

Flow diverter deployed length prediction by computational simulation in *PreSize Neurovascular* medical software: a retrospective study

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Motivation:

The use of flow diverting (FD) stents has proven to be increasingly important in the treatment of complex intracranial aneurysms. However, accurate sizing and landing zone prediction still remain a challenging task. This study aims at quantifying the accuracy of the novel medical software *PreSize Neurovascular* in predicting the length of deployed FD devices pre-operatively.

PreSize Neurovascular is a visualisation and simulation software tool for planning of neurovascular interventions in aneurysm treatment using flow diverting stents. It provides interventional neuroradiologists with advanced planning support, allowing them to 'test' different devices in the patient's anatomy before the procedure (see Figure 1).

Methods:

Pre- and post-operative historic data from sixty-five patients treated with Pipeline Embolisation Device (PED, Medtronic) were collected from four different interventional radiology centres in the UK, St George's University Hospital (n=12), Leeds Teaching Hospitals (n=25), National Hospital for Neurology and Neurosurgery (n=6), Royal Preston Hospital (n=22) and retrospectively analysed. FD deployed length was extracted from biplane angiographic images and compared to the FD length virtually deployed in *PreSize Neurovascular* software.

Results:

When assessing the post-operative deployed length, changes of 43.36% on average (std 24.77%) and up to 98.4% were observed between the nominal and measured device length, as shown in Figure 2. As such, the nominal length is not an accurate sizing metric when choosing a FD.

Good prediction of the deployed FD length was obtained in *PreSize Neurovascular*. Figure 3 shows the deployment accuracy calculated as the degree of agreement between measured and simulated stent deployed lengths. A mean deployment accuracy of 96.61% (95% confidence interval [95.79,97.42]) was achieved. This is the highest reported accuracy, as compared with similar software solutions. Paired t-test showed a mean difference of -0.37 mm between the measured and simulated length (P= .0032).

Conclusion:

Nominal length is not an accurate metric when sizing a FD. In particular, inaccurate sizing could result in the deployment of low-porosity flow-diverter stents across side branches or perforators, which has a potential risk of occlusion and related symptomatic ischemic lesions or landing of FDs ends on curved segments, increasing the risk of stent displacement or stroke. Conversely, *PreSize Neurovascular* software yields good estimate of the stent length after deployment, and as such could provide INRs with advanced preoperative planning support real time within minutes.

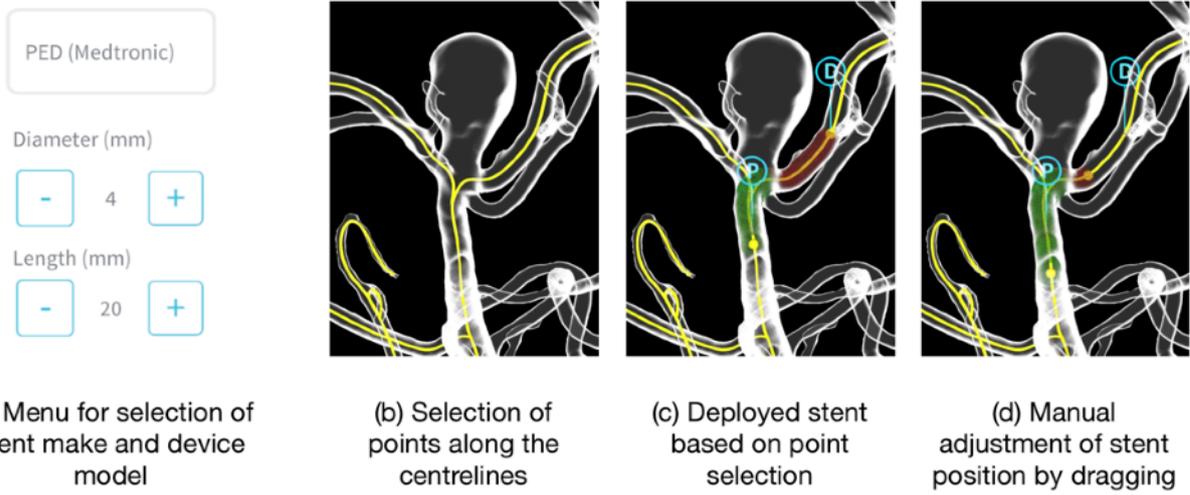


Figure 1: Illustration of the processing pipeline steps within *PreSize Neurovascular*.

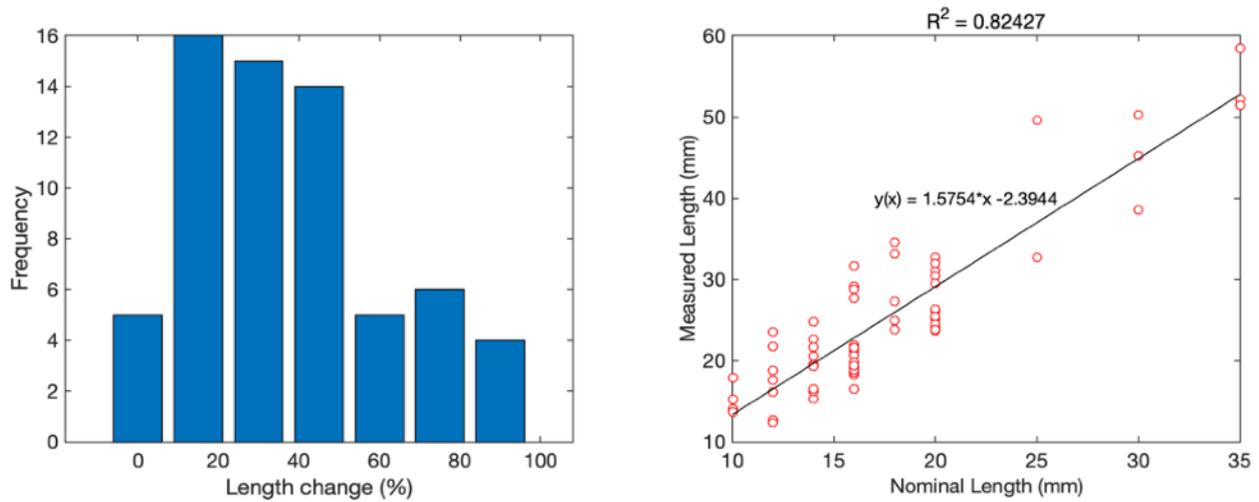


Figure 2: Distribution of relative difference between the measured deployed length and the nominal stent length (left) and linear regression between the measured deployed length and the stent nominal length (right).

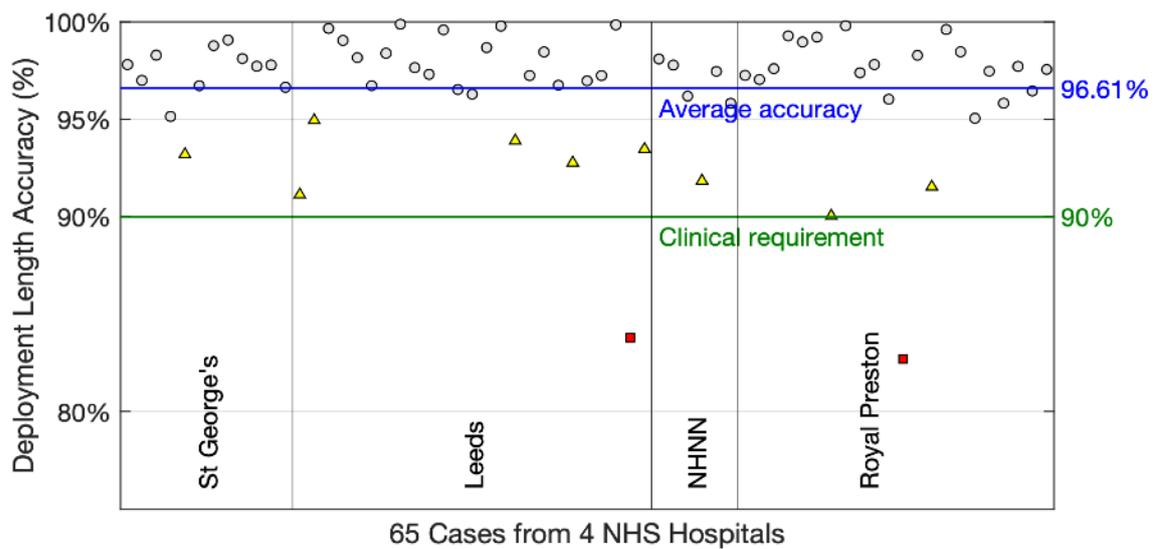


Figure 3: Deployment accuracy for all processed cases: $\geq 95\%$ (grey circles), $< 95\%$ and $\geq 90\%$ (yellow triangles), $< 90\%$ (red squares).