

**To compare Radio-Stereometric Analysis
(RSA) and Computed Tomography (CT) for
the assessment of lumbar spinal fusion in
a sheep model**

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Abstract

Study design: A comparison of Radio-Stereometric Analysis (RSA) and Computed Tomography (CT) for the assessment spinal fusion in a large animal model.

Introduction and Aims: Anterior Lumbar Interbody Fusion (ALIF) is a surgical procedure that is commonly performed for patients with chronic disabling low back pain that is unresponsive to conservative treatments. CT is a standard technique to assess the completeness of fusion but has a high radiation penalty to the patient. RSA is an alternative method to assess fusion with a much lower radiation exposure for the patient and is reported to have high accuracy. The study compares RSA to fine-cut CT scan using histology from necropsy specimens as the reference standard.

Methods: Three non-adjacent ALIFs (L1-L2, L3-L4, and L5-L6) were carried out in 9 sheep. The sheep were divided into three groups of 3 sheep. The first group had RSA immediately post-op, 3 and 6 months after surgery. The second group had RSA immediately post-op, 3, 6 and 9 months after surgery. The third group had RSA immediately post-op, 3, 6, 9 and 12 months after surgery. All the animals were humanly killed immediately after having the last scheduled RSA. The lumbar spine was removed and invitro fine cut CT and histopathology were performed.

The RSA was carried out by an experienced scientist to determine the number of fused levels. Post-mortem CT scans were performed and reviewed by up to three radiologists to assess the number of fused levels. Histology sections were taken through the ALIF segments and reviewed by a senior research scientist with expertise in histology and a consultant pathologist.

Results: Using histological assessment as the gold standard for assessing fusion, RSA demonstrated superior results (100% sensitivity and 66.7% specificity (PPV = 27.3%, NPV = 100.0%) when compared to CT (66.7% sensitivity and 60.0% specificity (PPV = 16.7%, NPV = 93.8%). The assessment of the inter-rater reliability of the first CT scan of the two radiologists

indicated no agreement ($k = 0.07$, $p\text{-value} = 0.353$). As indicated in the methods section, when a discrepancy occurred, a 3rd independent radiologist assessed the CT scans, with this review providing the final CT scan result. The Fleiss Kappa statistic indicated *no agreement* between the 1st and 3rd radiologist ($k = 0.10$, $p\text{-value} = 0.333$) on the occasions where the results of the 3rd radiologist were known ($n=12$ of the 27 results). The Fleiss Kappa statistic between the 2nd and 3rd radiologist also indicated *no agreement* ($k = -0.13$, $p\text{-value} = 0.668$). Significant inter-observer error was observed amongst radiologists using CT Scans for the assessment of fusion.

Conclusion: Using histological assessment as the gold standard for the assessment of fusion in this animal model, RSA demonstrated higher sensitivity and specificity when compared to CT. Furthermore RSA has the advantage of much lower radiation exposure compared to fine cut CT. Further studies are required to see if RSA remains superior to CT scan for the assessment spinal fusion in the clinical setting.

Declaration

1. The work contains no material which has been accepted for the award of any other degree or diploma in any University or other tertiary institution to **Ali Humadi** and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.
2. I carried out the work in this study from the research planning to the analysis of results with help of my supervisors.
3. The conclusion drawn from this study is my own true interpretation of the results.
4. I acknowledge the contribution of those individuals that assisted me in conducting this research.
5. I acknowledge the special contribution of Mr. Klas Holdin and Mr. Stuart Callary.
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Dr Ali H Humadi

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