XXX JCET LECTURE, 21.02.2014, 9.00

Clinical assessment of endothelial glycocalyx to identify early vascular risk

Prof. Hans Vink
Department of Physiology,
Cardiovascular Research Institute Maastricht,
Maastricht University, The Netherlands

Hans Vink received his physics degree in 1989 at the University of Amsterdam. After receiving his PhD in Medicine in 1994 and a post-doctoral fellowship at the dept. Molecular Physiology and Biological Physics, University of Virginia, Charlottesville, VA, USA, he returned to the University of Amsterdam and developed a research program on the endothelial glycocalyx (www.glycocalyx.nl),supported by grants from the Netherlands Organization for Scientific Research (NWO 1997 – 1999) and a fellowship from the Royal Netherlands Academy of Sciences (KNAW 2000 – 2005). In 2006 he was awarded an Established Investigatorship by the Netherlands Heart Foundation and moved to the University of Maastricht as a Principal Investigator at the Cardiovascular Research Institute of Maastricht and he was appointed professor of Circulatory Physics at the University in Amsterdam in 2008. His research on the endothelial glycocalyx progresses towards clinically applicable tools for early diagnosis of cardiovascular risk and new therapeutic approaches to protect the vascular wall against atherogenic challenges, and is supported by program grants from the Center for Translational Molecular Medicine, The Netherlands Heart Foundation, The Dutch Diabetes Research Foundation and the Netherlands Kidney Foundation. He has published more than 60 scientific publications and supervised 9 PhD projects. His Hirsh factor is 31.

Lecture abstract:

Clinical assessment of endothelial glycocalyx to identify early vascular risk.
Glycocalyx biophysics and biochemistry in relation to vascular (dys)function

The endothelial glycocalyx forms a complex, hydrated mesh of cell surface proteoglycans, glycosaminoglycans, and plasma proteins that is situated between the vascular wall and flowing blood. Strategically situated between flowing blood and the vascular surface, an intact glycocalyx forms the first line of defence of blood vessels against atherogenic challenges by limiting leakage of atherogenic lipoproteins into the vessel wall and preventing adhesion of circulating coagulatory and inflammatory cells to the vascular endothelial lining. Recent clinical studies have demonstrated that monitoring glycocalyx damage identifies early vascular vulnerability in patients with e.g. early cognitive impairment (neurology), premature atherosclerosis and coronary microvascular disease (cardiology), impaired renal function (nephrology), insulin resistance (diabetes) and acute vascular vulnerability in critically ill patients (ICU).
As a spin-off of MUMC, GlycoCheck BV is developing a non-invasive test for early detection of personal vascular vulnerability in the context of increased cardiovascular risk by e.g. diabetes. The test is based on automated analysis of clinical videomicroscopic recordings of microvascular hemodynamics to check the quality of the endothelial glycocalyx, a protective coating on the luminal surface of blood vessels.

References:

Endothelial glycocalyx as potential diagnostic and therapeutic target in cardiovascular disease. *Broekhuizen LN, Mooij HL, Kastelein JJ, Stroes ES, Vink H, Nieuwdorp M.*
Curr Opin Lipidol. 2009, 20(1):57-62.

Impaired glycocalyx barrier properties contribute to enhanced intimal low-density lipoprotein accumulation at the carotid artery bifurcation in mice.
van den Berg BM, Spaan JA, Vink H.
Pflugers Arch. 2008 Oct 7. [Epub ahead of print]

Endothelial glycocalyx damage coincides with microalbuminuria in type 1 diabetes.
Nieuwdorp M, Mooij HL, Kroon J, Atasever B, Spaan JA, Ince C, Holleman F, Diamant M, Heine RJ, Hoekstra JB, Kastelein JJ, Stroes ES, Vink H.
Diabetes 2006, 55(4):1127-32.

Oxidized lipoproteins degrade the endothelial surface layer - Implications for platelet-endothelial cell adhesion. *Vink H, Constantinescu AA, Spaan JAE*
CIRCULATION 2000 Volume: 101 Issue: 13 Pages: 1500-1502

Identification of distinct luminal domains for macromolecules, erythrocytes, and leukocytes within mammalian capillaries. *Vink H, Duling BR*
CIRCULATION RESEARCH 1996 Volume: 79 Issue: 3 Pages: 581-589

PUBLICATIONS (2010 – 2014):

1. Dane MJ, Khairoun M, Lee DH, van den Berg BM, Eskens BJ, Boels MG, van Teeffelen JW, Rops AL, van der Vlag J, van Zonneveld AJ, Reinders ME, Vink H, Rabelink TJ.
   Association of Kidney Function with Changes in the Endothelial Surface Layer.
   Clin J Am Soc Nephrol. 2014 Jan 23. [Epub ahead of print]

2. Eskens BJ, Zuurbier CJ, van Haare J, Vink H, van Teeffelen JW.
   Effects of two weeks of metformin treatment on whole-body glycocalyx barrier properties in db/db mice.
   Cardiovasc Diabetol. 2013 Dec 5;12:175. doi: 10.1186/1475-2840-12-175.

3. Brands J, van Haare J, Vink H, Vanteeffelen JW.
   Whole-body recruitment of glycocalyx volume during intravenous adenosine infusion.
   Physiol Rep. 2013 Oct;1(5):e00102. doi: 10.1002/phy2.102. Epub 2013 Oct 11.

4. Mulders TA, Nieuwdorp M, Stroes ES, Vink H, Pinto-Sietsma SJ.
   Non-invasive assessment of microvascular dysfunction in families with premature coronary artery disease.
   Int J Cardiol. 2013 Oct 12;168(5):5026-8. doi: 10.1016/j.ijcard.2013.07.166. Epub 2013 Jul 25.

5. Martens RJ, Vink H, van Oostenbrugge RJ, Staals J.
   Sublingual microvascular glycocalyx dimensions in lacunar stroke patients.
   Cerebrovasc Dis. 2013;35(5):451-4. doi: 10.1159/000348854. Epub 2013 May 31.

6. Dane MJ, van den Berg BM, Avramut MC, Faas FG, van der Vlag J, Rops AL, Ravelli RB, Koster BJ, van Zonneveld AJ, Vink H, Rabelink TJ.
   Glomerular endothelial surface layer acts as a barrier against albumin filtration.
   Am J Pathol. 2013 May;182(5):1532-40. doi: 10.1016/j.ajpath.2013.01.049. Epub 2013 Mar 19.

7. VanTeeffelen JW, Brands J, Janssen BJ, Vink H.
   Effect of acute hyaluronidase treatment of the glycocalyx on tracer-based whole body vascular volume estimates in mice.
   J Appl Physiol (1985). 2013 May; 114(9):1132-40. doi: 10.1152/japplphysiol.00842.2012. Epub 2013 Feb 28.

8. Eskens BJ, Mooij HL, Cleutjens JP, Roos JM, Cobelens JE, Vink H, Vanteeffelen JW.
   Rapid insulin-mediated increase in microvascular glycocalyx accessibility in skeletal muscle may contribute to insulin-mediated glucose disposal in rats.
   PLoS One. 2013;8(1):e55399. doi: 10.1371/journal.pone.0055399. Epub 2013 Jan 31.

9. Vlahu CA, Lemkes BA, Struijk DG, Koopman MG, Krediet RT, Vink H.
   Damage of the endothelial glycocalyx in dialysis patients.
   J Am Soc Nephrol. 2012 Nov;23(11):1900-8. doi: 10.1681/ASN.2011121181. Epub 2012 Oct 18.

10. Wijnands KA, Vink H, Briedé JJ, van Faassen EE, Lamers WH, Buurman WA, Poeze M.
Citrulline a more suitable substrate than arginine to restore NO production and the microcirculation during endotoxemia.
PLoS One. 2012;7(5):e37439. doi: 10.1371/journal.pone.0037439. Epub 2012 May 29.

11. Pacella JJ, Kameneva MV, Brands J, Lipowsky HH, Vink H, Lavery LL, Villanueva FS.
Modulation of pre-capillary arteriolar pressure with drag-reducing polymers: a novel method for enhancing microvascular perfusion.
Microcirculation. 2012 Oct;19(7):580-5. doi: 10.1111/j.1549-8719.2012.00190.x.

12. Brands J, Vink H, Van Teeffelen JW.
Comparison of four mathematical models to analyze indicator-dilution curves in the coronary circulation.
Med Biol Eng Comput. 2011 Dec;49(12):1471-9. doi: 10.1007/s11517-011-0845-9. Epub 2011 Nov 18.

13. Reitsma S, Oude Egbrink MG, Heijnen VV, Megens RT, Engels W, Vink H, Slaaf DW, van Zandvoort MA. Endothelial glycocalyx thickness and platelet-vessel wall interactions during atherogenesis.
Thromb Haemost. 2011 Nov;106(5):939-46. doi: 10.1160/TH11-02-0133. Epub 2011 Sep 8.

14. Broekhuizen LN, van Wijk DF, Vink H, Stalmach A, Crozier A, Hutten BA, Kastelein JJ, Hugenholtz PG, Koenig W, Stroes ES.
Reduction of monocyte chemoattractant protein 1 and macrophage migration inhibitory factor by a polyphenol-rich extract in subjects with clustered cardiometabolic risk factors.
Br J Nutr. 2011 Nov;106(9):1416-22. doi: 10.1017/S0007114511002431. Epub 2011 Jun 28.

15. Lekakis J, Abraham P, Balbarini A, Blann A, Boulanger CM, Cockcroft J, Cosentino F, Deanfield J, Gallino A, Ikonomidis I, Kremastinos D, Landmesser U, Protogerou A, Stefanadis C, Tousoulis D, Vassalli G, Vink H, Werner N, Wilkinson I, Vlachopoulos C.
Methods for evaluating endothelial function: a position statement from the European Society of Cardiology Working Group on Peripheral Circulation.
Eur J Cardiovasc Prev Rehabil. 2011 Dec;18(6):775-89.
doi: 10.1177/1741826711398179. Review.

16. Reitsma S, oude Egbrink MG, Vink H, van den Berg BM, Passos VL, Engels W, Slaaf DW, van Zandvoort MA.Endothelial glycocalyx structure in the intact carotid artery: a two-photon laser scanning microscopy study.
J Vasc Res. 2011;48(4):297-306. doi: 10.1159/000322176. Epub 2011 Jan 27.

17. Constantinescu A, Spaan JA, Arkenbout EK, Vink H, Vanteeffelen JW.
Degradation of the endothelial glycocalyx is associated with chylomicron leakage in mouse cremaster muscle microcirculation.
Thromb Haemost. 2011 May;105(5):790-801. doi: 10.1160/TH10-08-0560. Epub 2010 Dec 21.

18. Meuwese MC, Broekhuizen LN, Kuikhoven M, Heeneman S, Lutgens E, Gijbels MJ, Nieuwdorp M, Peutz CJ, Stroes ES, Vink H, van den Berg BM.
Endothelial surface layer degradation by chronic hyaluronidase infusion induces proteinuria in apolipoprotein E-deficient mice.
PLoS One. 2010 Dec 8;5(12):e14262. doi: 10.1371/journal.pone.0014262.

19. Broekhuizen LN, Lemkes BA, Mooij HL, Meuwese MC, Verberne H, Holleman F, Schlingemann RO, Nieuwdorp M, Stroes ES, Vink H.
Effect of sulodexide on endothelial glycocalyx and vascular permeability in patients with type 2 diabetes mellitus.
Diabetologia. 2010 Dec;53(12):2646-55. doi: 10.1007/s00125-010-1910-x. Epub 2010 Sep 25.

20. Snoeijs MG, Vink H, Voesten N, Christiaans MH, Daemen JW, Peppelenbosch AG, Tordoir JH, Peutz-Kootstra CJ, Buurman WA, Schurink GW, van Heurn LW.
Acute ischemic injury to the renal microvasculature in human kidney transplantation.
Am J Physiol Renal Physiol. 2010 Nov;299(5):F1134-40.
doi: 10.1152/ajprenal.00158.2010. Epub 2010 Sep 1.

21. VanTeeffelen JW, Brands J, Vink H.
Agonist-induced impairment of glycocalyx exclusion properties: contribution to coronary effects of adenosine.
Cardiovasc Res. 2010 Jul 15;87(2):311-9. Epub 2010 Apr 23.