Endovascular Repair of TAAAs with Stent-grafts and Multilayer Uncovered Stents (MLUS)

A possible solution in aortic pathologies for the flow-modulating concept

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Flow-modulating Strategy in Aorta
Experiences and Lessons

Further improvement of the Flow-modulating technique is necessary!

CONCERNS
Aneurysm expansion and rupture
Stent shortening
Stent rigidity
...

FEATURES
Easy-to-perform
Preservation of side branches
...

Inspiration from Previous Clinical Observation
Definition of Sac Entrance (SE)

➢ Sac Entrance (SE): defined as the threshold between the normal laminar flow of the native aorta and the turbulent flow entering the aneurysmal sac
➢ Short-SE aneurysms were observed to have a better clinical prognosis compared to Wide-SE ones

Inspiration from Previous Clinical Observation
Risk factors leading to a delayed sac thrombosis speed after MLUS

Table 1. Statistical analysis of the possible risk factors impacting on the aneurysm sac thrombosis process in a pilot patient cohort (n=28)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Fast-thrombosis group</th>
<th>Delayed-thrombosis group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aneurysm diameter</td>
<td>57.20 ± 4.81</td>
<td>54.85 ± 5.76</td>
<td>.279</td>
</tr>
<tr>
<td>Proximal aortic neck</td>
<td>20.65 ± 2.83</td>
<td>22.35 ± 2.12</td>
<td>.162</td>
</tr>
<tr>
<td>Sac entrance</td>
<td>14.95 ± 12.57</td>
<td>27.50 ± 17.94</td>
<td>.045</td>
</tr>
<tr>
<td>Stents number</td>
<td>3.25 ± 0.44</td>
<td>2.75 ± 0.46</td>
<td>.013</td>
</tr>
<tr>
<td>APTT</td>
<td>35.97 ± 2.09</td>
<td>36.96 ± 2.43</td>
<td>.286</td>
</tr>
<tr>
<td>PC</td>
<td>208.30 ± 30.66</td>
<td>189.13 ± 38.93</td>
<td>.159</td>
</tr>
<tr>
<td>Anti-platelet therapy</td>
<td>62(20%)</td>
<td>58(2.5%)</td>
<td>.044</td>
</tr>
</tbody>
</table>


Inspiration from Previous Clinical Observation
How to shorten the sac entrance (SE): The joint procedure

The joint procedure: concept and design

The length of the aneurysm sac entrance could be artificially shortened by a stent-graft covering part of it, followed by multiple layers of uncovered stents to cover the residual SE.

Stent-grafts: used to cover non-branch zone of the aneurysm, shortening the sac entrances
Uncovered stents: used to cover the reno-visceral segment of aorta, preserving the visceral branches
Validation of This Theory in Clinical Practice

CASE 1: 83-year-old female, pararenal saccular aneurysm

Pre-operative CTA: Side-wall saccular aneurysm involving the celiac trunk, and adjacent to the superior mesenteric artery and renal arteries

Validation of This Theory in Clinical Practice

STEP 1: Pre-stenting angiogram to confirm the size and location of the aneurysm

Validation of This Theory in Clinical Practice

STEP 2: The first uncovered stents was deployed to cover the entire aneurysm zone, providing circumferential bearing support for the subsequent stents

Validation of This Theory in Clinical Practice

STEP 3: A stent-graft was placed within the first bare stent to cover the most part of the sac entrance(SE), leaving a residual SE in the reno-visceral segment.

Validation of This Theory in Clinical Practice

STEP 4: The second uncovered stents was deployed overlappingly to cover the residual sac entrance at the reno-visceral zone.

Follow-up findings

- Complete thrombosis and shrinkage of the aneurysm sac
- Patent collaterals
Validation of This Theory in Clinical Practice

Follow-up findings: Formation of a special pathway for the celiac artery

The flow path for the celiac artery remained patent, whereas the rest part of the sac was totally thrombosed.

Validation of This Theory in Clinical Practice

Stress analysis: decrease in wall tensile stress after the joint procedure

Pre-operative
Average stress: 9.76e4
Maximum stress: 3.86e5

Post-operative
Average stress: 2.38e4
Maximum stress: 0.87e5

Validation of This Theory in Clinical Practice

Change in flow pattern after stents’ deployment

Pre-operative Angiogram
Post-operative Angiogram

Flow pattern could differ greatly in fusiform aneurysms compared with saccular ones: CASE 2  52-year-old male

Pre-operative Angiogram
Post-operative Angiogram

Change in Flow Pattern for Fusiform Aneurysms

Variation of the joint procedure

Standard joint procedure
Extended joint procedure
Reversed joint procedure

Type V TAAA
A stent-graft covering proximal aneurysm sac, MLUS covering reno-visceral segment

Type I TAAA
Two stent-grafts covering proximal aneurysm sac, MLUS covering reno-visceral segment

Type IV TAAA
A stent-graft covering distal aneurysm sac, MLUS covering reno-visceral segment

Validation of This Theory in Clinical Practice

CASE 3: 62-year-old female, Type I TAAA

Two stent-grafts covering proximal aneurysm sac, MLUS covering reno-visceral segment. Follow-up CTA revealed complete thrombosis of the aneurysm sac and patent side branches.
Short-term Outcome of the Joint Procedure
Single-centre Retrospective Analysis of the Pilot Patient Cohort

- 11 selective patients (7 men, mean age: 54 years)
- Average follow-up length: 19 months
- Aneurysm shrinkage was demonstrated in 7 patients; aneurysm stabilization was observed in 4 patients. No expansion.
- Mean aneurysm diameter decreased from 62.6 ± 9.1 mm to 55.2 ± 10.5 mm (p=0.072)
- Significant increase in sac thrombus deposition volume from 19.4 ± 9.7% to 96.0 ± 2.3% (p < 0.001)
- The majority of side branches (43/44 *) were successfully preserved

* A renal artery was already stenotic before surgery, and it was occluded at 12-month follow-up.

Initial Impression of the Joint Procedure

- The joint procedure could be a feasible alternative in complex aortic aneurysms where side branches need to be preserved;
- Short-term outcome seems acceptable, yet long-term follow-up is required;
- Might be a possible solution in aortic pathologies for the flow-modulating concept

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