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Research Article

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The Hypothesis of Navigation Guided Alarm (NGA), A New Software Technique To Be Used During Spinal Instrumentation

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Abstract

Background: *An innovative idea to be applied to the navigation software system during spinal instrumentation to enhance screw trajectory accuracy aiming to properly equalize the distribution of the loading forces on the spine and the instrumentation system.*

Methods: *The hypothesis of the navigation-guided alarm during spinal instrumentation is an idea under trial to be applied to the navigation system workstation software. Its application depends on proper anatomical and physiological localization of entry points, and Screws trajectory. The navigation-guided alarm idea works if the screws target the specific proper anatomical entry points, pedicle- body screw direction, and it will appear as a green line on the navigation screen with a green sound alarm.*

Results: *the hypothesis is still not investigated and theoretically it will be beneficial and promising for all types of spinal instrumentation aiming to preserve and restore normal spine alignment through proper instrumentation.*

Conclusions: *Different screw entry points or different screw directions inside the pedicles and or inside the vertebral bodies may theoretically result in various loading forces leading to instrumentation systems failure. The postulated value of the navigation-guided alarm (NGA) is to achieve a perfect screw trajectory during spinal instrumentation while preserving the normal spine alignment to avoid failed back surgeries.*

Keywords: Navigation Guided Alarm, Spinal Angles, Intraoperative Navigation Imaging Guide. Screw pedicle direction guide.

List of abbreviations:
NGA = Navigation Guided Alarm.
CT= Computed Tomography.
VR = Virtual Reality.

1. Introduction

The spinal navigation allows the spine surgeon and the neurosurgeon to perform accurate spinal instrumentation by avoiding misplaced screws and malposition screws. Medicolegal concerns over patient safety have further reinforced the need for more image-guided screw placements to improve accuracy. The aim of our study is to achieve all these purposes by adding a new technique which is the navigated guided alarm to the navigation system workstation software.

2. Method

The hypothesis of the navigation-guided alarm during spinal instrumentation is still under trial to be applied to the navigation system software. This study was approved by the Institutional Review Board (N. 2023031835)

Spinal Neuronavigation is a tool that provides correct localization of the different anatomical structures for proper screw direction during spinal instrumentation. Different pedicle size and angulation makes the insertion of the anatomical screw a challenge although the techniques and principles of screw placement are the same as for all systems [1]. The pedicle width is more important to know than its height during pedicle screw placement. As well as pedicle relations to each other and to the vertebral body [2].

The NGA proposal could be used with distinct types of navigation systems, especially the three-dimensional (3D) navigation system. This hypothesis when applied to the navigation system software workstation will lead to proper spinal instrumentation with good tracking of these instrumentations. The naviga-

tion-guided alarm idea depends on basic anatomical entry point, proper pedicle-body screw direction, and the sagittal/coronal pedicle angles relationship. When achieving these target points on the workstation they will appear as a green line with a green sound alarm (this means that the screw targets the correct points and direction inside the pedicle and inside the vertebral body). For example, in the lumbar spine, the proper target entry point of the pedicle is at the junction of the lateral facet and the transverse process, or at the bisection of a vertical line through the facet joints and a horizontal line through the transverse process. These anatomical entry points could be different from one vertebra to another according to the three-dimension changes because of degenerative, congenital, or traumatic changes in the spine. The aim is to reach these target points whatever the shape or direction of the pedicle or its relation to the vertebral body. With proper direction the screw will be inside the cancellous bone and parallel to the cortical shell along the pedicle with continuation of the screw inside the body with the long axis of the pedicle (Figure 1).

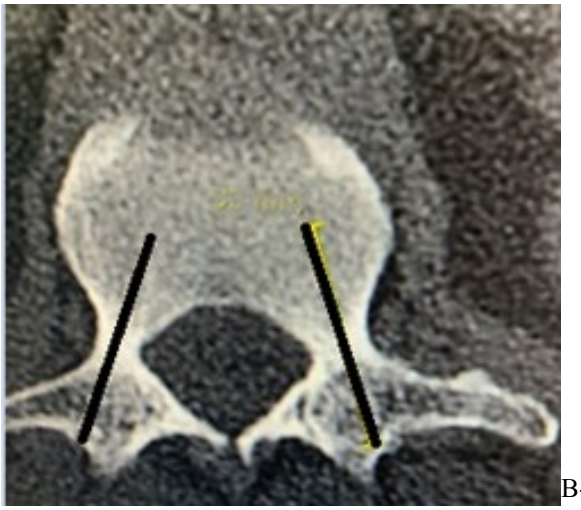
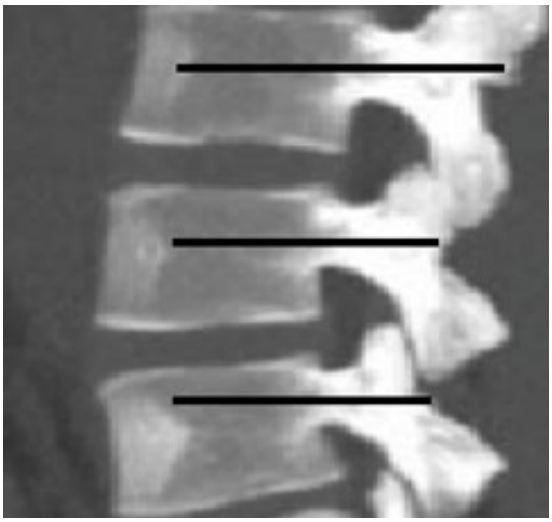
A-  B- 

Figure 1: An axial and coronal CT of the lumbar spine (A, B) shows the correct entry points and screw direction inside the pedicle and the vertebral body (no different angulation at each level).

Most spine surgeons depend on their happiness with the images obtained on the navigation system screen, or they use the pedicle-sounding probe to make sure there is no disruption in the cortex of the pedicles. Others may place K-wires into the pedicles to confirm the screw trajectory. All these methods do not guarantee accurate anatomical screw placement with respect to the pedicle long axis, and pedicle body angulation and it may lead to fixation system failure. By using this technique Any abnormal screw direction or different screws angulation at the same level or at different adjacent levels can easy be avoided.

3. Description of the idea

The idea depends on three anatomical points that are marked on the software of the preoperative, or intraoperative CT navigation system. The registration of these points to the navigation workstation as follow One point at the entry point, one point inside the pedicle along its long axis in the cancellous bone parallel to the cortical shell of the pedicle, and one point inside the vertebral body along the line of the other two points). The axial, sagittal, and coronal CT cuts must show the clear rim of cortical bone surrounding the cancellous core at the entry points, and at the junction of the pedicle with the body, (Figure 2). The point inside the vertebral body will be the continuation of the line with the previous two connected points. The correct screw direction inside the pedicle and the vertebral body will appear in the workstation as a green line with a green alarm sound when we are targeting these points. Once the direction changes, the green line will turn red with red alarm sound (denoting the wrong direction).

A-  B- 

Figure 2: A-B: sagittal CT cuts with the correct points of registration at the entry point as shown in fig, A. and at the pedicle-vertebral body junction as shown in fig. B. (please note the cancellous bone and the cortical bone shell surrounding).

4. Study design and illustrations

The learning and design process involves four main steps on the navigation software workstation:

1. Determine and register the correct anatomical entry points.
2. Determine and register the target points inside the pedicle and inside the vertebral body.
3. Correlate these three points on the sagittal and coronal imaging with the axial images to approach the proper and correct screw direction.
4. The three targeting points appear as a green line on the navigation workstation so the spine surgeon can follow during screw insertion

5. Discussion

The screw entry point during traditional open surgery is exposed so the assess with the spinous processes, transverse processes, and facet joints orientations. However, with pedicle screw placement, accuracy relies on imaging-based landmarks are not easily visualized or palpable, lack of these landmarks could cause different screw orientations than what would expecting. [3, 4]. The wobble created by manually tapping or inserting screws across the trajectories involved might result in inaccuracies due to the maximal radial movement from its center of axis. with using the hypothesis of NGA and its application to the navigation system all this error could be avoided [5].

Spinal surgeries are intricate procedures that may cause both mental and physical fatigue in the surgeon. This intraoperative stress might contribute to errors in judgment and decision making and, henceforth, be detrimental in terms of surgical outcomes, as reported by Wetzel et al. Therefore, the proposal of the navigation -guided alarm has been developed, hoping to decrease both mental and physical fatigue and overcome all the surgical error during spinal instrumentation [6]. More recent studies found an increase accuracy with the use of a new generation of intraoperative CT navigation systems depending on good imaging results without considering the relationship between screws direction, their correlation to each other [7].

In case of Virtual Reality (VR) systems which are gaining traction with recent technology development ventures, this theory could be applied to these systems with more accuracy, and it also supports the theory published by me in 2015 which discussed the relationship between angles between pedicles, pars-interarticularis, and facet joints [9] that theoretically indicated the different loading forces over each part of the fixation system and the spinal parts related are due to different screw entry points or screws directions inside the pedicles and the vertebral bodies [8,9]. These different forces are due to different angles initiated by different screws directions in relation to each other and leading to instrumentation system failure.

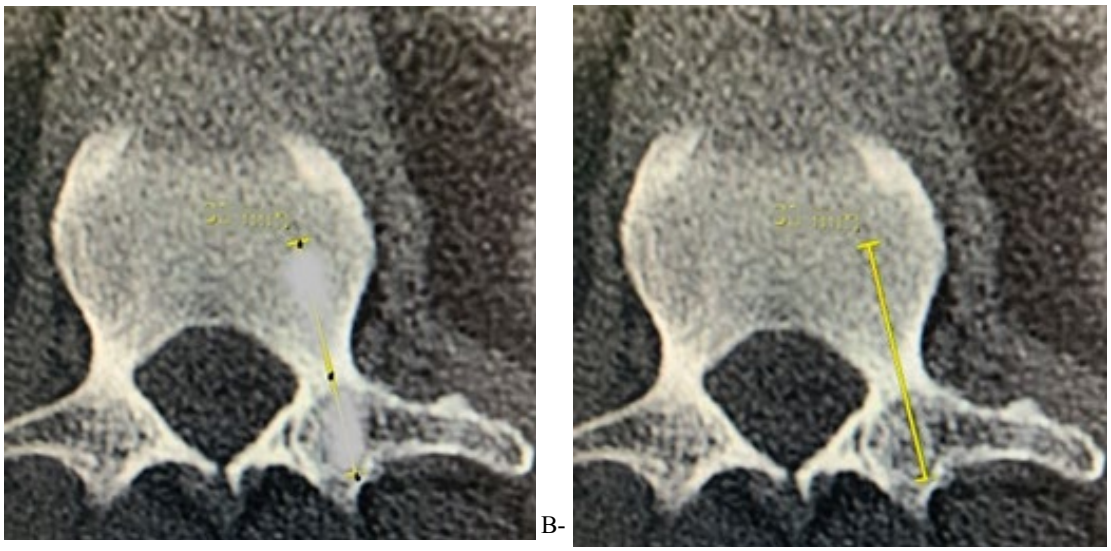


Figure 3: A-B: shows an axial cut of the lumbar CT: A-shows the 3-dot registered on the navigation system. B-displays the correct line when the correct points are targeted.

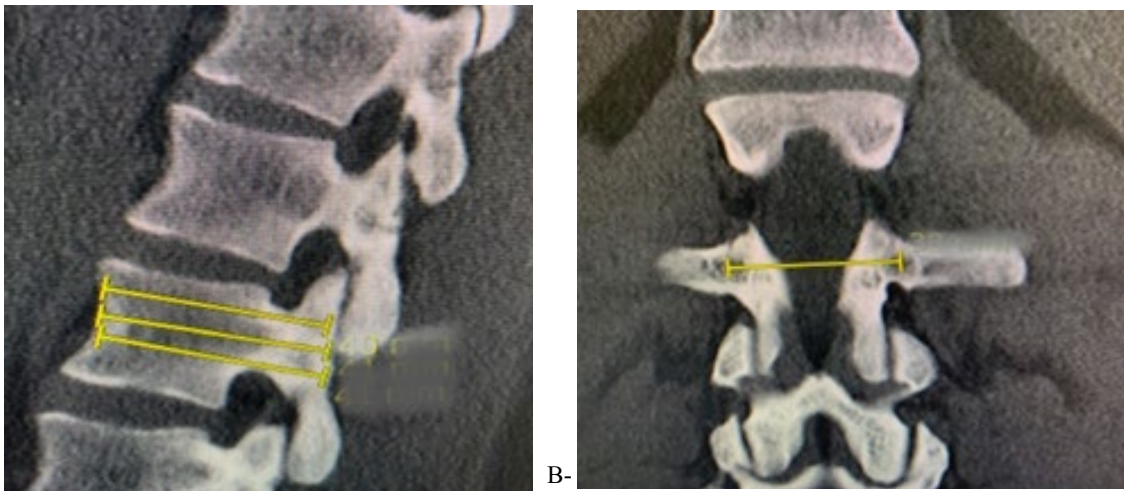


Figure 4: A-B coronal and sagittal CT lumbar spine cuts: A- shows three lines inside the pedicle. The middle line is the correct one which should be registered to the navigation system workstation. B. shows the two correct points on each side inside the cancellous bone.

6. Results

The hypothesis is still not investigated and theoretically it will be extremely helpful and promising for all types of spinal instrumentation aiming to preserve and restore the normal spine alignment through proper instrumentation. The NGA concept will be an extremely helpful and promising technology to both spine surgeons and neurosurgeons to reduce fixation system failure and failed back surgeries. The hypothesis needs more research and more updating works for proper application and use.

7. Conclusions

Different screw entry points or different screw direction inside the pedicles and or inside the vertebral bodies may be theoretically result in different loading forces leading to instrumentation systems failure. The postulated value of the navigation-guided alarm (NGA) is to achieve a perfect screw trajectory during spinal instrumentation with the preservation of the normal spine alignment to avoid failed back surgeries.

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References

1. JP, A. D., & JM, V. F. (2012). Posterior lumbar fusion using the O-arm surgical imaging system: initial experience. Neurocirugia (Asturias, Spain), 24(1), 1-8.
2. Wang, M., & Song, Z. (2013). Optimal number and distribution of points selected on the vertebra for surface matching in CT-based spinal navigation. Computer Aided Surgery, 18(3-4), 93-100.
3. Parker, S. L., McGirt, M. J., Farber, S. H., Amin, A. G., Rick, A. M., Suk, I., ... & Witham, T. F. (2011). Accuracy of free-hand pedicle screws in the thoracic and lumbar spine: analysis of 6816 consecutive screws. Neurosurgery, 68(1),

170-178.
4. Mason, A., Paulsen, R., Babuska, J. M., Rajpal, S., Burneikiene, S., Nelson, E. L., & Villavicencio, A. T. (2014). The accuracy of pedicle screw placement using intraoperative image guidance systems: a systematic review. Journal of Neurosurgery: Spine, 20(2), 196-203.
5. Rahmathulla, G., Nottmeier, E. W., Pirris, S. M., Deen, H. G., & Pichelmann, M. A. (2014). Intraoperative image-guided spinal navigation: technical pitfalls and their avoidance. Neurosurgical focus, 36(3), E3.
6. Lian, X., Navarro-Ramirez, R., Berlin, C., Jada, A., Moriguchi, Y., Zhang, Q., & Härtl, R. (2016). Total 3D Airo® navigation for minimally invasive transforaminal lumbar interbody fusion. BioMed research international, 2016.
7. Wetzel, C. M., Kneebone, R. L., Woloshynowych, M., Nestel, D., Moorthy, K., Kidd, J., & Darzi, A. (2006). The effects of stress on surgical performance. The American Journal of Surgery, 191(1), 5-10.
8. Archavlis, E., Schwandt, E., Kosterhon, M., Gutenberg, A., Ulrich, P., Nimer, A., ... & Kantelhardt, S. R. (2016). A modified microsurgical endoscopic-assisted transpedicular corpectomy of the thoracic spine based on virtual 3-dimensional planning. World neurosurgery, 91, 424-433.
9. Eldanasory, O. A. (2015). The relationship between disc space height in normal lumbar spine and its effect on spine alignment depending on measurement of the angles between pedicles-pars interarticularis, and pedicles-facet joints. Al-azhar assiut medical journal, 13(2).