Understanding the Role of Procedural Variations on Transcatheter Aortic Valve Implantation Outcomes

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STEPS

1 Prep & Drape
2 TAVI Access
3 Pacing Access
4 Digital Access
5 Preclose Femoral Artery for TAVI Access
6 Stiff Wire Access
7 TAVI Sheath
8 CEP
9 Aortic Root Angiogram
10 Cross AV
11 LV Wire Stiff Exchange
12 BAV
13 TAVI Check
14 TAVI: Delivery Sheath to Descending AO
15 TAVI: Across AV
16 TAVI: Deploy
17 TAVI: Release
18 TAVI: Deploy Assess – AO/LV Pressure
19 TAVI: Deploy Assess – Root Angiogram
20 CEP: Remove
21 TAVI: Sheath Remove

Introduction/Background

Procedural variation contributes to complications and inconsistent outcomes in TAVI. Despite growing use of standardised devices, operator technique and intraoperative decision-making vary widely. Artificial intelligence (AI) is revolutionizing periprocedural risk stratification and leading to more personalized approaches in interventional decision-making (1). Using chaptered intraoperative data, we aim not only to understand how these variations arise — but also to identify which specific deviations contribute to complications, and how these may be salvaged or avoided in the future.

The authors have previously published on simulation learning in minimally invasive surgery (2). This presentation describes our novel platform enabling structured post-hoc reviews and future simulation-based operator training.

Objective

To analyse how operator and device level procedural variations influence outcomes, complications and recovery in TAVI, using detailed intraoperative data capture and case-based analysis.

Methodology

Detailed procedural data was collected using Surgical XR®'s chapter-tagging and timestamping platform.

Cases were analysed for:
- Valve type, size, and access strategy
- Deployment, pacing rates and depth with over 20 procedural steps (see below)
- TAVI salvage strategies and surgical bailout protocols

For complicated cases, chaptered procedural maps were created to:
- Benchmark normal versus abnormal pathways
- Identify key decision points preceding complications
- Highlight critical errors and the salvage steps taken (e.g. embolised valve retrieval, device switching)

Case Study 1

Sapien 3 Embolisation + Internal Capsule Stroke

- **Fig 1**: Intermittent loss of pacing capture
- **Fig 2**: Aortic migration of valve
- **Fig 3**: 26mm Sapien 3 valve embolized

Later
- Repositioned to thoracic aorta
- 29mm Sapien 3 successfully deployed
- CEP used, but small embolic stroke occurred
- Mild right-sided weakness, recovered well

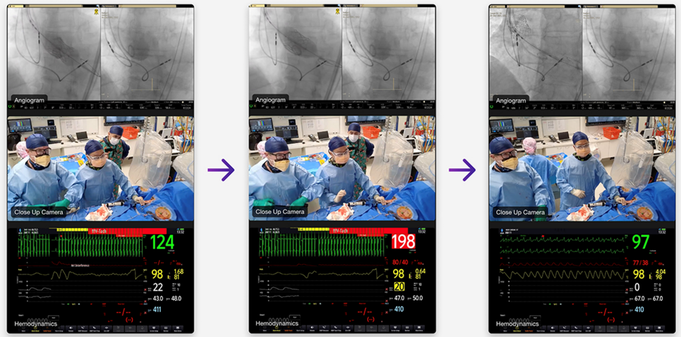

Figure 1 Figure 2 Figure 3

Case Study 2

Valve in valve: Navitor in Mitroflow

- **Fig 4**: Post deployment BAV with LMCA occlusion and VT
- **Fig 5**: ECMO salvage and Navitor explanted
- **Fig 6**: LMCA angiogram clear with return of cardiac function whilst on ECMO
- **Fig 7**: Successful surgical salvage with ascending aortic removal of Navitor

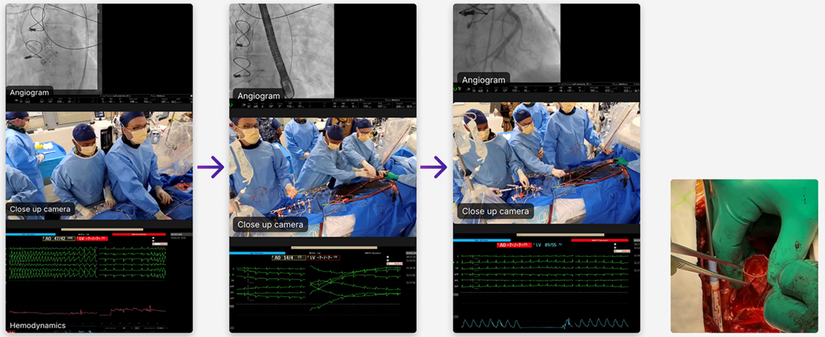

Figure 4 Figure 7 Figure 6 Figure 7

Discussion Conclusion

TAVI has revolutionized the treatment of patients with acquired severe aortic stenosis. Randomized clinical trials have documented benefits of TAVI in patients who are intermediate-high surgical risk (3). With the aging population and TAVI offering a less invasive treatment there are an increasing number of patients benefiting from TAVI options (4). There are however significant case variations.

In both routine and complicated cases, this platform enabled identification of key procedural variations that preceded complications. By mapping chapter-by-chapter deviations in real time, we could highlight not only where outcomes diverged, but also what recovery actions were taken, and how successful those were. This informs the current literature where there is little data on live-capture procedural variation and where ML-AI is developing.

This approach introduces a novel layer of procedural intelligence: benchmarking ideal pathways, flagging deviation points, and formalising structured salvage algorithms for rare but critical complications (e.g. valve embolisation, stroke after CEP). Longer term large data set acquisition is required. This should prove valuable not just for outcome improvement, but also for training, credentialing, and AI decision-support development.

For more information scan the QR code

References

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