

The Effect of Pressure and Shear on Fat Grafting

Jeffrey Lee, MD; John Kirkham, MD; Mike McCormack, MBA; Alexa Nicholls, BS; Mark Randolph, MS; William Austen, Jr., MD

Abstract

Introduction: Fat grafting has become routine in Plastic surgery due to low donor site morbidity, low complication rate, and fast recovery time. Two critical variables are pressure and shear, both defined as force divided by area. In this study, we examined the role of pressure and shear on human fat grafts in a nude mouse model.

Methods: *Negative Pressure:* Liposuction was performed in the laboratory on panniculectomy specimens. Suction pressure was either -15 inches Hg (-0.5 atmosphere) or -25 inches Hg (-0.83 atmosphere). Lipoaspirate was centrifuged at 1200G and injected into the flanks of nude mice. *Positive Pressure:* Lipoaspirate was obtained and positive pressure was applied up to 6 atmospheres for up to 3 minutes and then injected into nude mice. *Shear Stress:* Lipoaspirate was centrifuged at 1200G for 3 minutes and then injected at two different speeds: fast flow rate (3-5 cc/sec) versus slow flow rate (0.5-1 cc/sec). After 4 weeks, the fat grafts were analyzed for weight and histology.

Results: *Negative Pressure:* There were no differences in weight or histology with high versus low suction pressures. *Positive Pressure:* Application of positive pressures up to 6 atmospheres for up to 3 minutes did not create a significant difference in graft weight or histology at 4 weeks. *Shear Stress:* In vivo, a slow injection pressure yielded a 38% increase in weight ($p < 0.001$) compared to fast injection. Histology was similarly affected.

Conclusion: Higher aspiration pressures up to -0.83 atm did not affect fat grafts viability in vivo. Positive pressure up to 6 atmospheres over time (up to 3 minutes) also did not affect fat graft viability. The degree of shear stress, which is a function of flow rate, did significantly affect fat graft viability. Fat grafts injected slowly with low shear stress significantly outperformed fat injected with high shear stress.