

Evaluating MRI-Based Vertebral Bone Quality as a Predictor of Cage Subsidence following Anterior Cervical Discectomy and Fusion

Ara Khoylyan, Jason Salvato, Taylor N Moglia, Frank L. Vazquez, Arpitha Pamula, Alex Tang, Tan Chen

INTRODUCTION:

Anterior Cervical Discectomy and Fusion (ACDF) is a common spine procedure to treat degenerative cervical conditions. A significant surgical complication is cage subsidence, which can result in loss of indirect decompression, deformity, recurrent neck pain and radicular symptoms. Cage subsidence can be influenced by patient factors such as age, medical history, and bone quality. Recent advancements in magnetic resonance imaging (MRI) have introduced the Vertebral Bone Quality (VBQ) score, an MRI-based measure of trabecular bone, offering a potentially more precise measure of bone quality.

The primary objectives of this study are to determine the association between VBQ scores and subsidence after single-level ACDF and whether there is a clinically relevant cutoff that can be used to determine risk. We hypothesize that higher VBQ scores, which correlate with poorer bone quality, are associated with higher subsidence risk.

METHODS: Retrospective review was performed identifying patients who underwent elective single-level ACDF procedure for degenerative pathology between November 2019 and April 2023. Exclusion criteria included non-degenerative diagnosis, prior revisions at the index level, multilevel procedures, anterior/posterior fusions, and corpectomies. VBQ was calculated at C2-C7 from pre-operative T1-weighted MRI images within one year of surgery. Based on prior literature, moderate radiographic subsidence was defined as collapse of the interbody cage by greater than one-third but less than two-third of cage height. Collapse greater than two-third of total cage height was defined as severe subsidence. Descriptive and inferential statistics were performed.

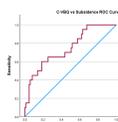
RESULTS:

A total of 117 patients undergoing ACDF were included. Moderate radiographic subsidence was present in 22 patients (19%), and severe subsidence was present in 3 patients (2%) post-operatively.

Mean VBQ score was significantly higher in those with clinical subsidence than those without (2.2 vs. 2.7, $p < .001$). There was moderate correlation between VBQ score and clinical subsidence ($R = 0.388$, $p < .001$). Those with a higher VBQ demonstrated significantly higher odds of developing clinical subsidence post-operatively (OR=14.59, 95% CI 1.64-128.58, $p = .016$).

A VBQ score of 2.11 demonstrated 90% sensitivity and 38% specificity in detecting clinical cage subsidence. A VBQ score of 2.79 was 45% sensitive and 91% specific (AUC=0.747, $p < .001$). There were no differences in one-year postoperative outcomes between those with and without clinical subsidence based on PROMIS (31.1 vs 29.6; $p = .566$) and NDI (32.3 vs 32.5; $p = .984$) scores.

DISCUSSION AND CONCLUSION: Patients with higher cervical VBQ scores are at a significantly greater risk of developing radiographic cage subsidence following single-level ACDF, with a VBQ cutoff of 2.11 demonstrating high sensitivity. Our findings further elucidate the utility of VBQ scores in cervical spine surgery and help guide pre-operative planning and patient counseling.



Source of the Curve
 Histogram
 Histogram (with normal curve)

	Subsidence Subsidence			
	None	Mild	Severe	Total
C-VBQ	2,284	2,284	2,284	2,284
Age	1,081	1,081	1,081	1,081
Sex	1,146	1,146	1,146	1,146

C-VBQ vs. Radiographic Subsidence

AUC	Cutoff	Sens. Spec.	95% CI	P-value
0.747	2.11	0.90 0.38	0.520 0.974	<.001
	2.79	0.45 0.91	0.164 0.836	<.001

Subsidence	No Subsidence	Subsidence	Total
None	2,284 (100%)	0 (0%)	2,284
Mild	2,284 (100%)	0 (0%)	2,284
Severe	2,284 (100%)	0 (0%)	2,284