Computer-aided design used for breast tissue reconstruction

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A technology usually reserved for designing buildings, bridges and aircraft has now been used to aid breast tissue reconstruction in cancer patients.

In a study published today, Thursday 8 September, in IOP Publishing's journal *Biofabrication*, researchers used computer-aided design (CAD) to create an extremely accurate mould of a breast that was used as a visual aid to surgeons in tissue reconstruction operations.

Furthermore, CAD was used to design and produce patient-specific physical scaffolds that could potentially be used in conjunction with one of the most promising areas of medicine - tissue engineering.

In theory, patients' own cells could be harnessed and grown onto the

highly specific scaffold and then transferred to the affected area, avoiding the need to transfer tissue from other parts of the body which can cause large scars, result in considerable blood loss and require five to ten hours of anaesthesia.

Study co-author, Professor Dietmar Hutmacher, said, "We would take a laser scan of the healthy breast and use the CAD modeling process to design a patient-specific scaffold in silico. We would then produce a scaffold of very high porosity and load it with the patient's own cells in combination with a hydrogel. The construct would then be implanted."

CAD – the use of computer technology in the process of design – holds several advantages over traditional pen and paper approaches including the ability to work to full scale, examine the design from all angles and maintain absolute accuracy.

After informed consent, 3D laser scanning was performed on three female patients who suffered from breast cancer. The images were then fed into a piece of CAD-software which produced a single image representing the patient's breast and surrounding thorax region.

This image was then "printed" to form a 3D mould which was used as an operative aid for surgeons who performed autologous tissue reconstructions – the transferring of tissue from another part of the patient's body – on each of the patients.

After each of the operations, the surgeons observed a more perfect shape with a higher degree of symmetry between the breasts whilst, more importantly, the patients reported a higher satisfaction of the surgery outcomes than the control group, again with respect to shape and symmetry of their breasts.

The long-term aim of the study, however, was on the development of a

material that could be used in tissue engineering and it showed that CAD could be an effective way of achieving this.

A function was created using the CAD software that enabled the creation of a mould for any scanned tissue with the ability to independently tailor the porosity and pore size – a property that is essential to the seeding and diffusing of cells throughout the structure and something that limits modern technologies.

Professor Hutmacher continued, "The development of a clinically translatable method of engineering adipose tissue for soft tissue reconstruction requires investigation of several components.

"There must be coordination between all key aspects of the tissue engineering process, including the selection of cell source, scaffold material, cellular environment, and means of device delivery in order for the engineering of any tissue to be successful."

An Institute of Physics spokesperson said, "This advance offers hope to women who have undergone mastectomies. It's enlightening to see how a technique, first designed for the construction of buildings, bridges and aircraft, is now being used in medicine."

More information: "CAD/CAM-assisted breast reconstruction" 2011 *Biofabrication* 3 034114. www.iopscience.org/bf/3/3/034114

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