**Purpose:** Blood vessel growth is essential for the viability of all tissues. Angiogenesis is paramount to normal development, injury recovery, and more recently, vital to the integration of bioengineered grafts. However, innate blood vessel proliferation is slow and often inadequate. Therapeutic angiogenesis aims to stimulate the growth of new blood vessels from preexisting vasculature using various strategies such as exogenous pharmacologic stimulation, cytokine supplementation, stem cells, and in situ cell homing. However, widespread clinical translation has proven suboptimal and the side-effects significant. Here we describe a novel microsurgical intervention to safely induce rapid therapeutic angiogenesis, which could be used in a variety of settings.

**Methods:** The rat hindlimb macrovasculature (N=10) was micropunctured (MP) using a 60 μm diameter needle at defined intervals prior to implantation of a prepared Type I collagen scaffold directly on top of the punctured segment. The contralateral hindlimb served as a normal (non-micropunctured) intrinsic control. Collagen grafts and the underlying vascular segment were explanted en bloc for gross and histologic analysis after 24, 48, and 72 hours. Cellular infiltration and capillary ingrowth were assessed per high powered field (HPF) following trichrome staining. Single cell-lined lumens were characterized by both number and diameter; from which the overall perfusable area was calculated. The presence of endothelial cells was verified by CD31/PECAM-1, von Willebrand factor (vWF), and Tie2 immunofluorescence staining. Endothelial cell proliferation was estimated by VEGFR2, Notch 1, and delta-like 4 (DLL4). Statistical significance was determined using the one-tailed Mann-Whitney U test.

**Results:** Micropunctured vessels demonstrated an increase in cellular infiltration, capillary outgrowth and luminal diameter across all time points when compared to non-micropunctured samples. This resulted in a two-fold overall increase of perfusable area within the explanted collagen, reaching statistical significance (P<0.05) at 24 and 72 hours. Immunofluorescence labeling of CD31, vWF, and Tie2 confirmed the increased presence of endothelial cells along the periphery of measured luminal structures in micropunctured specimens. Additionally, micropunctured samples exhibited increased cellular staining of VEGFR2, Notch 1, and DLL4. This suggests the specific proliferation of endothelial stalk and tip cells which are fundamental to sprouting angiogenesis.

**Conclusion:** Microsurgical induction of angiogenesis was first described with the arduous creation of arteriovenous-loops. However, the time to new capillary formation is slow, limiting widespread clinical translation. Here we describe an innovative alternative technique that leads to the rapid proliferation of endothelial cells and robust capillary formation. Because our approach evaluates the paradigm of therapeutic angiogenesis from a completely novel perspective it has enormous potential to mitigate ischemia in both conventional surgery and bioengineered applications.

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**Latissimus Dorsi-rib Osteomyocutaneous Flap For Composite Cranial Defects: Report On 8 Cases And Anatomical Study**

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**Purpose:** Latissimus dorsi-rib osteomyocutaneous flaps (LDRFs) are versatile in reconstructing compromised composite defects of the cranium. The flap restores the contour of the skull, protects the brain, and improves neurologic status. There are benefits to using autologous rib instead of alloplastic material; however, rib viability and flap success rely on adequate blood supply. Our aim was to present the outcomes of 8 patients treated with LDRF and provide an anatomical basis for this flap.

**Methods:** Eight patients with cranial defects treated with LDRF were evaluated retrospectively. Defect size, etiology, previous reconstructive attempts, outcomes, and complications were assessed. Patient reported outcomes were assessed with 36-Item Short Form Survey, Selective Functional Movement Assessment test, Karnofsky Performance Scale test, Functional Independence Measure test, Barthel test, University of Washington Quality of Life Questionnaire, Headache Disability Index, The Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) and Pain Disability Questionnaire. Red latex was injected into the subscapular arterial system of 20 fresh cadaver sides. In the prone position, latissimus dorsi muscle was dissected from the ribs in a mediocaudal to superolateral direction to locate interconnecting vessels between the thoracodorsal and lateral posterior intercostal systems. The number, diameter
and length of perforators, and distance from midline were measured. Statistical analysis was performed with SPSS 16.0, one-way ANOVA, and post-hoc Tukey’s tests.

**Results:** All patients had a history of ≥2 previous failed reconstructions. Defects were secondary to gunshot injury, bone flap infection after cranioplasty performed for CVA and aneurism clipping, post-ablation irradiation, and post-frontal intracranial hemorrhage cranioplasty. Four defects were reconstructed using 2 ribs, whereas the remaining 4 patients received 1 rib. A prolene mesh was used to fill in the donor site defects in 6 patients. Average follow-up was 26 months (1-56 months). All patients had stable reconstructions. Headache resolved in 2 patients after reconstruction, and neurologic status improved in 3 patients. All patients showed some donor site morbidity with an increase in the Pain Disability Index. An average of 13.75 perforators could be localized in each cadaveric latissimus dorsi muscle. No perforator was found for the 7th rib. Not all cadaver sides contained perforating vessels for the 8th and 12th ribs. The distance from the midline to the first perforator was not different between the ribs (p = 0.499). Perforator diameter and pedicle length tended to decrease at more inferior rib levels. The 10th rib (4.65 ± 2.01) followed by the 9th rib (3.7 ± 1.63) had the highest number of perforators. The 8th and 12th ribs contained the least perforators. The 8th rib had the longest perforators (4.26 ± 1.52 cm). The 8th and 9th had larger perforators than the 10th-11th-12th ribs (p = 0.021).

**Conclusions:** The LDRF can successfully address large composite cranial defects, provide support, and enhanced contour with acceptable donor-site morbidity. The 10th followed by the 9th rib has the best vascular supply for this flap. If 2 ribs are considered for the flap, the 9th and 11th are recommended. If only 1 rib is necessary for reconstruction, the 10th is ideal.

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**A “Free Flap Timeout” Improves Maintenance Of Blood Pressure Goals In Cases Of Free Tissue Transfer**

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**Purpose:** Free tissue transfer has been established as an invaluable technique within the field of reconstructive surgery. While there is no consensus regarding the optimal intraoperative blood pressure during cases of free tissue transfer, it has been demonstrated that intraoperative hypotension confers an increased risk of complication and flap failure. Blood pressure preferences vary from surgeon to surgeon. Maintenance of goal blood pressure is carried out by the anesthesia team but is heavily dependent on “across-curtain” communication. We chose to study the effect of a formal “free flap timeout” on maintenance of intraoperative blood pressure during cases of free tissue transfer at the University of Wisconsin.

**Methods:** A formal free flap timeout card was created containing a script, which was performed following the standard surgical timeout. The script included: 1) A statement that blood pressure is a major factor in the case, 2) A goal systolic blood pressure of 110mmHg (determined by a staff survey), 3) A prompt to share preferred interventions for maintenance of blood pressure, and 4) The specific request that anesthesia notify the surgical team when such measures are being employed. The anesthesia team was provided a “hand-off card” to keep at their station, which was used to record the blood pressure goals and preferred interventions during the timeout. Chart review was used to assess blood pressure during free flap cases prior to and following the installment of our “free flap timeout.” We recorded the number of instances systolic blood pressure dropped below the set goal during each case, how long each episode of sub-goal blood pressure lasted, the trough blood pressure of each episode, and the total amount of time the blood pressure spent below goal for the entire case. Data from pre- and post-intervention groups were compared using unpaired t-tests.

**Results:** A total of 68 pre-intervention and 55 post-intervention cases were assessed. Following our intervention, the duration of blood pressure episodes below goal significantly improved from a mean of 25.8 minutes to 15.8 minutes (p<0.0001). We also saw a significant improvement in the number of blood pressure dips per hour, decreasing from a mean of 4.4 dips to 1.7 dips (p<0.0001). The percentage of the case spent below the goal pressure significantly decreased from 48.1% to 36.9% (p=0.0045). The average trough blood pressure of each episode showed improvement from 97.8 mmHg to 99.0 mmHg, though was not significant (p=0.15).

**Conclusion:** We have demonstrated that a formal “free flap timeout” improves maintenance of intraoperative blood pressure during cases of free tissue transfer at the University of Wisconsin. Opportunities for explicit discussion of goals