Preconditioning by Pressure Controlled Cupping Enhances Survival of Random Flap in Rat Model

Kyung S. Koh,M.D., PhD., Sung Woo Park, M.D., Tae Suk Oh, M.D., PhD., Jong Woo Choi, M.D., PhD.

Disclosure/Financial Support

None of the authors has a financial interest in any of the products, devices, or drugs mentioned in this manuscript.

INTRODUCTION

Flap survival is essential for the success of soft tissue reconstruction, and surgical and medical methods aimed to increase flap survival have been previously introduced. Flap survival is affected by the innate vascular supply, therefore traditional methods of preconditioning mainly target vasodilatation or vascular reorientation to increase blood flow to the tissue. External stress on skin such as external volume expander or cupping induces vascular remodeling which were adopted in the field of fat grafting or Asian traditional medicine.

MATERIAL AND METHODS

In this study, we used a rat random flap model to study the effectiveness of a preconditioning using externally applicable device (cupping) at the flap site through which negative suction was directly applied on skin. Flap surgery was performed after preconditioning for 30 minutes every 5 days, followed by 9 days of postoperative observation.

RESULTS

Flap survival was assessed as the area of viable tissue compared to a control group.The results showed 19.03±7.6% improved viability of the flap following negative pressure preconditioning. Tissue perfusion was increased by 24.23±10.38%, and histologic analysis of H&E, CD31 and Masson-Trichrome staining showed increased vascular density in the subdermal plexus and more organized collagen production with hypertrophy of attached muscle.

CONCLUSION

Our data suggests that mechanical stretching caused by externally applicable device induces vascular remodeling, which leads to increased tissue perfusion and enhances flap survival.

REFERENCES

1. Heit, Y. I., Lancerotto, L., Mesteri, I., Ackermann, M., Navarrete, M. F., Nguyen, C. T., ...&Orgill, D. P. (2012). External volume expansion increases subcutaneous thickness, cell proliferation, and vascular remodeling in a murine model. *Plastic and reconstructive surgery*, *130*(3), 541-547.
2. Tham, L. M., H. P. Lee, and C. Lu. "Cupping: from a biomechanical perspective." Journal of biomechanics 39.12 (2006): 2183-2193.
3. Pietramaggiori, G., Liu, P., Scherer, S. S., Kaipainen, A., Prsa, M. J., Mayer, H., ...&Orgill, D. P. (2007). Tensile forces stimulate vascular remodeling and epidermal cell proliferation in living skin. Annals of surgery, 246(5), 896-902.

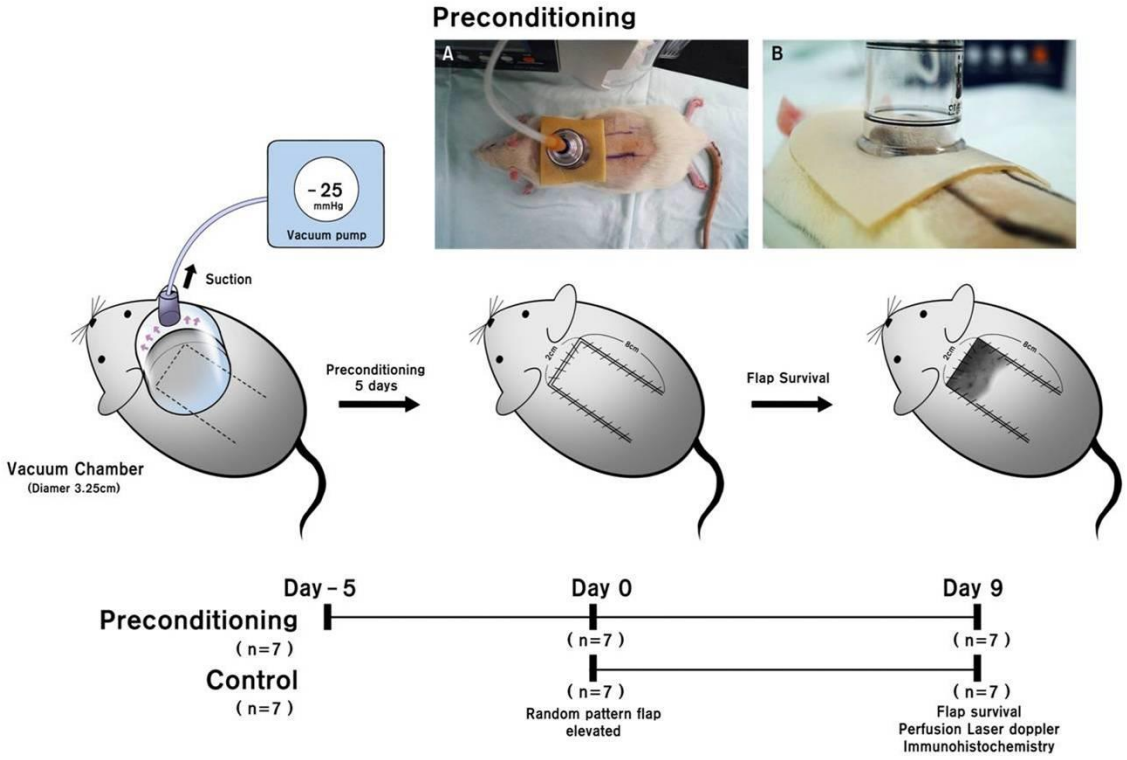
FIGURE LEGENDS

Figure 1.

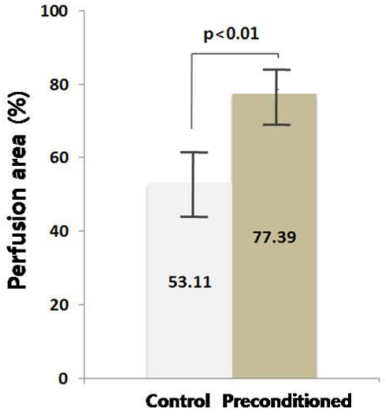
Experimental model of preconditioning with an external negative pressure chamber

Figure 2.

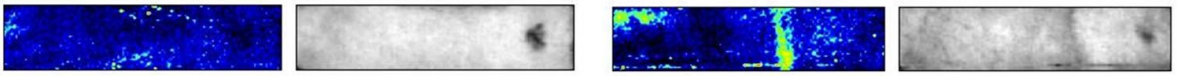
Macroscopic evaluation of flap survival area using digital photographs. Preconditioned group show average extra 1.9±0.7cm more flap survived area than control group.


Preconditioning
A
B
- 25
mmHg
Vacuum pump
Suction
Vacuum Chamber
(Diamer 3.25cm)
Preconditioning
5 days
Flap Survival
2cm
8cm
Day - 5
Day 0
Day 9
Preconditioning
(n=7)
Control
(n=7)
(n=7)
(n=7)
(n=7)
(n=7)
Random pattern flap
elevated
Flap survival
Perfusion Laser doppler
Immunohistochemistry

Laser Doppler Perfusion Analysis



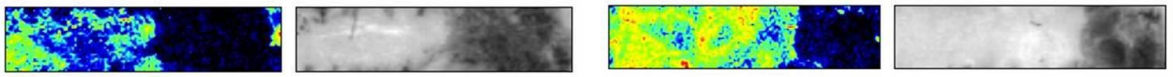
B. Perfusion analysis before & after preconditioning



Before preconditioning

After 30 minutes preconditioning

C. Perfusion analysis after 9 days from random flap elevation



Control group

Preconditioned Group