Spinal Computer-Assisted Intra-Operative Three-Dimensional Navigation in Canada: A Population-Based Time Trend Study

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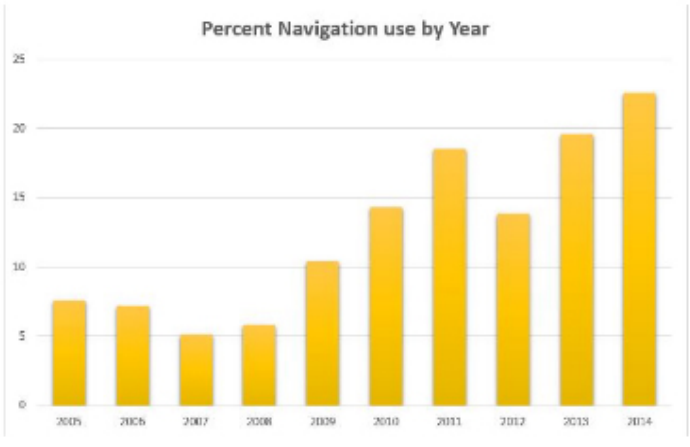
Introduction

Spinal computer-assisted navigation (CAN) is proven to increase instrumentation accuracy. Adoption remains limited by workflow restrictions, learning curves and costs. Here, we assess spinal CAN usage among Ontario surgeons to identify gaps in application, and temporal trends of usage.

Methods

A prospectively-collected database of provincial insurance billables and diagnostic codes was reviewed retrospectively, from 2002-2014. Patients undergoing instrumented spinal fusions or percutaneous vertebroplasty/kyphoplasty were identified. Fee and diagnostic codes were applied to distinguish surgical indication and approach. The use of intra-operative navigation was determined for each case.

Fig. 1



Percentage of instrumentation cases performed with CAN, by year.

Table 1

	No Navigation	Navigation	Total	P-Value
Year				
<2013	2,918 (88.94)	363 (11.06)	3,281	<0.001
≥2013	1,046(78.88)	280 (21.12)	1,326	
Academic Institution				
No	2,184 (87.68)	307 (12.32)	2,491	<0.001
Yes	1,780 (84.12)	336 (15.88)	2,116	
Specialty				
Neurosurgery	566 (79.05)	150 (20.95)	716	<0.001
Orthopedics	1,318 (87.63)	186 (12.37)	1,504	
Other	150 (93.75	10 (6.25)	160	
Pathology				
Kyphoplasty	797 (99.5)	797 (99.5)	801	<0.001
Degenerative	602 (80.16)	149 (19.84)	751	
Deformity	582 (97.49)	15 (2.51)	597	
Trauma	39 (58.21)	28 (41.79)	67	
Other	22 (95.65)	1 (4.35)	23	
Surgical Approach				
Anterior	178 (85.17)	31 (14.83)	209	0.001
Posterior	1,830 (91.91)	161 (8.09)	1,991	
Gender				
Female	2,171 (86.81)	330 (13.19)	2,501	0.104
Male	1,793(85.14)	313 (14.86)	2,106	
Rural Setting				
No	3,489 (86.15)	561 (13.85)	4,050	0.545
Yes	472 (85.2)	82 (14.8)	554	
Age Group				
25-64yrs	1,909 (85.07)	335 (14.93)	2,244	<0.001
65+yrs	1,368 (84.03)	260 (15.97)	1,628	
<25yrs	687 (93.47)	48 (6.53)	735	

Univariate analysis of predictors of navigation usage

Results

We identified 4607 instrumented spinal fusions in our cohort. Most cases were performed by orthopedic surgeons (63.2%) and the remainder by neurosurgeons. Of 2239 cases with identifiable etiology, CAN was utilized in 8.8%, predominantly for trauma and degenerative pathologies rather than deformity. In univariate analyses, CAN was used more often by neurosurgeons (21.0% vs. 12.4%, p<0.001), in academic institutions (15.9% vs. 12.3%, p<0.001), and when performed in/after 2010 (18.9% vs. 8.9%, p<0.001). Differences by specialty and year remained significant in multiple logistic regression.

Learning Objectives

By the conclusion of this session, participants should be able to:

1) Identify the spatial and temporal trends in navigation usage for spinal procedures in a single-province cohort in Canada

2) Identify shortcomings in navigation technology leading to gaps in usage, with the goal of improving the development of future navigation techniques to address these translational gaps

Table 2

	ODDS RATIO	95% CONFIDENCE INTERVAL	P-VALUE
YEAR			
<2013	1.00		
≥2013	2.88	1.34-6.21	0.007
ACADEMIC INSTITUTION			
NO	1.00		
YES	1.23	0.51-2.99	0.648
SPECIALTY			
ORTHOPEDICS	1.00		
NEUROSURGERY	2.87	1.32-6.27	0.008
OTHER	1.68	0.49-5.71	0.408
PATHOLOGY			
KYPHOPLASTY	1.00		
DEGENERATIVE	20.01	5.41-74.1	<0.001
DEFORMITY	7.34	2.05-26.3	0.002
TRAUMA	90.14	13.7-592.94	<0.001
GENDER			
MALE	1.00		
FEMALE	1.01	0.49-2.10	0.973
RURAL SETTING			
NO	1.00		
YES	1.20	0.45-3.21	0.718
AGE GROUP			
<25YRS	1.00		
65+YRS	7.87	2.14-28.95	0.002
25-64YRS	4.52	1.21-16.89	0.025
SURGICAL APPROACH			
ANTERIOR	1.00		
POSTERIOR	1.86	0.45-7.72	0.394

Multivariate analysis of predictors of navigation use

Conclusions

Spinal CAN has proven benefit for instrumentation accuracy, but is used preferentially by academic neurosurgeons. Significant gains must be made in cost and usability to improve access across disciplines and institutions.