USING GID TO DESIGN AN INTRAVASCULAR SUPPORT SYSTEM

Maurizio Bordone*, Eduardo Soudah*, Eugenio Oñate*, Michele Chiumenti*

* International Center for Numerical Methods in Engineering (CIMNE)
Universidad Politécnica de Cataluña
Campus Norte UPC, 08034 Barcelona, Spain
E-mail: gidconf@cimne.upc.edu, web page: http://www.cimne.com/

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Abstract. *Vascular diseases are very common, nowadays, especially as people age, due to bad eating habits and physical inactivity, among other causes. This fact is very important because this problem trends to grow up quickly, especially in industrialized countries. New kinds of surgical techniques use to detect and treat vascular diseases, every day, micro-invasive approaches, like endo-surgery, endoscopy and catheterism. Medical solutions like stent applications, substitutions of cardiac valvulas use today these innovative techniques. Due to this fact the study of the materials used in these devices becomes an important matter. GiD gives the possibility to design and study through different problems type's devices that can be used to solve problems like these. The object of this work is to model and analyze with GiD and with the thermo-mechanical computational code COMET an intravascular metallic support that can be compressed until the right dimension is reached, so it can be inserted via-catheter in situ. The decompression of the device is of primary importance because every plastic deformation can interests the final disposition of the support and it could change its properties and the capacity to perform properly. This investigation will focus in the study of the forces implied and the effects on the device material. Also the different behaviour of various bio-materials like Steel, Titanium and Nitinol are studied. This study can help to find the best configuration for this kind of devices.*

1 INTRODUCTION

Cardiovascular diseases (CVD) are the first cause of death in European people. CVD provokes 4,35 millions of deaths in the 52 states of European Region. WHO estimates more than 1,9 millions of deaths in EU, and affirm that CVD plays a big rule in reduction of quality life and like cause of physical handicaps, especially in older people; this fact is very important considering that the world population trend to get older generation by generation.

Modern surgery looks for minimal invasive solutions like the mini-invasive technique of surgery. This technique consists to reach internal cavity without cut or open the patients minimizing post-operative risks, in this group are included endoscopy, arthroscopy and other more.

Mini-invasive surgery finds also applications in the applications of cardiovascular stents, probe, valves replacements, using catheters and travelling trough arteries like femoral, coronary or aortic vessel. *GiD* results very utile to design and reproduce the movements of these devices

2 METHODS

Target of the study will be the design of a new indo-vessel support and a comparison of this new hypothetical device with a commercialized support. Studying with FEM[i] the existent devices it is possible to have some guide-lines that will be followed to design new devices. The design of the support wants to follow some fundamental directive: the simplicity of the structure, the employ of hyper-elastic material (Nitinol in these tests), the repetition of a single sample that will be repeated to construct the complete geometry. Four different geometries will be comparated in the capacity of flexibility and resistance at radial stress, finally radial force of every devices will be comparated with the radial force of the *Edward Sapien THV valve support.*

2.1 Geometry

The first requirement for a support is the possibility to couple the support with the vessel, so a pseudo-cylindrical geometry is required. Implementing a m*acro* that transform a 3D-planar mesh in a 3D-cylindrical one, is possible to design a single sample in Cartesian coordinates, and work assigning the properties of the material, conditions and meshing the geometry and finally transform the mesh in the desired configuration.

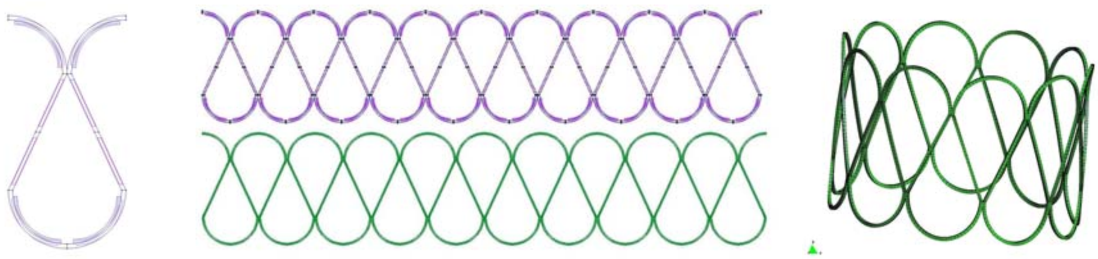

Figure 1: Design of the support

Comet[ii] will be the *problem type* used to solve the mechanical problem studied. The four geometries propose different characteristics, model N1 is a simple snake-curled blade, model N2 takes the N1 geometry but presents two samples more and a curvature in upper and lower extremity to enjoy a better radial force and improve the coupling capacity of the device. Model N3 and N4 have similar geometries to N1 and N2 but present more compacted samples, able to reach upper level of radial force. N4 presents less linear parts and bigger common strong parts respect N3.

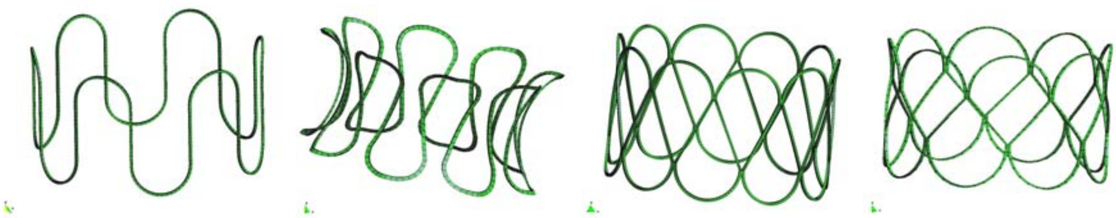

Figure 2: N1, N2, N3 and N4 in the final configurations of work.

2.1 Conditions

The testes performed focus to study the behaviour of the different models in compression, to value the capacity to reach a diameter of only 5 mm, so that have a compression of 500%. The tests study the possibility to reach this dimension without present plastic deformation on the material, for this reason Nitinol[iii] will be selected. Secondly will be effectuated a comparison between these 4 prototypes and a commercial device, actually on sale. The comparison shows the resistance to an external pressure that simulates the body vessel compression, because the real action of the body is unknown. For first test a prescribed displacement is used to compress the supports, the tension and stresses are studied and compared to value the best geometry in compression. Second test is performed with a surface load that provokes a compressive pressure in all the external surfaces of the device

3 RESULTS

3.1 Compression Study

First test studies the maximal stress provoked in the devices. Every single model reaches the desired final configuration.

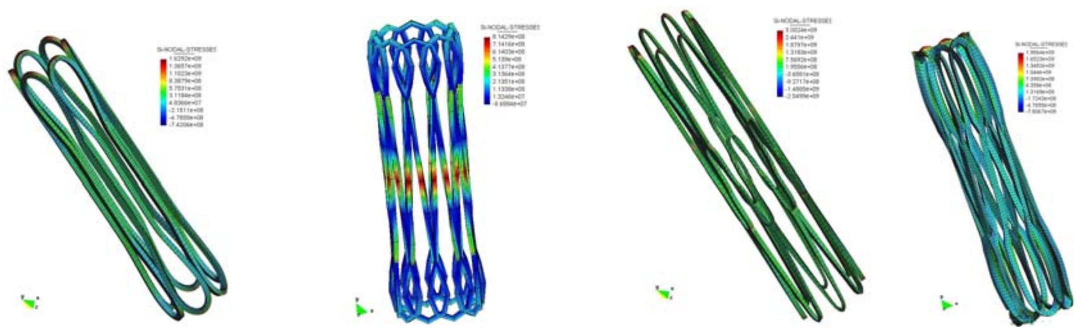

Figure 3: N1, N2, N3 and N4 in the compressed configurations.

GiD Permits to study precisely the zones of maxim tension and stresses, allowing to define the regions that overpass elastic regime, identical results are been obtained studying only half part of the body. GiD post-processor can mirror the geometry in result configuration and visualize the entire structure, this option permit to save time and to reduce computational costs, this operation was possible with another macro, inserted in GiD that transform linear coordinates in cylindrical ones but with only 180 degrees of rotation . Videos of simulations was been registered to show clearly the movements and the displacement of the different devices.

3.1 Radial Forces Study

The comparison of the different models in work-configuration is performed by the study of the device deformation under external superficial pressure. Using graph tools of GiD, deformation / pressure graphics was exported and elaborated to obtain other interesting data in the points of interest for every studied geometry.

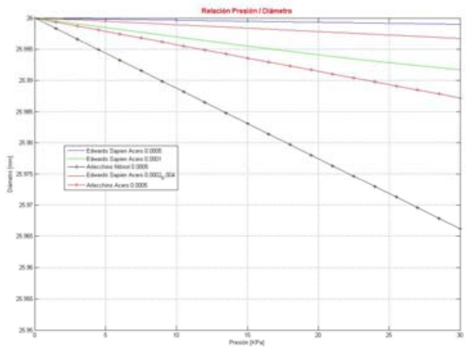

Figure 4: Relation between pressure and diameter reduction in some of studied devices.

4 DISCUSSION

The precision of registered and exported data permits to study exhaustively the devices characteristics, and allows raising the quality of the geometry that can performs all the required technical characteristics. Almost every corrections were been effectuated trough GiD wizard enjoying simplicity and rapidity data modifications the others one was done directly in calculation files created by GiD pre-processor. The possibility of work with calculation files permits to export GiD outputs and use them with other software, raising the portability of GiD technology.

5 CONCLUSIONS

All goals imposed at the beginning of the study was been reached trough GiD pre and post processor. The results were used to give the bases of future probable development of a real vascular support. The development of geometrical transformation macro, allows constructing hard geometry in a simpler way and saving time to calculate the tests.

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