Represents the change in selected genes’ expression (as fold change) in the same model, showing the level of expression at the apex (i.e. area of maximal stretch), the side, and base of the expander compared to contralateral controls. These data show correlation between the magnitude of stretch and fold change in gene expression. Subsequent isogeometric analysis provides the tools for determination of the proportion of tissue growth attributable to expansion versus elastic stretch or animal growth.

CONCLUSION: We have correlated skin growth with changes in gene expression levels and the mathematically calculated mechanical forces applied to each tissue expansion scenario tested. With the addition of histological analysis, we will attain a multi-scale model of skin expansion. Future translational studies will aim to guide tissue expansion protocols in humans to minimize complications and maximize tissue growth.

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Reflexive Visual Inspection of Cleft Lip Faces - Analysis of Lookzone Focus Over Time

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PURPOSE: Humans reflexively inspect faces. Elucidating facial lookzone focus over time of cleft lip faces may offer insight into the early visual processing of facial normality/abnormality. By delineating the time sequence of visual impression formation, surgeons and their patients may pinpoint the most salient facial features so as to better direct prioritization of surgical reconstruction.

METHODS: 179 experimental and 179 control facial images were obtained from the senior author’s practice. Experimental images included 41 individuals with repaired cleft lip, and a variety of other facial diagnoses. 720 subjects rated the images for attractiveness. Twenty standardized lookzone regions were mapped onto each facial image. A separate group of 402 subjects observed the images while an infrared eye-tracking camera continuously recorded their eye movements for 6 seconds. R console TraMineR was utilized to analyze the time sequence data. The gender and personal history of observer facial deformity was recorded. OUTCOMES MEASURED: Image attractiveness was rated on a 1–7 Likert scale. Total number of eye fixations within different lookzone regions was recorded continuously over the 6 seconds viewing period.

RESULTS: (i) All observers start focusing on the face after 500ms, and on the cleft defect 200ms after facial scanning, but they revert to the control pattern of focusing on the peri-orbital area after 2400ms. (ii) Male maintain their focus on cleft defect much longer than females (3600ms vs 1800ms) (iii) Observers with family history of facial deformity maintain their focus on cleft defect throughout the 6000ms viewing period, while those without facial history lose focus on the cleft defect after 2000ms. (iv) The attractiveness ratings of the cleft images had no discernable impact on the sequence of reflexive inspection of the cleft images, except for the most attractive cleft images, for which the lip was not focused upon at all (but rather the nasal deformity). (v) Laterality of the cleft deformity did not impact the sequence of facial inspection, but bilateral clefts were less of a visual draw, with reversion to a control pattern of inspection early, versus a more continued focus on the cleft defect for unilateral clefts.

CONCLUSION: Observers are reflexively drawn to the abnormal region of cleft faces upon immediate exposure, before reverting to a more natural pattern of facial inspection after about 2.5 seconds. Unilateral clefts - and cleft faces that are considered less attractive overall - induce a more sustained fixation within the perioral region. A personal history of facial deformity in general appeared to heighten sensitivity for cleft deformity. Males focused longer on the cleft defect compared to females.

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PURPOSE: Autologous free flaps may be used to reconstruct defects arising in a variety of contexts, including trauma and cancer. With improving microsurgical techniques flap failure rates are decreasing; however, this devastating complication may still occur in up to 5% of cases. In this study, we present results of a first in-human trial of a new, non-invasive, optical oxygen-sensing liquid bandage (OSLB) formulation in post-operative monitoring of tissue perfusion.

METHODS: Four women undergoing mastectomy and deep inferior epigastric artery perforator (DIEP) flap reconstruction were prospectively enrolled from February-June 2017. In addition to standard post-operative monitoring with near-infrared spectroscopy tissue oximetry (ViOptix), the OSLB was painted on the flap skin paddle. The formulation consists of New-Skin™ liquid bandage, incorporating an oxygen-sensing metallo-porphyrin exhibiting bright red phosphorescence and the green-fluorescing reference dye: fluorescein. Using a custom-modified camera with red and green filters, we captured phosphorescence and fluorescence, respectively, at regular time periods for 48 hours post-operatively. The relative phosphorescence intensity was calculated.

RESULTS: Three Caucasian and one African American woman took part. Two cases were bilateral, producing a total of six breasts. When comparing the OSLB red/green ratio with the ViOptix, an inverse correlation was observed, as expected. Notably, this persisted for an African American patient with Fitzpatrick Type V skin. No complications or flap losses occurred.

CONCLUSIONS: The success of attempted flap salvage is highly reliant on early identification of flap compromise and prompt re-exploration. Results show that OSLB phosphorescence intensity correlates well with the stO2 values provided by our current gold standard of care, the ViOptix. The OSLB proved easy to apply and remove, was well-tolerated, and enabled visualization of flap skin due to its intrinsic transparency. Moreover, we demonstrated successful use of the OSLB in a patient with Fitzpatrick type V skin. This oxygen-sensing liquid bandage offers reproducible, accurate detection of tissue oxygenation. Further research is needed to validate this technology on a larger scale.

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A New Hernia Mesh Precisely Engineered to Prevent Hernia Recurrence

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PURPOSE: Approximately 405,000 ventral hernia repairs are performed annually in the US and the recurrence rate is approximately 20% as a result of failure at the suture, mesh, tissue anchor interface. To overcome this failure mode, we invented a knitted polypropylene hernia mesh with suture-like integrated mesh extensions that are 15X the surface area of #0 suture and anchor the mesh akin to suture. Physicomechanical benchtop and sterility testing was completed to FDA standards and the test mesh was implanted in swine to determine anchoring strength compared to a control reference mesh.

METHODS: The polypropylene T-line mesh was fabricated with extensions .5-1cm wide, 50cm long, and spaced 2cm apart. Mesh thickness was 0.5mm, average pore size 2.8mm and density was 90g/m2. Tongue tear resistance, ball burst, suture retention, tensile strength-strain, and extension tensile strength testing were performed (n=10 per each test) and compared to a control reference polypropylene mesh. Meshes were sterilized by ethylene oxide, gas, and gamma sterilization (n=10 per each mesh) and physicomechanical testing performed post sterilization. The test mesh and predicate mesh were implanted in a swine ventral hernia model (n=4) and harvested 1 day post-operatively for mechanical testing to model mesh/suture/tissue failure in the peri-operative period when anchor strength is needed most. Future efforts are directed towards manufacturing the T-line mesh mesh with needles swaged onto the extensions, determining packaging conformations, and completing systemic and local tissue toxicity testing per FDA standards for 510(k) clearance. The T-line mesh has the potential to dramatically reduce hernia occurrence and recurrence.

RESULTS: In vitro mechanical performance demonstrated that the T-line mesh outperformed the control predicate mesh in all tested parameters. Mechanical analysis of swine specimens demonstrated the mean peak load to failure for T-line mesh was 134.5 N (SD +/- 54.5 N), compared to 49.0 N for the control reference mesh (SD +/- 13.4 N). The T-line mesh failure always occurred by the extensions tearing through tissue. The control mesh failed 60% of the time by one suture tearing through tissue and the second suture tearing through mesh, and the remaining 40% of failures was from both sutures tearing through mesh. The T-line mesh significantly outperformed control mesh and averaged 275% stronger on peak load performance.

CONCLUSION: The T-line mesh is a polypropylene, macro-porous, heavyweight mesh that meets all FDA standards and outperforms a control predicate mesh in all mechanical performance tests. The T-line mesh can be sterilized by ethylene oxide, gas, or gamma sterilization without undue effects. The T-line mesh is 275% stronger than a control reference mesh in the immediate post-operative period when anchor strength is needed most. Future efforts are directed towards manufacturing the T-line mesh mesh with needles swaged onto the extensions, determining packaging conformations, and completing systemic and local tissue toxicity testing per FDA standards for 510(k) clearance. The T-line mesh has the potential to dramatically reduce hernia occurrence and recurrence.

Poly-caprolactone Nanofiber Nerve Wrap Improves Nerve Regeneration and Rodent Functional Outcomes after Delayed Nerve Repair

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PURPOSE: Proper nerve repair plays a critical role in facilitating a neuron’s ability to regenerate an axon after nerve injury. Unfortunately, nerve repairs can be compromised by scar proliferation and inter-fascicular connective tissue formation. These factors can have a deleterious impact on patient recovery. As a result, there has been a long-standing clinical interest in developing neuroprotective agents that can reduce the scar burden and improve peripheral nerve regeneration after nerve transaction. The purpose of this study was to assess the efficacy of biodegradable, electrospun poly-caprolactone (PCL) nanofiber nerve conduits in improving nerve regeneration. We hypothesized that PCL