THE USE OF HIGH RESOLUTION CAD-CAM SYSTEM IN THE MANUFACTURING OF FINGER AND HAND PROSTHESES

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INTRODUCTION

At the Institute for Rehabilitation, the manufacturing of silicone prostheses has so far based on the shape of similar PVC cosmetic gloves or on the model of a similar hand of a third person. None of the mentioned methods has allowed manufacturing of prostheses that would be similar enough to a patient's healthy hand. Therefore, in collaboration with partners the Institute has developed CAD-CAM technology for manufacturing of prostheses, the shape of which is a mirror-copy of the patient's healthy hand.

Method

During the development phase, three laser and optical scanners were tested in the making of a digitalized 3D model of a hand and stump. The following scanners were tested: freescanner CAPOD CAD-CAM system, Zscanner 700 and 3D optical scanner ATOS II 400.

The 3D digital model of the healthy hand was corrected and adjusted to the digital model of the stump by means of internal software ATOS 6.0.0.3.

In the making of the master-model and tool, three technologies for fast manufacturing of pre-models and tools were tested: DMLS (Direct Metal Laser Sintering), SLS(Select Laser Sintering) and 3D print technology.

RESULTS

Among the three tested scanners, the highest quality of scanning was achieved by ATOS II 400 produced by German company GOM, which enabled digital models with visible skin details.

The highest apparency of skin details in the tool was achieved by the DMLS technology (Direct Metal Laser Sintering) with 0.04mm accuracy. In the testing of the SLS (Select Laser Sintering) technology and the print technology, the accuracy was 0.1mm. When inspecting the tools, the most accurate surface was found to be that produced by the DMLS technology. Silicone was poured into the tools and after the vulcanization the quality of test prostheses was found to depend on the apparency of skin prints. The highest quality of the tool surface was achieved by the DMLS technology and the lowest by the 3D print technology, which produced a rougher surface of the prostheses test model despite the satisfactory apparency of the skin prints. The SLS technology was selected for tool manufacturing due to its accessible cost. The apparency of skin prints achieved by the SLS was not essentially lower than that achieved by the DMLS technology.

Discussion

During the development phase, CAD-CAM technology processes were defined to enable the production of silicone prostheses after partial hand amputation, which in their form mirror the patient's healthy hand. Most centers for manufacturing silicone hand prostheses nowadays use the procedures of manual modelling (O´Farrell D.A.,1996 and Pilley M.J.,1999). The quality of such prostheses depends on the artistic skills of the prosthetist. By using CAD-CAM high resolution technology, the highest-quality prosthetic design can be achieved even when the prosthetist lacks artistic skills. Such technology has been already used in designing and making of partial facial prostheses – epitheses (Sykes LM.,2004). The same procedure is mentioned by Didrick (2005).

CONCLUSION

The final appeareance of the prosthesis depends greatly on its shape. Our experiences in using the CAD-CAM high resolution technology have shown that such technology enables computer-based manufacturing of prostheses, which in their form mirror the healthy hand. This technology provides the patients with the highest-quality lifelike prosthetic design.

REFERENCES

O´Farrell, DA. J of Hand Surgery. 21B: 5: 696-700, 1996.
Pilley, MJ. J of Hand Surgery. 24B: 5: 539-541, 1999.
Sykes, LM. Int J Prosthodont. 17, 454-9, 2004.
Didrick, D. http://www.oandp.com/edge/issues/articles/2005-11_06.asp