Relative Efficacy of Cervical Total Disc Arthroplasty Devices and ACDF for Cervical Pathology: A Network Meta-Analysis

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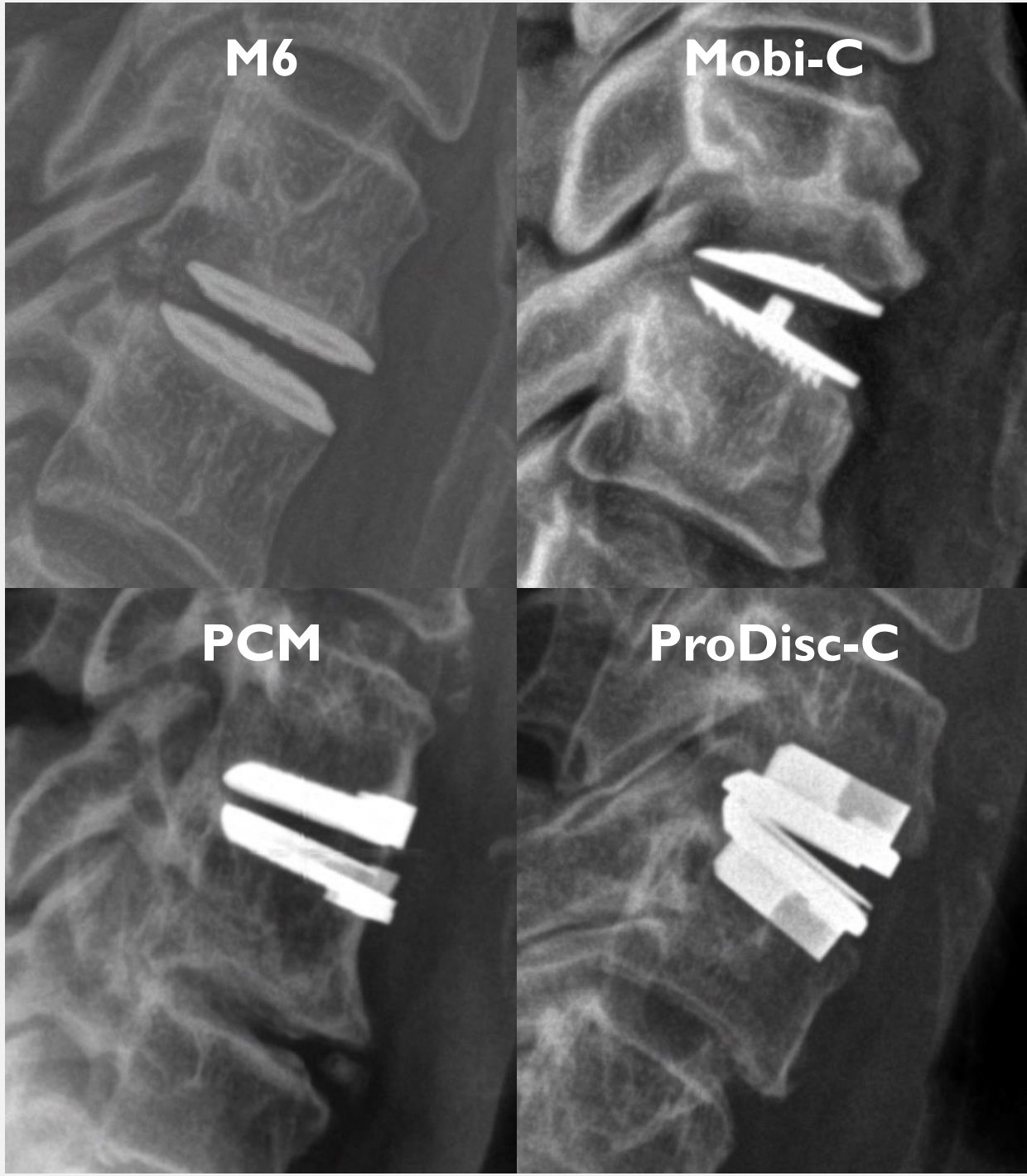
INTRODUCTION

- Cervical total disc arthroplasty (TDA) has been shown to be an effective and safe treatment for cervical degenerative disc disease at short and mid-term follow-up.
- Individual studies have shown TDA to be equivalent or even superior to anterior cervical discectomy and fusion (ACDF) with regards to:
  - Patient reported outcomes (PROs)
  - Device-related serious adverse events
  - Subsequent surgery at the index and adjacent levels
- There remains a paucity of literature regarding the individual efficacy of TDA devices in comparison to other devices and ACDF



METHODS

Clinical Outcomes

- Overall procedural success
- Neurological success
- Patient satisfaction
- Postoperative dysphagia
- Device or procedure-related adverse events
- Index-level secondary surgical interventions (SSI)
- Adjacent segment surgeries

PROMs

- Neck Disability Index (NDI)
- Visual Analog Scale (VAS) for neck and arm pain
- Physical Component Score of the Short-Form Health Survey (SF PCS)

Radiographic Outcomes

- Segmental ROM
- Cervical C2-C7 ROM
- HO in TDA or Arthrodesis in ACDF

RESULTS

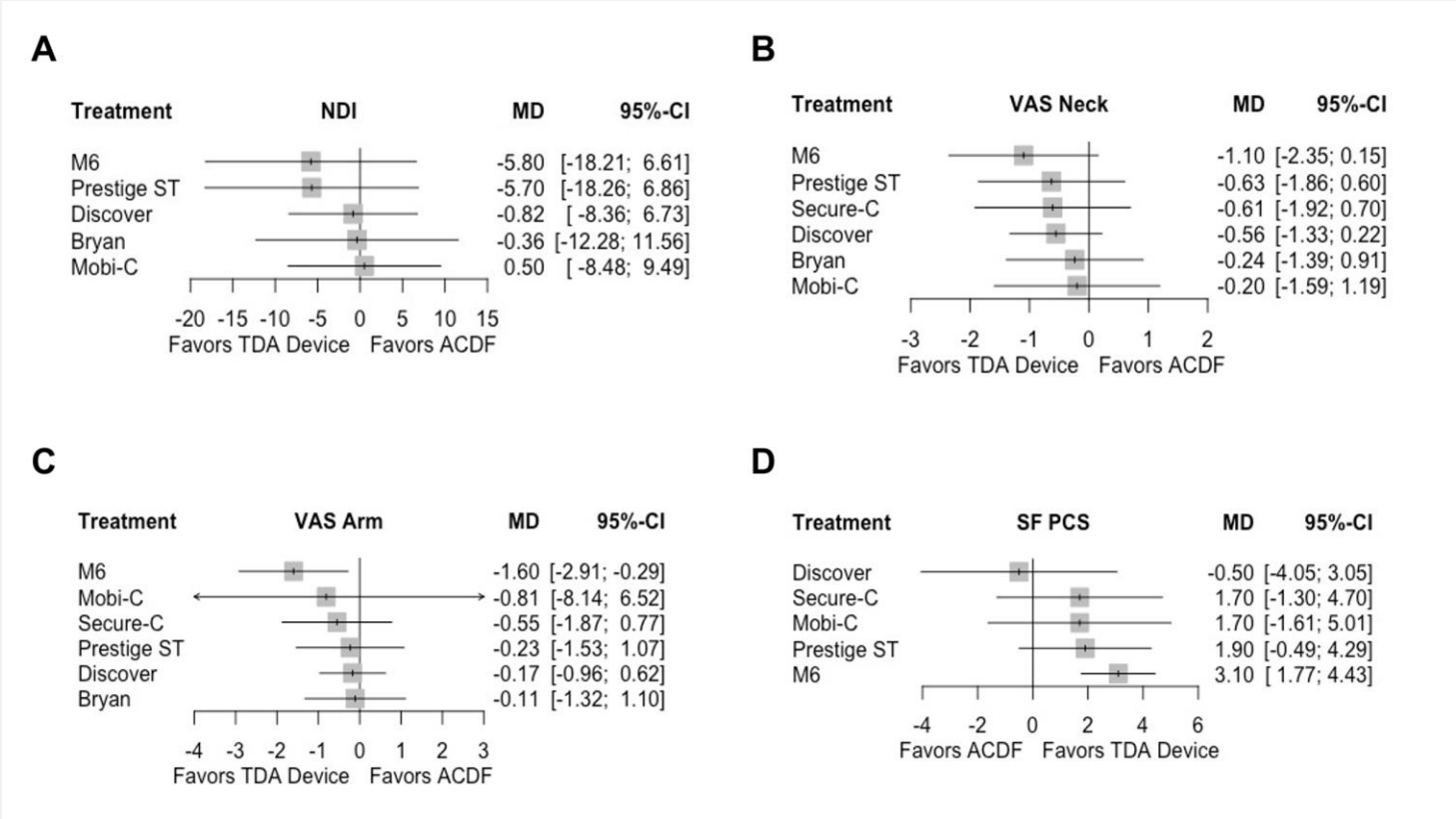
- The 15 studies included initially enrolled 3952 patients (2061 TDA, 1891 ACDF), and reported the outcomes of 2643 patients (1417 TDA, 1226 ACDF)
- The weighted mean average follow-up was **67.3 months** (range: 24-120 months)
- All studies were two-arm RCTs comparing a single TDA device to ACDF
- Nine TDA devices were compared to ACDF: **Bryan, Discover, Kineflex, M6, Mobi-C, PCM, Prestige ST, ProDisc-C, and Secure-C**

Author	FDA IDE	Device	Patients (n)		Age (SD)		Follow-up (SD)
			TDA	ACDF	TDA	ACDF	
Burkus et al. 2014	Y	Prestige ST	212 (Of 276)	183 (Of 265)	43.3 (r: 25-72)	43.9 (r: 22-73)	84
Coric et al. 2018	Y	Kineflex	93 (Of 136)	83 (Of 133)	43.7 (7.8)	43.9 (7.39)	60
Donk et al. 2017	N	Bryan	50	47	44.1 (6.4)	43.1 (7.5)	106.8 (22.8)
Hou et al. 2016	N	Mobi-C	51 (Of 56)	48 (Of 51)	46.3 (7.8)	48.5 (8.3)	61 (1.2)
Janssen et al. 2015	Y	Prodisc-C	79 (Of 103)	79 (Of 106)	42.1 (8.42)	43.5 (7.15)	84
Lavelle et al. 2019	Y	Bryan	128 (Of 242)	104 (Of 221)	44.4 (7.9)	44.7 (8.6)	120
Loidolt et al. 2021	Y	Bryan	130 (Of 242)	104 (Of 221)	44.4 (7.9)	44.7 (8.6)	120
MacDowall et al. 2019	N	Discover	67 (Of 83)	70	46.9 (6.8)	47 (6.9)	66 (r: 57-77)
Phillips et al. 2015	Y	PCM	163 (Of 218)	130 (Of 185)	45.3 (9.0)	43.7 (8.3)	60
Phillips et al. 2021	Y	M6	152 (Of 160)	164 (Of 189)	43.6 (9.1)	44.7 (7.9)	24
Radcliff et al. 2017	Y	Mobi-C	131 (Of 164)	54 (Of 81)	43.3 (9.2)	44.0 (8.2)	84
Rozankovic et al. 2017	N	Discover	51 (Of 52)	50 (Of 53)	41.32 (8.8)	41.94 (9.36)	24
Sundseth et al. 2017	N	Discover	60 (Of 68)	60 (Of 68)	44.7 (7.2)	43.4 (6.8)	24
Vaccaro et al. 2018	Y	Secure-C	124 (Of 151)	101 (Of 140)	43.4 (7.50)	44.4 (7.86)	84
Zhang et al. 2012	N	Bryan	56 (Of 60)	53 (Of 60)	44.8 (5.6)	45.57 (5.83)	24

FDA, Food and Drug Administration; IDE, Investigational Device Exemption; TDA, Total Disc Arthroplasty; ACDF, Anterior Cervical Discectomy and Fusion; n, Number; SD, Standard Deviation, Y, Yes; N, No; r, Range

RESULTS

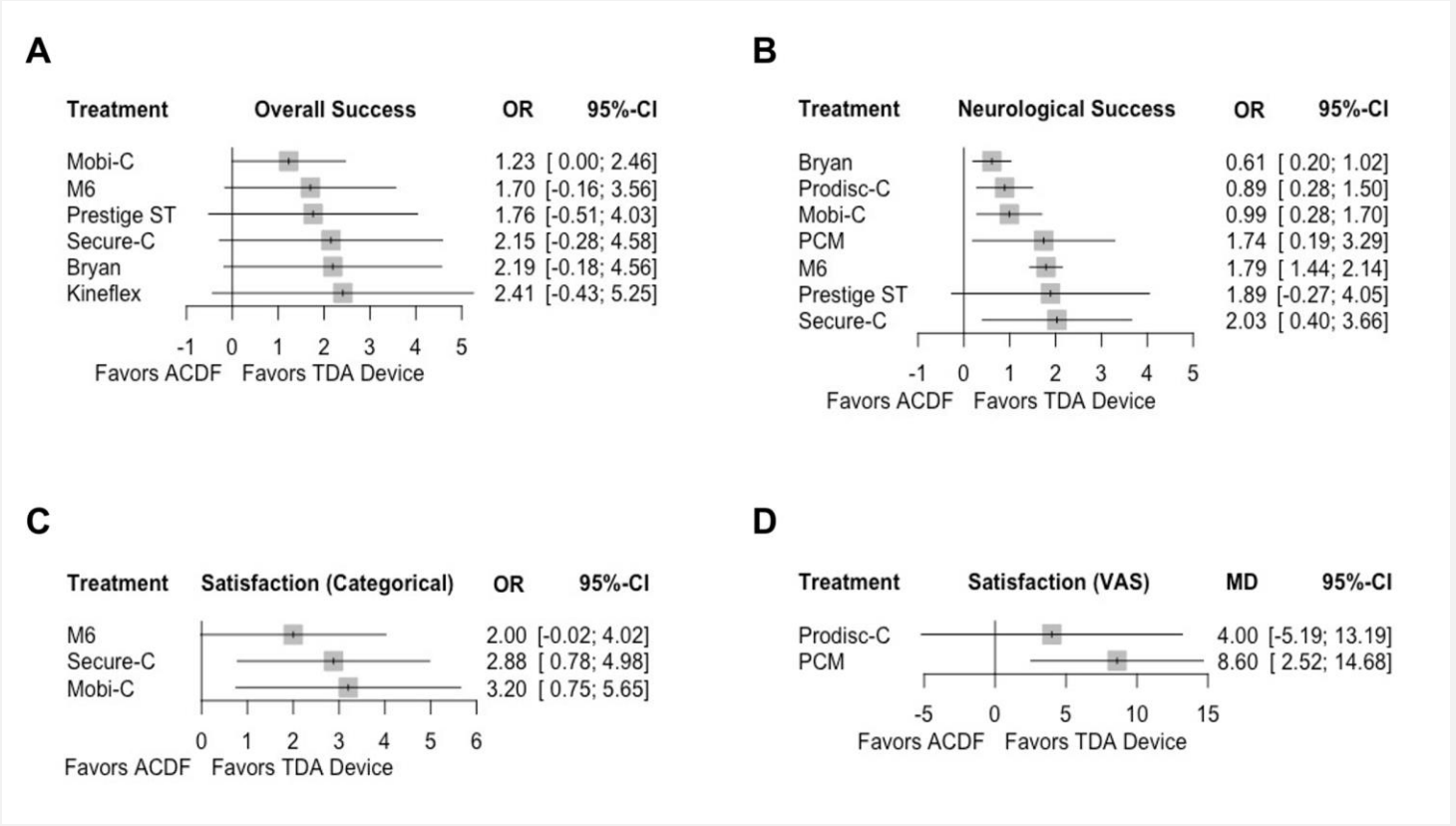
- *NDI*
  - 8 studies comparing 5 TDA devices
  - No single TDA device significantly outperformed ACDF for reducing neck disability
  - Indirect comparison between devices found similar results across all paired comparisons
- *VAS Neck & Arm*
  - 8 studies comparing 6 TDA devices
  - VAS Neck - similar outcomes between all TDA devices and ACDF
  - **VAS Arm - M6 device performed significantly better than ACDF in reducing arm pain**
  - No other significant differences were noted in direct or indirect comparisons
- *SF PCS*
  - 5 studies comparing 5 TDA devices
  - **M6 device performed significantly better than ACDF in improving physical health status**
  - No other significant differences were noted in direct or indirect comparisons.



Forest plots demonstrating the MD and 95% CI of each device compared to ACDF as the reference for (A) NDI, (B) VAS Neck, (C) VAS Arm, and (D) SF PCS.

RESULTS

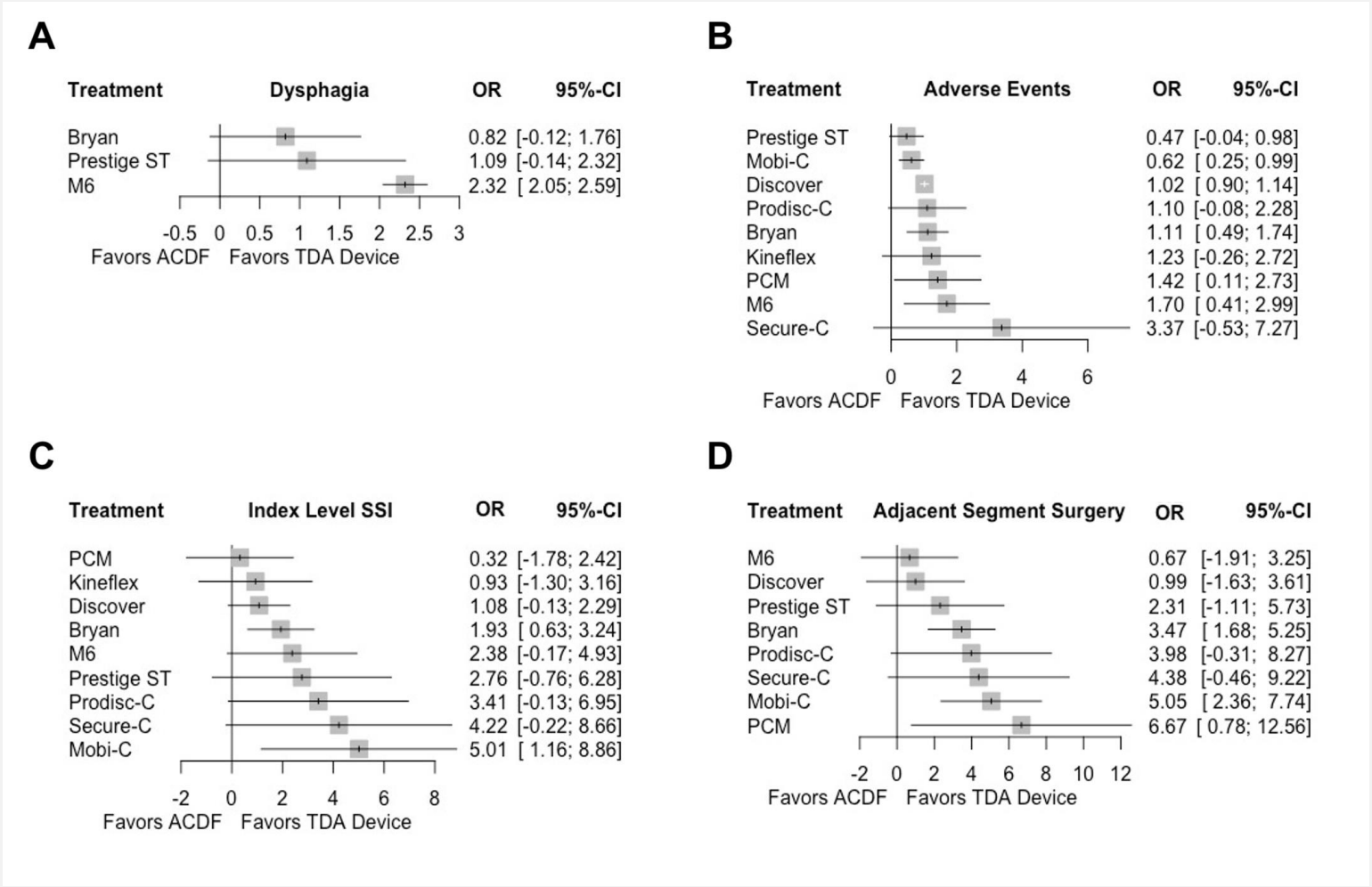
- *Overall Success*
  - 6 studies comparing 6 TDA devices
  - Similar achievement of overall success between all TDA devices and ACDF
- *Neurological Success*
  - 7 studies comparing 7 TDA devices
  - All devices except for the Prestige ST performed significantly better than ACDF
  - **Comparison between devices found that the M6 outperformed the Bryan, Mobi-C, and ProDisc-C prostheses.**
- *Satisfaction*
  - **For categorical satisfaction, both Mobi-C and Secure-C significantly outperformed ACDF**
  - **For VAS satisfaction, only PCM performed significantly better than ACDF**
  - Comparisons between devices found similar results across all paired comparisons for both categorical and VAS satisfaction



Forest plots demonstrating the MD or log OR and 95% CI of each device compared to ACDF as the reference for (A) overall success, (B) neurological success, (C) categorical satisfaction, and (D) VAS satisfaction.

RESULTS

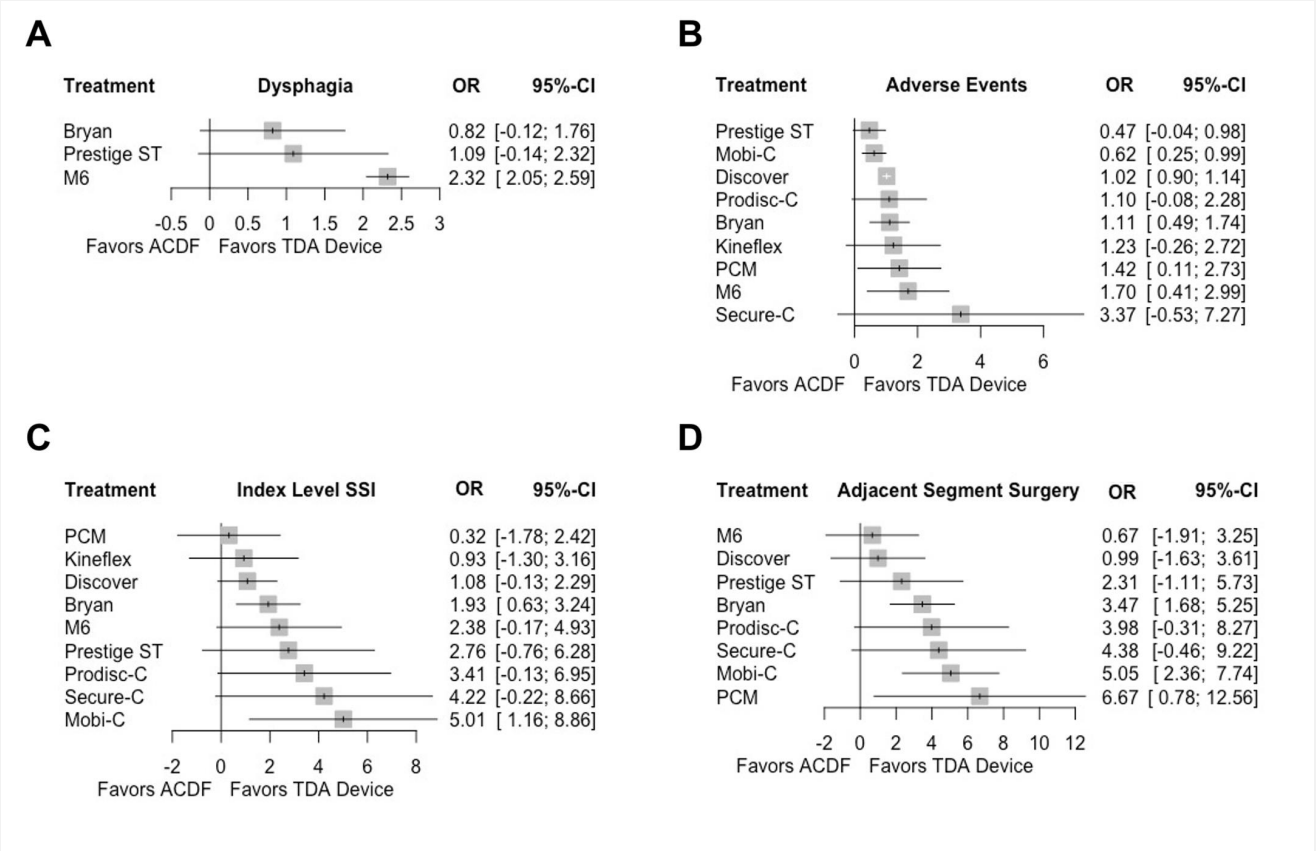
- *Dysphagia*
  - 4 studies comparing 3 TDA devices
  - **M6 device had a significantly lower association with dysphagia when compared to ACDF**
  - **Comparison between devices found that the M6 device performed significantly better than the Bryan prosthesis**
- *Adverse Events*
  - 10 studies comparing 9 TDA devices
  - Both direct and indirect comparisons between all TDA devices and ACDF demonstrated similar associations with adverse events
- *Index-Level Secondary Surgical Intervention*
  - 14 studies comparing 9 TDA devices
  - **Direct comparison to ACDF demonstrated that the Bryan and Mobi-C devices were associated with significantly fewer surgeries at the index operative level**
  - **Comparing between TDA devices, Mobi-C was significantly associated with fewer subsequent index-level surgeries than the PCM disc**



Forest plots demonstrating the log OR and 95% CI of each device compared to ACDF as the reference for (A) dysphagia, (B) adverse events, (C) index level SSI, and (D) adjacent segment surgeries.

RESULTS

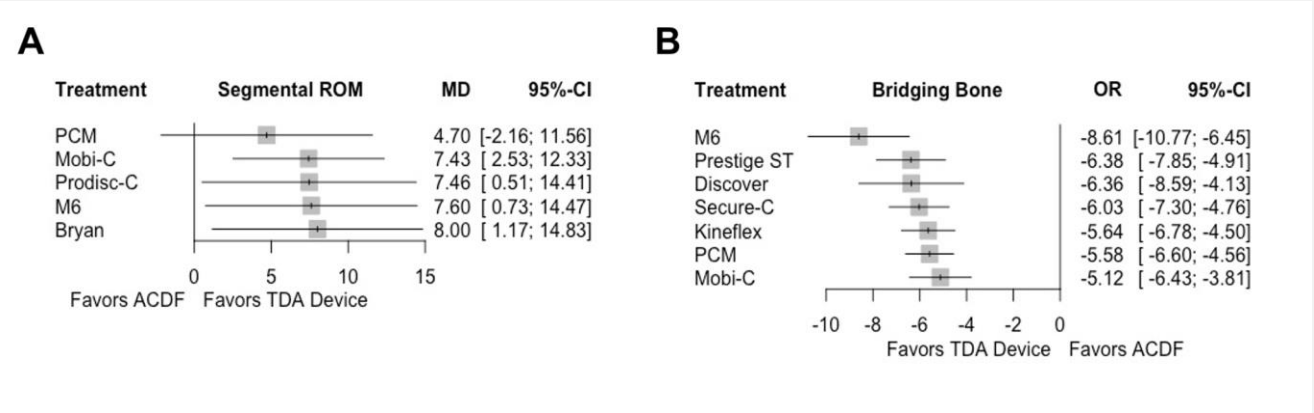
- *Adjacent Segment Surgery*
  - 13 studies comparing 9 TDA devices
  - **When compared to ACDF, a significantly lower association with adjacent segment surgery was seen with the Bryan, Mobi-C, and PCM devices**
  - **Indirect comparison between devices demonstrated that the Mobi-C device was associated with fewer adjacent segment surgeries than both the Discover and M6 prostheses**



Forest plots demonstrating the log OR and 95% CI of each device compared to ACDF as the reference for (A) dysphagia, (B) adverse events, (C) index level SSI, and (D) adjacent segment surgeries.

RESULTS

- *Segmental Range of Motion*
  - 6 studies comparing 5 TDA devices
  - **Direct comparison between devices and ACDF demonstrated greater segmental ROM for all devices assessed. This difference was significant for all devices except PCM**
  - Indirect comparison between devices found similar results across all paired comparisons.
- *Bridging Bone*
  - 7 studies comparing 7 TDA devices
  - **ACDF was associated with a significantly higher incidence of bridging bone than all TDA devices assessed**
  - **Indirect comparison of HO with bridging bone between TDA devices demonstrated a significantly lower association with M6 than the Kineflex, Mobi-C, PCM, and Secure-C devices**



Forest plots demonstrating the MD or log OR and 95% CI of each device compared to ACDF as the reference for (A) segmental ROM and (B) bridging bone across the operative segment.

CONCLUSION

Cervical TDA was found to be superior on most outcomes assessed in the literature of high-quality clinical trials

While most devices demonstrated similar outcomes, certain prostheses such as the M6 were found to outperform others across several outcomes assessed

These findings suggest that the restoration of near-normal cervical kinematics may lead to improved outcomes