SL, Brody LC, et al. Genome-wide studies of von Willebrand factor propeptide identify loci contributing to variation in propeptide levels and von Willebrand factor clearance. J Thromb Haemost [Internet]. 2016 Sep [citado 2018 Ene 20];14(9):1888-98. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5035595/

43. Muia J, Zhu J, Gupta G, Haberichter SL, Friedman KD, Feys HB, et al. Allosteric activation of ADAMTS13 by von Willebrand factor. Proc Natl Acad Sci U S A [Internet]. 2014 Dic 30 [citado 2018 Feb 17];111(52):18584-9. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4284596/?report=reader

44. South K, Luken BM, Crawley JTB, Phillips R, Thomas M, Collins RF, et al. Conformational activation of ADAMTS13. Proc Natl Acad Sci U S A [Internet]. 2014 Dic 30 [citado 2018 Feb 17];111(52):18578-83. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4284544/?report=reader

45. Al-Awadhi AM, Al-Sharrah SK, Jadaon MM, Al-Sayegh F. Investigating the influence of age, gender and ABO blood group on ADAMTS-13 antigen and activity levels in healthy Arabs. Blood Transfus [Internet]. 2014 Jan [Citado 2018 Feb 10];12(1):138-40. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3926720/

46. Giebeler N, Zigrino P. A Disintegrin and Metalloprotease (ADAM): Historical Overview of Their Functions. Toxins (Basel) [Internet]. 2016 [citado 2018 Marzo 10];8(122). Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4848645/pdf/toxins-08-00122.pdf

47. South K, Lane DA. ADAMTS-13 and von Willebrand factor: a dynamic duo. J Thromb Haemost [Internet]. 2018 enero 1 [Citado 2018 Feb 10];16(1):6-18. Disponible en: http://onlinelibrary.wiley.com/doi/10.1111/jth.13898/full

48. Habe K, Wada H, Higashiyama A, Akeda T, Tsuda K, Mori R, et al. The Plasma Levels of ADAMTS-13, von Willebrand Factor, VWFpp, and Fibrin-Related Markers in Patients With Systemic Sclerosis Having Thrombosis. Clin Appl Thromb Hemost. 2018;24(6):920-27. doi: 10.1177/1076029617736382

49. Jacobi PM, Gill JC, Flood VH, Jakab DA, Friedman KD, Haberichter SL. Intersection of mechanisms of type 2A EVW through defects in VWF multimerization, secretion, ADAMTS-13 susceptibility, and regulated storage. Blood [Internet]. 2012 May 10 [citado 2018 Feb 17];119(19):4543-53. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3362367/

50. Nowak AA, McKinnon TAJ, Hughes JM, Chion ACK, Laffan MA. The O-linked glycans of human von Willebrand factor modulate its interaction with ADAMTS-13. J Thromb Haemost [Internet]. 2014 Ene 1 [citado 2018 Feb 17];12(1):54-61. Disponible en: http://onlinelibrary.wiley.com/doi/10.1111/jth.12451/full

51. Liu X, Chen X, Yang J, Guo R. Association of ABO blood groups with von Willebrand factor, factor VIII and ADAMTS-13 in patients with lung cancer. Oncol Lette [Internet]. 2017 [citado 2018 Mar 1];14(3):3787-3794. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5587991/

52. Song J, Chen F, Campos M, Bolgiano D, Houck K, Chambless LE, et al. Quantitative Influence of ABO Blood Groups on Factor VIII and Its Ratio to von Willebrand Factor, Novel Observations from an ARIC Study of 11,673 Subjects. PLoS One [Internet]. 2015 [citado 2018 Mar 12];10(8):e0132626. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4526567/

53. Sousa NC, Anicchino-Bizzacchi JM, Locatelli MF, Castro V, Barjas-Castro ML. The relationship between ABO groups and subgroups, factor VIII and von Willebrand factor. Haematologica [Internet]. 2007 [citado 2018 Abr 02];92(2):236-9. Disponible en: http://www.haematologica.org/content/92/2/236.short

54. Wang Z, Dou M, Du X, Ma L, Sun P, Cao H, et al. Influences of ABO blood group, age and gender on plasma coagulation factor VIII, fibrinogen, von Willebrand factor and ADAMTS13 levels in a Chinese population. PeerJ [Internet]. 2017 [citado 2018 Abr 03];5:e3156. Disponible en: https://peerj.com/articles/3156/?utm\_source=TrendMD&utm\_campaign=PeerJ\_TrendMD\_1&utm\_medium=TrendMD

55. Johansson Å, Alfredsson J, Eriksson N, Wallentin L, Siegbahn A. Genome-Wide Association Study Identifies That the ABO Blood Group System Influences Interleukin-10 Levels and the Risk of Clinical Events in Patients with Acute Coronary Syndrome. PLoS One [Internet]. 2015 [citado 2018 Mar 9];10(11):e0142518. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4658192/

56. Larson NB, Bell EJ, Decker PA, Pike M, Wassel CL, Tsai MY, et al. ABO blood group associations with markers of endothelial dysfunction in the Multi-Ethnic Study of Atherosclerosis. Atherosclerosis [Internet]. 2016 Ago [citado 2018 Mar 15];251:422-9. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4983247/

57. Nagy EE, Varga-Fekete T, Puskas A, Kelemen P, Brassai Z, Szekeres-Csiki K, et al. High circulating osteoprotegerin levels are associated with non-zero blood groups. BMC Cardiovasc Disord [Internet]. 2016 [Citado 2018 Mar 15];16(1):106. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4937555/

58. Pike MM, Larson NB, Wassel CL, Cohoon KP, Tsai MY, Pankow JS, et al. ABO blood group is associated with peripheral arterial disease in African Americans: The Multi-Ethnic Study of Atherosclerosis (MESA). Thromb Res [Internet]. 2017 May [citado 2018 Mar 16];153:1-6. Disponible en: https://www.sciencedirect.com/science/article/pii/S0049384817300531

59. Albánez S, Ogiwara K, Michels A, Hopman W, Grabell J, James P, et al. Aging and ABO blood type influence von Willebrand factor and factor VIII levels through interrelated mechanisms. J Thromb Haemost [Internet]. 2016 May [citado 2018 Mar 16];14(5):953-63. Disponible en: https://onlinelibrary.wiley.com/doi/abs/10.1111/jth.13294

60. Akin M, Balkan C, Karapinar DY, Kavakli K. The influence of the ABO blood type on the distribution of von Willebrand factor in healthy children with no bleeding symptoms. Clin Appl Thromb Hemost [Internet]. 2011 Sep [citado 2018 Jul 26];18(3):316-9. Disponible en: https://doi.org/10.1177/1076029611422364

61. Shahidi M. Thrombosis and von Willebrand Factor. Adv Exp Med Biol. 2017;906:285-306.