BACKGROUND/PURPOSE: Stem cell therapy has been shown to promote tissue regeneration and wound healing. However, the isolation and expansion of mesenchymal stem cells can be an invasive, costly, and time-consuming process. Therefore, we sought to improve this process by enhancing the regenerative abilities of stem cells, thereby reducing the quantity of stem cells that must be harvested. Marijuana is a commonly used substance, both recreationally and more recently therapeutically, given its low toxicity and relatively benign side effect profile. Certain marijuana components, namely the non-psychoactive cannabidiol (CBD), have been found to function as immunomodulators. Our aim was to determine whether CBD-exposed stem cells would demonstrate improved regenerative abilities.

MATERIALS/METHODS: Human adipose-derived stem cells (ASC) and bone marrow-derived mesenchymal stem cells (BM) were treated for 6 hours with either low CBD (300 nM) or high CBD (3 mM). A Transwell Migration assay was performed, and absorbance measured at 36 hours. Next, the treated ASC and BM underwent an MTT proliferation assay, with absorbance measured at 36 hours. Finally, a wound healing scratch assay in human keratinocytes was performed, again with ASC treated with low and high dose CBD.

RESULTS: Both ASC and BM demonstrated a significant increase in migration with exposure to CBD. Compared to the control, ASC migration increased 412% with low-dose CBD, and 251% with high-dose CBD. For BM, migration increased 298% and 166% with low- and high-dose CBD, respectively. BM demonstrated improved proliferation with exposure to CBD. Compared to the control, proliferation increased 48% with low CBD, and 86% with high CBD ($P < 0.05$). There were no differences in proliferation in ASCs primed with low or high CBD ($P = 0.68$). Compared to unexposed ASCs, the low CBD ASC group had 49% faster wound closure at 20 hours and 78% at 44 hours.

CONCLUSION: CBD priming of ASCs and BM, at both low and high doses, enhances a number of regeneration parameters, suggesting that this component of marijuana induces or improves stem cell-based therapy. Given the large number of people using various marijuana products, which are largely unregulated and under-studied, these findings may greatly effect management of complex wounds after reconstructive surgery.

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Hand3D: 3-dimensional Printed Hand Simulator for Surgical Education

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PURPOSE: Simulation-based training has become widely used in surgical residency programs to complement traditional learning. Simulators provide an environment for plastic surgery residents to advance their surgical skills while keeping patient safety at a premium. Several hand-related procedures, such as percutaneous pinning with Kirshner wires, can be accomplished via a simulation model. In addition, these procedures train many of the basic motor skills required for residents such as proprioceptive feel of bone drilling and fluoroscopy. Unfortunately, many current hand simulators are inadequate. Cadaver labs provide an operation setting similar to living tissue but incur high costs with maintenance facilities and technical upkeep. In contrast, simulation bones or PVC pipes can provide proprioceptive feedback but do not provide realistic tissue anatomy or fluoroscopy training. Our goal was to design a 3-dimensional (3D) printed, anatomically accurate hand simulator for improving surgical skills.

METHODS: We created a training model hand designed entirely from the computerized tomography (CT) data of an adult male’s right hand. Engineers created volumetric solid models of the hand by segmenting the CT using a DICOM
segmentation software package (3D Slicer) and further modified in CAD software (Blender). Metacarpals and phalanges were created with polylactic material with an FDM style printer to mimic dense cortical bone surrounded by a lattice structure resembling cancellous bone. The bones were casted into a clear silicone, chosen to provide accurate density for proprioceptive feel in drilling procedures while still affording high tensile strength and durability.

RESULTS: Our device performs well in joint arthrodesis and CRPP under fluoroscopy. The hand provides excellent proprioceptive feedback to train pinning and plating due to the model’s dense cortical bone surrounding an intramedullary bone matrix. The silicone soft tissue is durable yet malleable allowing for the utilization of techniques such as Jahss maneuver or bone forceps. The model also gives high quality fluoroscopic imaging due to the discrepancies in density of the silicone soft tissues, dense cortical bone, and lattice structured intermedullary space. 3D printing using CT data provides accurate anatomy of the hand. Additionally, multiple fracture patterns and anatomic variations can be programmed into the model before printing offering a wide range of simulated clinical scenarios. The estimated cost of the device is between $200 and $300 making it significantly cheaper than high fidelity simulators or cadaver alternatives, while still providing high-quality training for motor skills and spatial reasoning.

CONCLUSIONS: With this hand simulator, we created a 3D printed, anatomically accurate, polyfracture model for resident education. Due to the model’s low cost and ability to represent a wide range of fractures and hand procedures, it has the potential to be an excellent tool in resident education. Future research with a pilot study is warranted.

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PURPOSE: Cleft-lip surgery aims to restore oral functionality while striving to achieve normal lip aesthetics. Preoperative planning using anthropological landmarks of the lip guide surgeons through the process. However, identifying and placing these markings on the fine anatomy of the lip in children can be extremely difficult and can lead to compromised functional and aesthetic outcomes. The purpose of the study is to develop a novel approach to improve the accuracy of markings for cleft-lip surgery. To do so, we developed a machine-learning algorithm which reliably places anthropological landmarks on unilateral cleft-lip pictures in order to guide intraoperative markings.

METHODS: We utilized High-Resolution Net (HRNet), a recent family of deep learning models that has achieved state of the art results in many computer-vision tasks, including facial landmark detection.¹ HRNet follows the current trend in computer vision of stacking multiple convolutional layers², but differs in one key area. Whereas previous models generally downsample the dimensionality of the input at each layer, HRNet performs this downsampling in parallel with a series of convolutional layers that preserves dimensionality, which allows for intermediate representations with higher dimensionality while simultaneously extracting lower dimension features. To adapt the facial landmark detection HRNet for our task, we employed transfer learning, a technique in machine-learning to transfer knowledge gained from a source task to a target task.³ Transfer learning has shown to dramatically reduce training time, increase accuracy on target task, and reduce required training examples in the target task.

RESULTS: For model evaluation, we calculated error using the Normalized Mean Error (NME), an evaluation metric in facial landmark detection. Here, a craniofacial plastic surgeon manually marked 50 Mulliken unilateral cleft-lip images, and these images are compared against the detected markings assigned by our algorithm. After training on our dataset, we obtained a test NME of 0.1065. In comparison, the state of the art for facial point detection test NME in other datasets is in the range of 0.0385 (300W) to 0.0460 (WFLW), but our training dataset size is about 1% the size of these benchmarks. These results illustrate the possibility of leveraging relatively small amounts of data to achieve surprisingly accurate labeling in cleft-lip annotations.

Harnessing Machine-learning to Personalize Cleft Lip Markings

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