

SUBNORMOTHERMIC MACHINE PERFUSION IN THE NON-HUMAN PRIMATE FOREARM MODEL: A PRELIMINARY STUDY

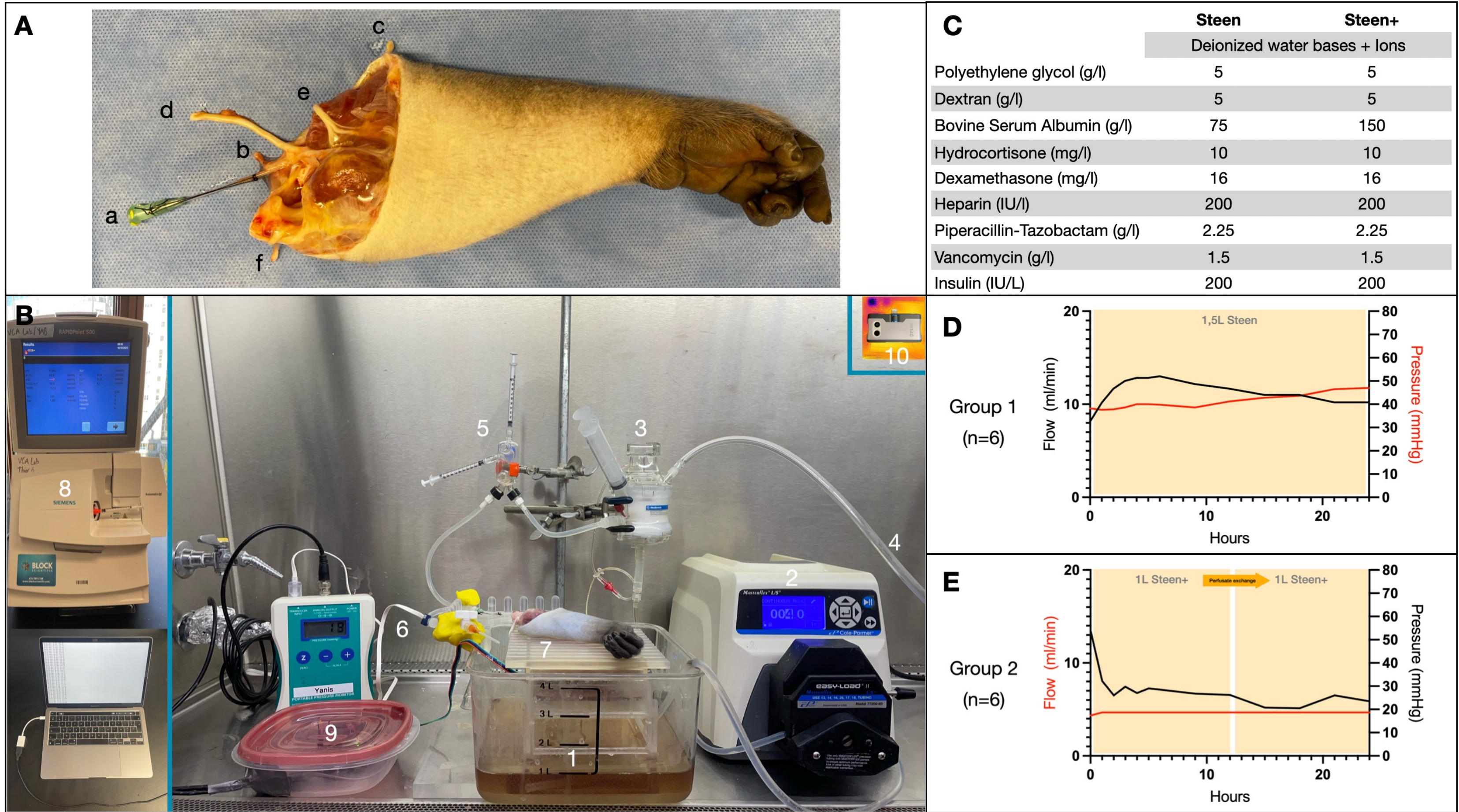
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Introduction

- The gold standard for preserving vascularized composite allotransplants (VCA) is 4°C Static Cold Storage (SCS).
- Subnormothermic machine perfusion (SNMP) is a promising alternative to SCS.
- SNMP studies are limited to small animal and swine models.
- There is a need for a physiological and preclinical large animal model.
- We describe SNMP for 24hours in the non-human primate forearm model.

Methods

- Forearms:** n=12, Cynomolgus Monkeys.
- 2 groups:** 6 limbs preserved in the standard group 1 for 24hrs VS 6 limbs preserved in the optimized group 2.
- Monitoring:** every hour (6 h) , then every 3 hours (18 h).
- Measurements (inflow and outflows):** Flow, pressure, weight, temperature, [K], [Ca], [Na], [Cl], [Lactate], [HCO3], [glucose], P02, PCO2, pH.
- Assessments:** neurostimulation, contrast X-rays, histology.



A - Brachial artery (a), brachial veins (b), cephalic vein (c), median (d), radial (e) and ulnar (f) nerves.

B - SNMP Set Up. Perfusate reservoir (1), pump (2), oxygenator (3), carbogen mixture (4), bubble trap (5), pressure sensor (6), 3D-printed scale (7), Rapidpoint500® system (8), microcontroller (9), FlirOne® smartphone-based thermal camera (10).

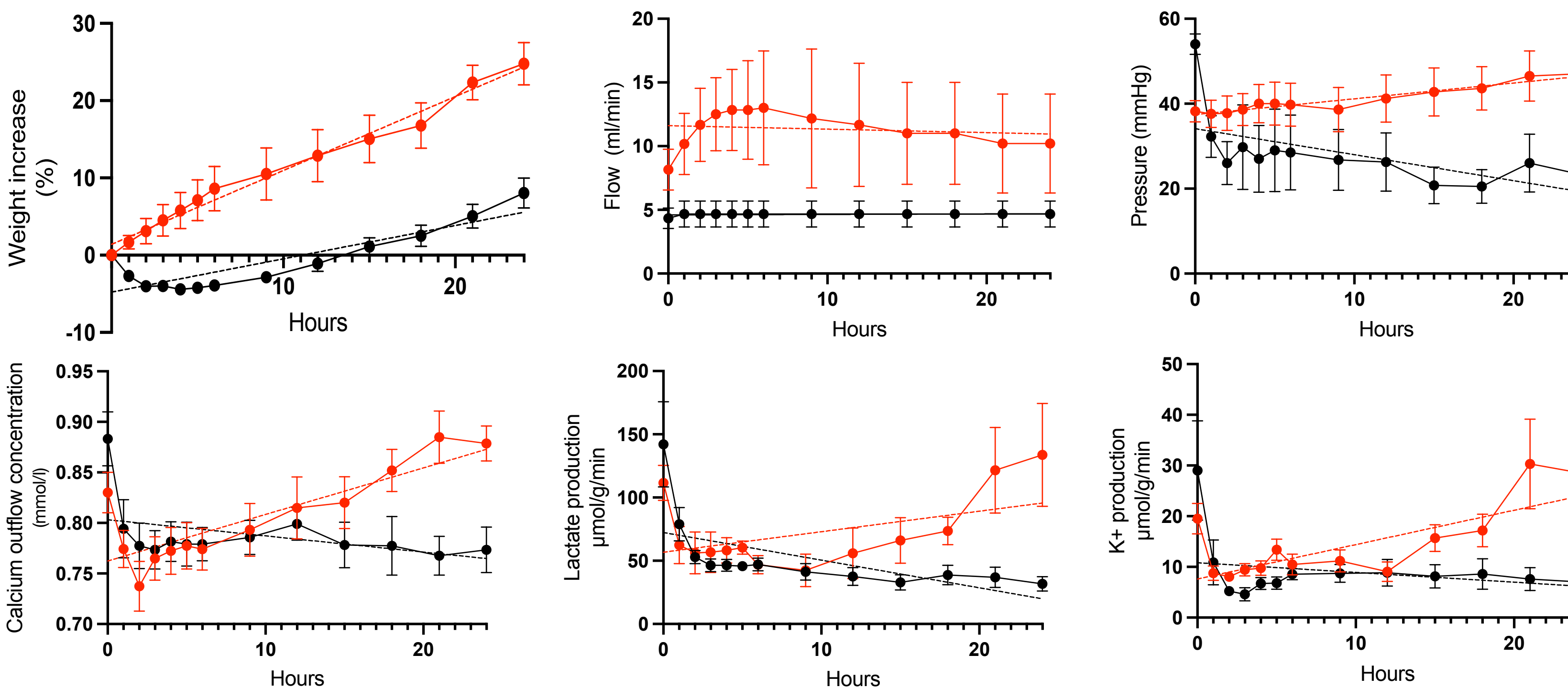
Methods

C - Main perfusate compounds and concentrations in both Steen and Steen+ solutions.

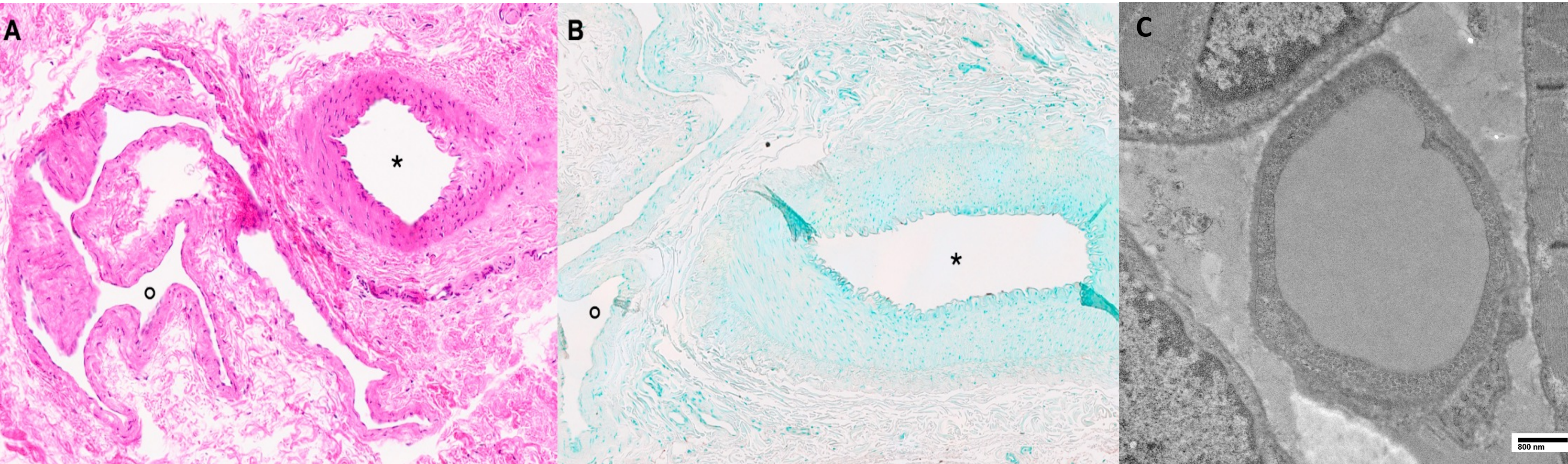
D - In group 1, the pressure is aimed to be the stable parameter (red) and 1,5 liters of recirculating Steen solutions are used for the entire experiment.

E - In group 2, the flow rate is kept stable (red), and 1 liter of fresh Steen+ solution is recirculated for 12 hours.

Results

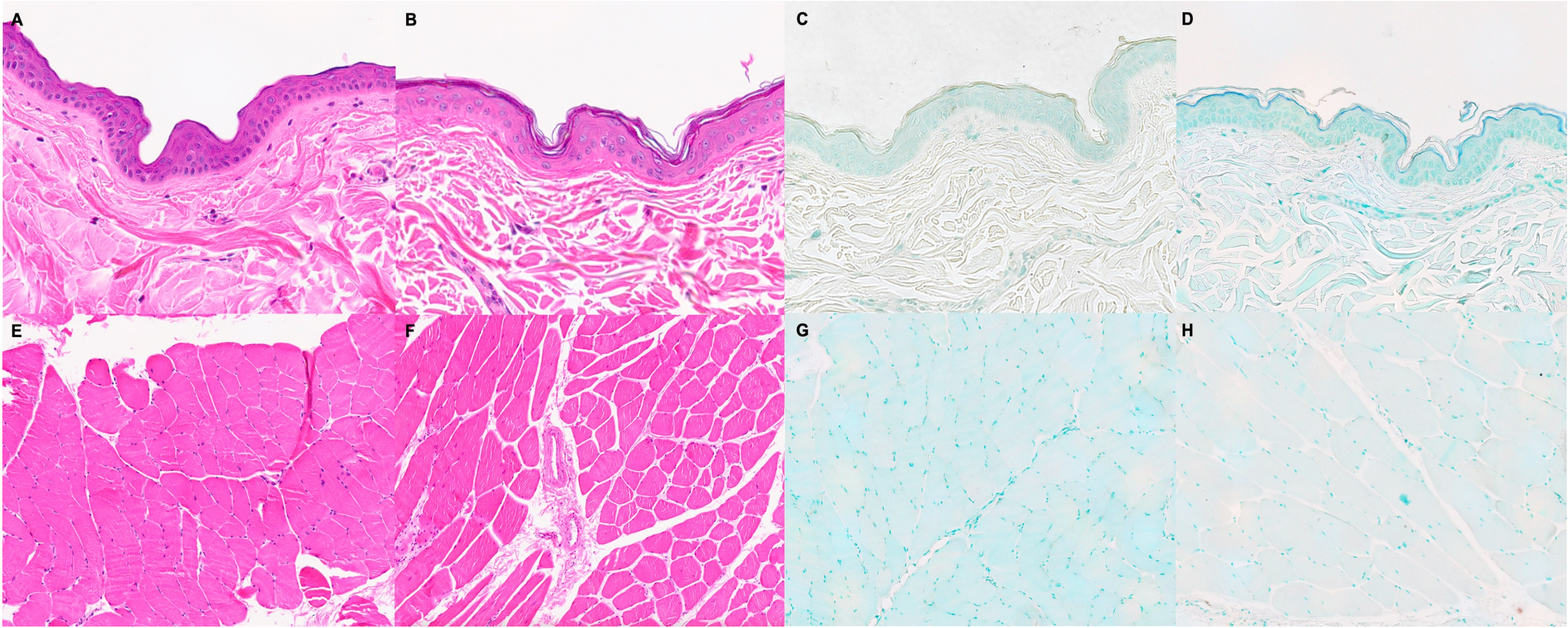


Perfusion and metabolic parameters demonstrating the onset of a compartment syndrome at mid-perfusion in group 1 (red) and an optimal preservation in group 2 (black).

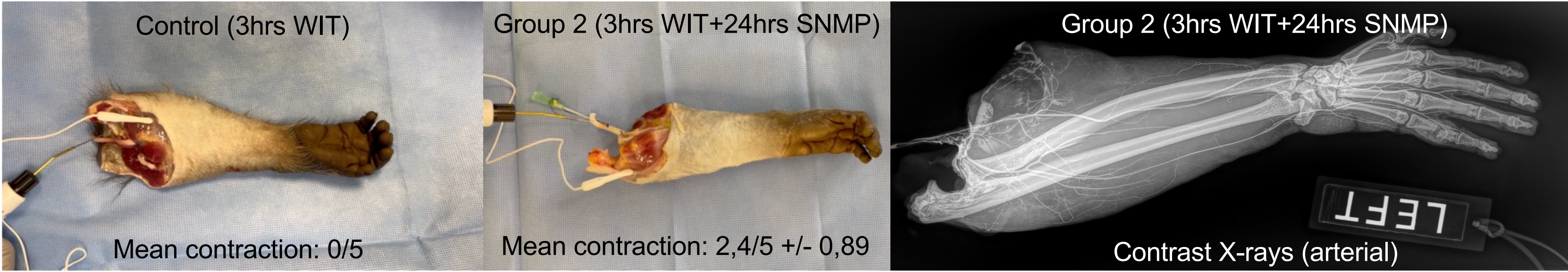


Representative histology of group 2 after 24 hours of SNMP. Proximal artery (*) and vein (°) sections stained with H&E (A) and Tunel (B) demonstrating structural integrity and absence of apoptotic cells. Electron microscopy shows well preserved capillaries (C).

Results



Representative histology of group 2. skin (H&E) X20 before (A) and after (B) perfusion; skin (Tunel) X20 before (C) and after (D) perfusion; muscle (H&E) 10 before (E) and after (F) perfusion; muscle (Tunel) X10 before (G) and after (H) perfusion. The only difference noticed is the appearance of limited interstitial edema after 24 hours of SNMP.



Conclusion

- Group 1: The onset of compartment syndrome helped understand the physiology of this experimental model.
- Group 2: stable perfusion was achieved, approaching physiological equilibrium, with no apparent structural damage to the limb. The optimized 24 hours preservation. protocol helped recover muscle contractility after 3 hours of warm ischemia.
- Clinical relevance of the model for VCA from donors in cardiac arrest and major limb replantation.

Acknowledgments

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