Presenter: Meghan McCullough, MD
Co-Authors: Caroline Yao, MD, MS; Allyn Auslander, MPH; Jordan Swanson, MD, MS; Thomas Imahiyerobo, MD; Pedro Sanchez, MD; William P. Magee, MD, DDS
Affiliation: University of Southern California, Los Angeles, CA

INTRODUCTION: There is no universally accepted severity scale for unilateral cleft lip that quantifies the spectrum of disease. Furthermore, measurement systems utilizing calipers are cumbersome, time-consuming and difficult to standardize. Facial Dysmorphology Novel Analysis technology (FDNA, Inc, Boston MA) enables automatic detection and evaluation of subtle craniofacial dysmorphology, as well as recognizable facial patterns associated with multiple rare diseases, by processing and analyzing regular two dimensional facial photographs. This study serves as a preliminary technical analysis to assess the potential of FDNA’s technology to automatically identify severity levels of unilateral cleft lip.

METHODS: 30 frontal facial images of patients with cleft-lip were uploaded to the HIPAA compliant Face2Gene tool. These images were collected on four different Operation Smile missions in Bolivia, Madagascar, Morocco and Vietnam, representing broad ethnic diversity. Three cases were excluded from this cohort due to image problems, leaving a total test set of n=27. In addition, images of unaffected controls (n=100) were collected from independent resources. A severity scale was created based on holistic image analysis, using the proprietary FDNA technology.

RESULTS: FDNA technology demonstrated an ability to able to discriminate between unaffected controls and the affected cohort. Additionally, FDNA demonstrates the ability to recognize a spectrum of severity within cleft cases. Severity index ranged from 0.103 (representing the least severe) to 1.270 (representing the most severe), mean 0.69 (SD 0.29).

CONCLUSION: Current methods of preoperative morphologic evaluation of unilateral cleft lip are subjective and non-standardized, making a universal discussion of disease severity difficult. Additionally, standardized, objective measurements utilizing calipers are difficult to obtain in an awake child. FDNA technology provides the potential for development of a computer-generated cleft severity scale for a rapid, clinically practical, simple and standardized evaluation of preoperative severity.

Optimizing Measurements in Plastic Surgery through Holograms with Microsoft Hololens

Presenter: Kian Adabi, BA
Co-Authors: Hayeem Rudy, BA; Carrie S. Stern, MD; Katie Weichman, MD; Oren Tepper, MD; Evan S. Garfein, MD
Affiliation: Montefiore Medical Center/ Albert Einstein College of Medicine, Bronx, NY

INTRODUCTION: Microsoft HoloLens (Hololens)™ is a wearable computer headset that enables visualization and interaction with holograms. Using various laser sensors, Hololens users can take measurements in their surrounding physical space using sterile hand gestures and voice commands. This tool can be applied to clinically and ideally suited to use in the operating room given the hands free nature of the device. In this study, we use typical breast and body measures to investigate the accuracy and reliability of measurements made with Hololens.

METHODS: Using third-party software (HoloMeasure) with Microsoft HoloLens, holographic lines were projected and measured between the sternal notch to nipple, and areolar horizontal and vertical diameter. The same distances were then measured using a standardized ruler. The mean error of these measurements and the user variability was then calculated. Users were then instructed to take a 9-question survey assessing comfort level, ease of use, and overall satisfaction. Survey responses were graded on a five-point Likert scale, and averages were calculated.

RESULTS: Using Microsoft HoloLens, our group successfully made precise measurements of breast and body parameters routinely used in plastic surgery. The mean error of distance measurements was 4.3% with a SD of 0.71 among the users. The average ease of the voice-activated controls was
4.5 the average ease of using the hand gesture features was 4.7. Overall, subject rated the comfort of wearing the HoloLens highly.

**CONCLUSION:** This study shows that the HoloLens can make accurate and reproducible measurements in plastic surgery. Furthermore, our survey demonstrated the accessibility and comfort of the technology for surgeons using the device. Additional studies are underway to further define applications of this technology in plastic surgery.

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**A Benchtop Culture System for Growing Vascularized Tissues in Vitro**

**Presenter:** John P. Morgan, PhD  
**Affiliation:** Cornell University Medical College, New York, NY

**INTRODUCTION:** Tissue engineering seeks to develop physiologically appropriate tissues to restore, maintain or improve function in clinical contexts, provide platforms to study basic biological processes and screen drug candidates/delivery strategies. It aims to reduce use of patient tissue and associated morbidity at donor sites; improve economics and efficacy of drug development/ screening and replace animal testing with human tissues. The overall field has suffered from the lack of a complete toolset to control physical and biological parameters of these complex cultures and make them compatible with microsurgery. We have pioneered approaches to form microvascular networks within 3-D tissue scaffolds.1

We present an autonomous tissue cartridge (ATC) for recapitulating the microvasculature in vitro which solves these problems threefold: 1) Precise flow control within vessels, perfusing microvascular networks with nanoliter-precision control. 2) Hardware enabling fluidic, thermal and atmospheric control of cultures in a compact, portable and versatile benchtop platform. Importantly, it eliminates conventional incubators and provides live fluorescence imaging 3) Scaffolding that enables microsurgical anastomosis of cellularized vessels within 3-D matrices in animal models. Experimental results of the effect of hemodynamic forces on vascular cells provide new biological insights.

**METHODS:** Microvessel tissues were lithographically constructed in collagen and seeded with endothelial/perivascular cells. The fully assembled microfluidic tissue culture device with enclosed microvessels was cultured in the benchtop system with live imaging for 7–14 days under pump-driven flow using a range of flow rates to achieve physiologic shear stress against the vessel walls. Cell morphology, alignment and migration were analyzed.

**RESULTS:** The ATC provided consistently stable environmental/temperature control throughout extended cultures. Live imaging revealed dynamic endothelia with cells migrating throughout the vessel walls, both downstream/upstream of the flow direction. Contiguous cell-cell junctions indicated confluent, healthy endothelia with intact cytoskeletons. Microvessel cross-sectional areas expanded and changed profile from original lithographically defined squares toward elliptical cross-sections with larger dimensions. Migrating cell displacement correlated positively with applied shear stress, with maximum displacement at highest shear 2.5 Pa. Similarly, cells elongated/aligned in the direction of flow; net alignment increased with the magnitude of shear.

**CONCLUSION:** This breakthrough sets the stage for clinical translation of pre-vascularized tissues, provides new insights into relationships between hemodynamic forces and cell morphology/dynamics, and advances studies of mechano-biology seeking to identify molecular mechanisms by which cells sense shear stress.

**Reference Citation:**

1. Morgan, J. P. et al. Formation of microvascular networks in vitro. Nat Protoc 8, 1820–1836, doi:nprot.2013.110 [pii] 10.1038/nprot.2013.110 (2013).