

Novel Extended Vertebral Registration for Wrong Level Spinal Surgery - A Virtual Trial with Data Multiplexing Using Patient Specific Anatomy and Machine Vision Image Guidance (NEVER Wrong)

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Introduction

Wrong level spine surgery is a significant problem for both patients and surgeons. Although it has a low incidence of between 1 in 2222 and 1 in 3010, 50% or more of spine surgeons will perform a wrong level spine surgery at some point in their careers. In a third of these cases, preoperative imaging is used but fails to detect the wrong level. Therefore, better detection methods are needed with which to verify surgeons' clinical judgment.

Methods

Using historical data from prospective, pre-clinical, and clinical cases, we sought to test the efficacy of a proposed wrong level detection approach. Our approach involved pairing each preoperative x-ray with imaging of four nearby levels to see if any of these represent a better match than the surgeon's hypothesized correct level. The ability of four different Detector Methods was analyzed in terms of their ability to identify the correct level. The dataset included 310 measurements from 46 unique cases.

Results

Data were analyzed using a hierarchical regression approach to test Detector Methods One, Two, Three, and Four. At a significance level of $p < 0.001$, all four methods were able to correctly determine if a given spine level was correct with an accuracy of around 94%. Detectors One, Two, and Three were within a 95% confidence interval of each other in being slightly over 94% accuracy but had a slight liberal bias. Detector Four had a very slightly lower accuracy of 93.8%, but a conservative bias.

Conclusions

All four Detection Methods demonstrated strong ability to correctly predict whether a spine level was the correct level. The slight liberal biases in Detectors One, Two, and Three makes them slightly inferior to Detector Four because a false positive is more dangerous in choosing the right level than is a false negative.

Learning Objectives

By the conclusion of this session, participants should be able to: 1) Describe the importance of selecting the right level when conducting spinal surgery and the consequences of failing to do so, 2) Discuss, in small groups the identification correct spine level in spinal surgeries and the standard approach to so doing, and 3) Identify an effective technique to improve surgical outcomes by reducing the incidence of wrong level spine surgery.

% of matched points of each level (all data)

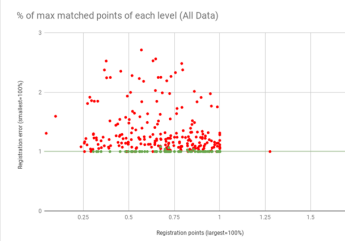


Figure 1: Percentage of max matched points at each level (total dataset)

% of matched points of correct level (all data)

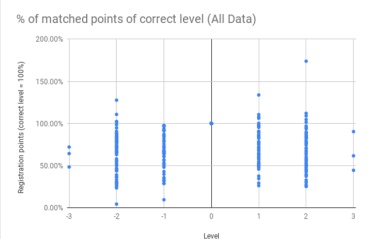


Figure 2: Percentage of matched points at the correct level (total dataset)

% of registration error of correct level (all data)



Figure 3: Percentage of registration error relative to the correct level (total dataset)

Tables

Table 1
Frequency statistics for Detector One

Site Location	Detector One Decision		Total
	Incorrect	Correct	
Incorrect	61	9	70
Correct	9	226	235
Total	70	235	305

Table 2
Frequency statistics for Detector Two

Site Location	Detector Two Decision		Total
	Incorrect	Correct	
Incorrect	61	9	70
Correct	9	226	235
Total	70	235	305

Table 3
Frequency statistics for Detector Three

Site Location	Detector Three Decision		Total
	Incorrect	Correct	
Incorrect	53	17	70
Correct	0	235	235
Total	53	252	305

Table 4
Frequency statistics for Detector Four

Site Location	Detector Four Decision		Total
	Incorrect	Correct	
Incorrect	69	1	70
Correct	18	217	235
Total	87	218	305

Table 5

Sensitivity and criterion measures for each Detector Method

Classification Accuracy	Detector Method			
	Detector One	Detector Two	Detector Three	Detector Four
Classification Accuracy	94.1%	94.1%	94.4%	93.8%
Sensitivity d'	2.904	2.904	4.033	3.618
Criterion c	-0.319	-0.319	-1.319	0.381

Frequency statistics for all four Detectors and Sensitivity and criterion measures for each Detector Method

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