Three-Dimensional Printing from Somatom Plus CT Data

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Introduction

Stereolithography (three-dimensional, 3D printing) is a new technology in which plastic models are constructed from computed digital raw data. Its primary commercial use is in design model building for prototype construction. Its application in medicine is a natural extension of its commercial use.

Material and Methods

Fine slice, 2-mm, high-resolution CT was performed with the Somatom Plus. Then, 3-D reconstruction using a 256 or preferably a 512 matrix was performed. The raw data was transferred to the stereolithography workstation using a magnetic disc. Preprocessing is the next step in which 3-D mathematical reconstruction of the CT raw data takes place. In this operation, the object's outer boundaries are detected, thinned, and joined together.

The final preprocessing step consists of creating a wire frame model mathematically [1]. The stereolithography system (3D Systems) consists of a helium-cadmium laser, an optical scanner, a photopolymer vat with elevator, and a controlling com-
puter (Figs. 1,2). The photopolymer liquid (Cibatool SL) changes to solid resin on exposure to light and is particularly sensitive to ultraviolet (uv) light – this process is called curing. The ultraviolet laser generates a small intense spot of UV light which is precisely moved across the liquid surface by computed generated vectors. The slice is illuminated, and therefore solidified (cured) and is mechanically lowered into the vat allowing a new layer of liquid resin to flow over the object. This sequence is repeated slice by slice until the model is complete. The cured model is then removed and is strengthened by further exposure to UV light in a postcur­ing oven. A 3-D reconstruction of a knee (contiguous 2-mm slices, 256 matrix) and its stereolithographic plastic model are demonstrated (Fig. 3). The preprocessing steps are currently performed by computer manipulation, which delays the development of the model considerably. When performed automatically in the near future, models will be available in 12–18 h, making the process more clinically relevant.

Discussion

Several publications have discussed the clinical advantages and applications of 3-D imaging [2-5]. Stereolithography is a further extension of 3-D imaging. Computer-derived raw data can be transferred to the stereolithography unit by magnetic tape directly through workstations from CT or magnetic resonance units. The main purposes of 3-D printing of imaging data will be in:

- Trauma, for the operative planning of facial fractures, depressed zygomatic arch or mandibular fractures, spinal and especially sacral fractures, such as those of the tibial plateau and the calcaneus.
- Prostheses, the ideal “cementless” hip prosthesis requires a perfect fit of the pros-