

Objectives: Surgical training is currently done in the operating room according to the halstedian model which is questioned since the appearance of the surgical simulators. Simulators actually propose progressive courses with interventions in virtual reality and objective measurements of the learning curve. We set up a center of endovascular surgical simulation in adequacy with the recommendations of the French National Authority for Health. The purpose of the study was to establish a specific training program for each category of students.

Materials and Methods: We analyzed three categories of students: experts, intermediates and beginners. Three clinical cases were selected, and each one was carried out three times. The criteria of evaluation were: duration of fluoroscopy, product of contrast injected, choice and handling of the devices, surgical tactic, training of the basic sequences. We evaluated the following criteria: satisfaction, achievement of the teaching objectives, modification of the professional behavior, evaluation of the trainers.

Results: All the students showed a progressive reduction in duration of fluoroscopy, of product of contrast, quantity of material used, and procedural irregularities. The experts always carried out various surgical approaches; the intermediates initially carried out the same tactics in the first two cases and a different approach in the third case; the beginners always used the same tactics. The teacher intervened as facilitator more often for the beginners than for the experts.

Conclusion: The simulator is an important teaching tool for the training of endovascular techniques. The results of the automatic analysis carried out by the software do not reflect the performance levels and a secondary analysis by the expert-teacher is necessary. If the presence of the teacher during the sessions of simulation is desirable for experienced surgeons, it remains essential for the training of the residents.

<http://dx.doi.org/10.1016/j.avsg.2014.06.029>

Digital Simulation of the Delivery of Stentgrafts: Towards a Clinical Application

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Objectives: The endovascular treatment is a very common technique to treat aortic aneurysms. However, in spite of a sometimes long phase of preoperative planning, postoperative complications are not rare and secondary interventions are then necessary. Digital simulations of the delivery of stentgrafts (SG) could provide better tools for

the planning of the operation, but they still require too computing time. Consequently, the aim of this study was to develop a methodology of simulation of delivery of SG effective and adapted to the clinical environment.

Materials and Methods: An idealized geometry of very tortuous iliac aneurysm was created. The SG was modelled by specifically differentiating the textile and the nitinol metal stents. The geometries of the aneurysm and the SG were linked with finite elements having adapted mechanical properties. This digital model of SG was validated on in vitro tests. Two methodologies of deployment were compared. The first, similar to the surgical procedure, uses a stent-carrying catheter in which the SG is inserted. It is curved to fit in the aneurysm, and its diameter increases so that the SG is adjusted to the aneurysmal wall. The intra-luminal pressure is then applied. The second method does not take at all into account the surgical procedure and is interested only in the final positioning of the SG in the aneurysm. A cylinder contains the SG and its geometry gradually becomes that of the aneurysm. The intra-luminal pressure is then applied. The position of the centers of gravity of the stents and their ray were compared between the two methodologies, as well as the computing times.

Results: The average variation in position of the stents in the second method compared to the first was 1.0 ± 0.5 mm, and the relative variation in radius was $2.7 \pm 1.7\%$. The computing times obtained with the first and the second methodology were 14h15 and 2h50 respectively, which corresponds to a reduction in the computing time of 80%.

Conclusion: This study made it possible to develop a powerful methodology of simulation of delivery of SG. A speed of calculation five times higher was obtained in comparison with a traditional method of simulation of deployment, without any degradation in the precision of the solution. This simulation is very promising to improve the preoperative procedure of planning of the endovascular treatment.

<http://dx.doi.org/10.1016/j.avsg.2014.06.028>

Feasibility and Safety of Robotic Navigation for the Endovascular Treatment of Complex Aortic Aneurysms and Peripheral Vascular Pathologies

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Objectives: The objective of this observational retrospective study was to evaluate the feasibility, the safety and the