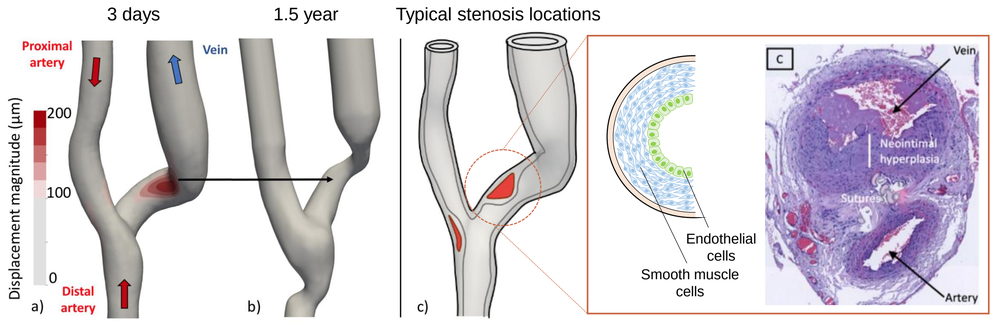
HIGH-FREQUENCY VIBRATIONS AND VASCULAR REMODELING: IN-VITRO INVESTIGATION OF ARTERIOVENOUS FISTULA (AVF) STENOSIS MECHANISMS

Elena Carrara[1], Marta Ripamonti[1], Andrea Remuzzi[2], Michela Bozzetto[1], Chiara Emma Campiglio[2]

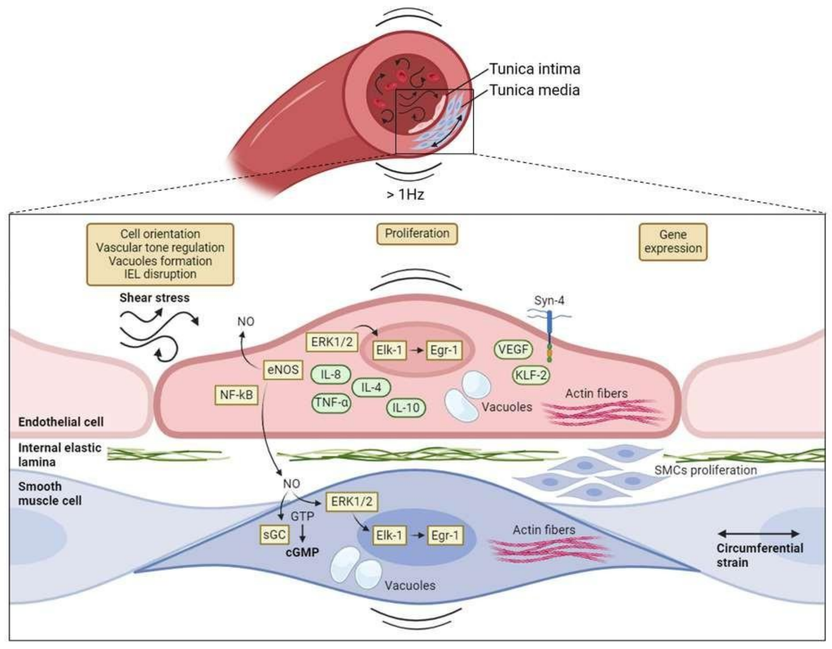
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1. INTRODUCTION

Arteriovenous fistula (AVF), the vascular access created for hemodialysis, fails in about 40% of the cases within one year due to stenosis caused by intimal hyperplasia (IH) [1]. Recently, it has been demonstrated that the turbulent-like blood flow developing in AVFs causes vessel wall vibrations at regions where stenosis typically occurs [2].



Several studies have investigated the impact of mechanical vibrations on vascular cell behavior, demonstrating their ability to induce both morphological and functional changes [3].

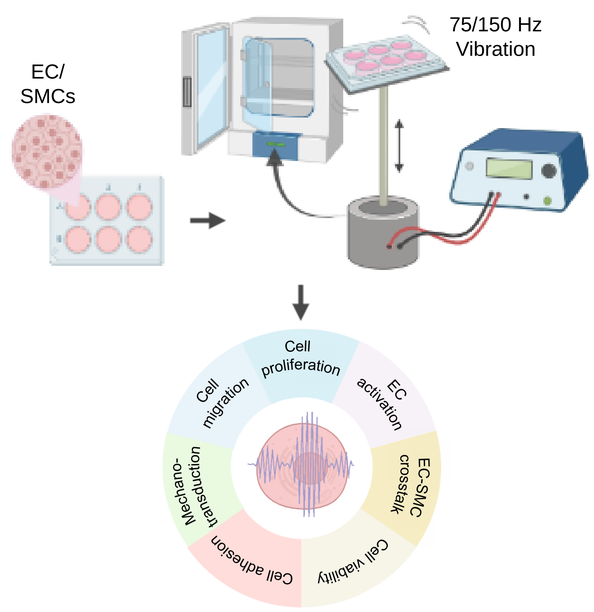


2. AIM

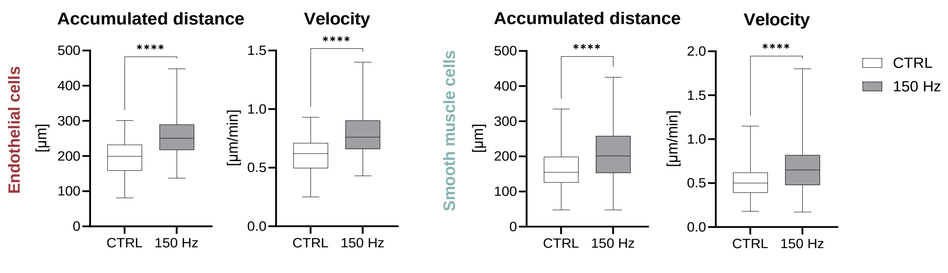
Investigate the **role of flow-induced vibrations in intimal hyperplasia** by exposing cells to vibrations at 75 and 150 Hz generated by a purpose-designed device.

3. MATERIALS and METHODS

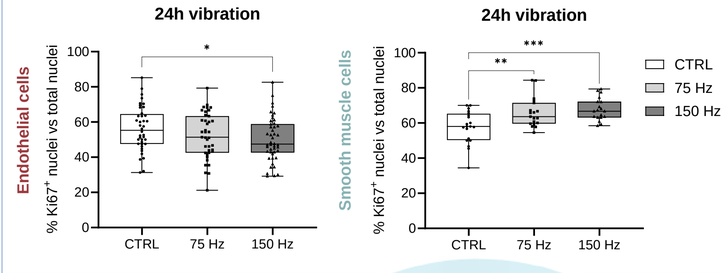
Confluent ECs or SMCs cultured in 6-well plates were exposed to vertical vibrations [4] (75 or 150 Hz) for 1 or 24 hours. At the end of the experiment, cell responses to the mechanical stimulation effect was analyzed.



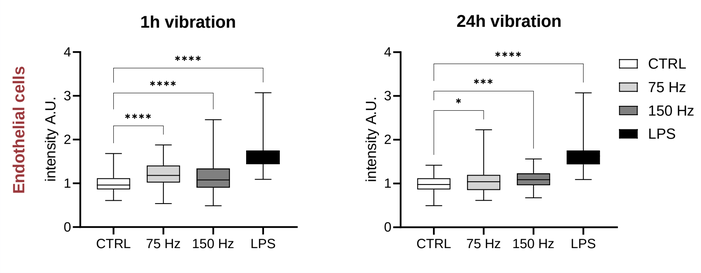
4.1. CELL MIGRATION



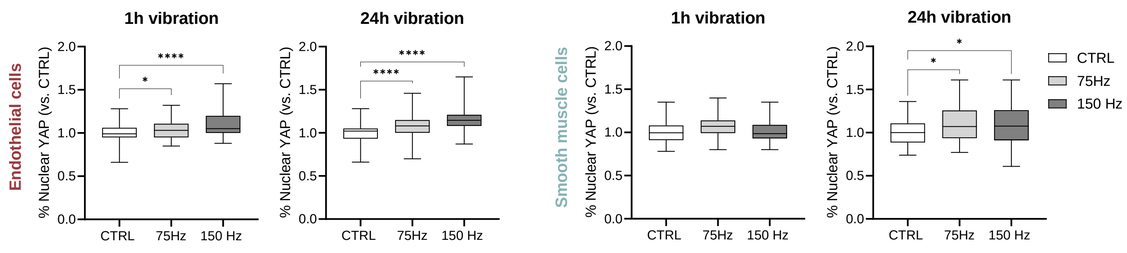
4.2. CELL PROLIFERATION



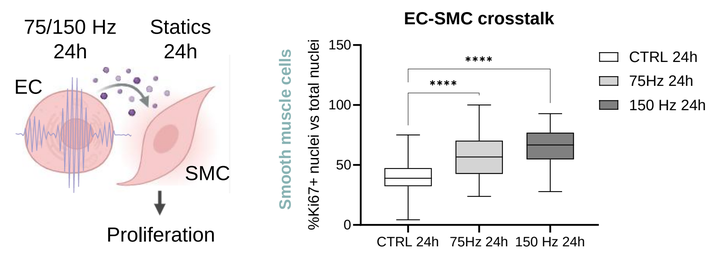
4.3. EC ACTIVATION



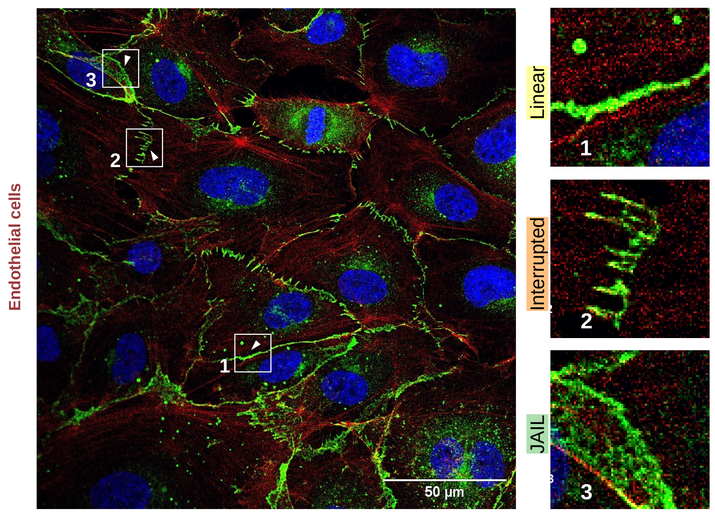
4.7. MECHANO-TRANSDUCTION



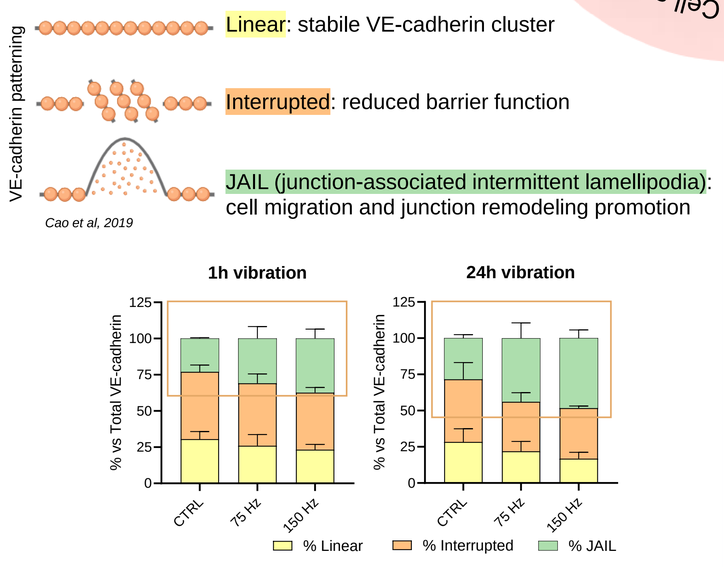
4.4. EC-SMC CROSSTALK

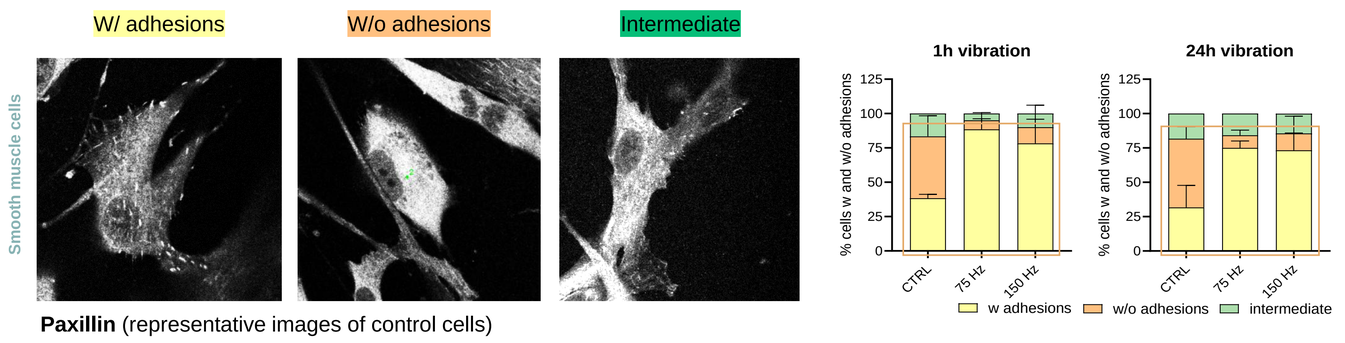


4.6. CELL ADHESION



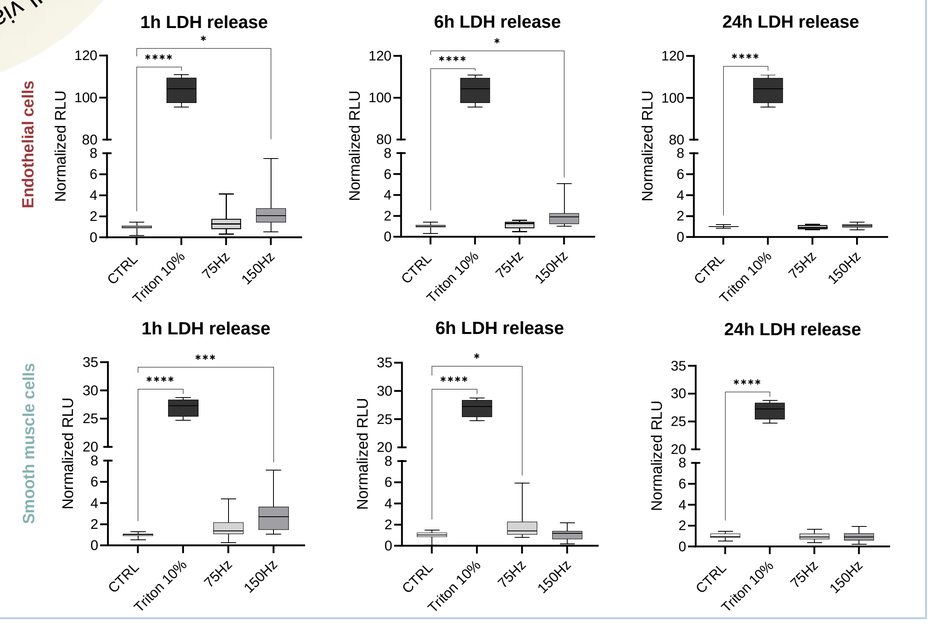
VE-cadherin (representative image of 150 Hz-stimulated cells)





Paxillin (representative images of control cells)

4.5. CELL VIABILITY



5. CONCLUSIONS

Our study demonstrates the device's applicability in exploring the effects of mechanical vibrations on EC and SMC cultures. Exposure to 150 Hz vibrations slightly and transiently impaired cell viability early on. Both 75 and 150 Hz vibrations affect cell-cell and cell-substrate interactions, maybe impacting on cell motility. 150 Hz vibrations for 24 hours enhanced YAP activation in ECs, potentially suggest an athero-prone effect, while 75 and 150 Hz vibrations promoted SMCs proliferation, potentially reflecting an early hyperplastic response contributing to neointimal formation.

References

[1] Roy-Chaudhury, P., et al. (2009) Nephrology Dialysis Transplantation, 24(9), 2786-2791
[2] Soliveri, L., et al. (2025) Kidney Medicine, 7(3),100957
[3] Carrara, E., et al (2024) The International Journal of Artificial Organs, 47(8), 590 –601
[4] Ponti, F., et al (2022) J Nanobiotechnology. 2022 Nov 19;20(1):489.

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