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Surgical simulation of congenital heart disease by using flexible biomodels made by streolithography and vacuum casting

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Introduction: Stereolithography is a rapid prototype technology whereby an ultraviolet laser beam selectively polymerizes and solidifies photosensitive and polymeric liquid plastic. By using this technique, 3D volumetric image data of multi-slice CT (MSCT) can be converted into plastic models that enhance our spatial perception of real-life anatomy and pathology. However, the materials of the stereolithography are restricted to specific photosensitive plastic or urethane, which are not satisfactory for idealistic simulation surgery. Recently, a vacuum casting method has been developed in rapid prototype industries, where more detailed prototypes with different stiff materials can be manufactured. **Methods**: Six biomodels of various congenital heart diseases were manufactured in this study. The patients include single right ventricle with right isomerism (4m), double outlet right ventricle (1y), congenitally corrected transposition of the great arteries (3y), atrial septal defect (9y), and tetralogy of Fallot (56y). Three-dimensional volumetric data sets of MSCT angiography were converted into standard triangulated language (STL) files to guide the laser beam of stereolithography. Plastic replicas representing the both outer and inner surface of the heart tissues were initially made with stereolithography. Then, urethane materials with appropriate stiffness representing the real heart tissue were injected into the space between the inner and the outer casts by using vacuum casing method. After solidification of the urethane materials, the casts were carefully removed and the final products of flexible heart replicas were obtained (PCT-International Patent Application submitted: PCT/JP2010/061249)). **Results**: The vacuum casting in association with stereolithography technique enabled us to manufacture precise replicas with similar texture of the real individual heart in all the 6 cases. This technique also allowed the surgeon to cut and suture, facilitating the simulation of the surgical operation. **Conclusions**: The vacuum casting method in association with stereolithography is a promising technique for medical education, preoperative practice, simulation of individual surgery, and planning of novel and innovative surgical procedures of congenital heart disease.