CADCAM Technology in Prosthetics and Orthotics – A Review on Efficiency, Efficacy and Training Capability

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Prosthetics & Orthotics

- Design and Fitting Process
  - Application of Biomechanics for treatment and restore function
- Via
  - Interface pressure, Alignment, Location of force application & shaping
- And
  - Increase comfort
Conventional Methods of Shape Capture

- Manual Casting
Latest Methods of Shape Capture

- Digital Imaging
  - Mechanical
  - Optical (e.g. IR scanning)
- Simple Measurement
  - Circumference, distance
  - Marking bony landmarks
Non-contact & Non-invasive Measurement
Conventional Prosthetic & Orthotic Design

- Manual Rectification and modification
Latest Design Method using CAD/CAM

- Computer Aided Design (CAD)
Computer Aided Design

- Compare shape with X-ray film
- Accurate force application
- Comparison of finished design
Computer Aided Design

- Modification to avoid pressure
Computer Aided Design

- Many different rectification tools
Computer Aided Design

- Merge, Duplication, Expansion
  - For complex design
Latest Fabrication using CADCAM

- Computer Aided Manufacturing (CAM)
CADCAM Efficiency & Efficacy

- Reduced time of manual works
- Simplified production procedures
- Increase time for patient care
- Increase efficacy by accurate force application
- Data and design comparison
- Possibility for outcome measure
- Evidence base practice
- Evaluation of treatment protocol
**COMPARISON WITH SPINAL BRACE DESIGN AND FABRICATION**

<table>
<thead>
<tr>
<th></th>
<th>Conventional</th>
<th>CADCAM</th>
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<tbody>
<tr>
<td>Casting</td>
<td>30mins</td>
<td>10mins</td>
</tr>
<tr>
<td>Orthotic Design</td>
<td>60mins</td>
<td>15mins</td>
</tr>
<tr>
<td>Positive Model Fabrication</td>
<td>60mins</td>
<td>15mins</td>
</tr>
<tr>
<td>Completed Case/ year</td>
<td>~180</td>
<td>400+</td>
</tr>
<tr>
<td>Waiting Time</td>
<td>4-5 months</td>
<td>6 weeks</td>
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i.e. Decreased time for design and rectification process => increased time for pt’s care, & training on the use of rehab devices
Comparison with Conventional Method

- Cost effectiveness in long run
  - Automation for design and fabrication
- Document anatomical & volumetric changes
- Provide reference for baseline and progress of treatment regimen
- Simulate final design to optimize outcome
Training Capability

- Step-by-step virtual learning
- Data library to retrieve special case, interested case for study
Future Development

- 3D Printing (CAM)
- Orthotic Devices
- External Prosthetic Limb
- Prosthetic Implant design and fabrication
Future Development

- For surgical planning and outcome
  - Guided surgery devices
The first transparent 3D-printed skull has been successfully implanted

By John Hewitt on March 27, 2014 at 12:00 pm  |  3 Comments

Three months ago, surgeons in Holland implanted a transparent plastic skull in a woman whose skull has never stopped growing. Incredibly, the rare bone disease that was wrecking her vision and destroying her life has been bested by a simple 3D printer. The team of surgeons, led by Dr. Bon Verweij at the University Medical Center in Utrecht, expect her new skull to last indefinitely, opening up new vistas for cranial transformation.

The precursor to this achievement was a similar patching done last year, where 75% of a patient’s skull was replaced with a 3D-printed implant made of polyetherketoneketone (PEKK, a thermoplastic). While the cost and man-hours required to build a skull would have been prohibitive, printing to exact specification is now routine. PEKK and its larger family of related plastics are extremely strong and temperature resistant (for sterilization), however, this new implant appears to be made from some new, and rather mysterious material.

The skull, made by an Australian firm, is actually fairly transparent. Lots of plastics can be transparent — acrylics, polycarbonates, etc. — but the stringent medical requirements, and also print requirements, place limits on the possible. While the transparency may be incidental, the picture above shows the clear advantage of such transparency: one can see the underlying brain and vasculature. Not only is this a nice feedback to see how things are going macroscopically, it also entices with potential to optically image activity in the brain like never before.

The 22-year-old woman patient may not have such things immediately in mind, and is probably just thankful to have a normal cranium. Her disorder had caused overgrowth of her old skull from a normal thickness of 1.5 centimeters to a battle-axe busting 5cm (2 inches). While the new skull appears permanent, details of attachment and integration to protective layer just beneath (known as the dura, for hard layer) are not yet publicly available. The two halves appear to be attached with standard titanium clasps which one finds in a typical “internal-fixation” kit. These kits are simple erector sets from which the surgeon can select the right pieces, and then bend and shape to fit unto broken bones.

The potential to further customize these printings is huge. As a start, simple features to capture and mate the two halves against sliding motion may be of immediate advantage. Also, a more scalloped interface edge to the existing skull could be built in to later models. We previously discussed the possibility of adding provision for the kinds of implants that are now used to augment or restore hearing into replacement skulls. In particular, variant on the “BAHA” style implant system which uses bone conduction like Google Glass might be directly incorporated.

We’ll be sure to update you on this story when more information is made available — this is a big one.

Thank You

Don't be afraid to be open-minded. Your brain isn't going to fall out.