Bone quality

Good bone quality is key in avoiding a multitude of afflictions, including osteoporotic fragility fractures and poor outcomes after spine surgery. In patients undergoing instrumented spine fusion, bone quality often dictates screw pullout strength, insertional torque, and vertebral body loading properties. While dual-energy X-ray absorptiometry (DEXA) screening is the current method of assessing bone mineral density, the majority of patients do not have DEXA measurements available before undergoing surgical instrumentation.

The use of pedicle screws in low bone quality patients implicate risks of secondary implant loosening for grip lack. In fact, the result is a reduced mechanical stability at the bone-screw interface and consequently an increased chance of pullout and hardware failure. Augmentation techniques have been described for many years and fenestrated screws that allow cement injection is one of them.

In a retrospective observational study of patients treated with polymethylmethacrylate- (PMMA) augmented fenestrated screws. Indications for posterior instrumentation were traumatic fracture in osteoporotic spine, oncological disease, post-traumatic deformity, degenerative disease, revision surgery and sickle cell disease fractures. Implant stability was evaluated with X-Rays and CT scan performed 3 days after surgery and every 3 months during the follow-up. Accuracy of screw placement was evaluated with Heary classification. Fifty-three surgical treatments in 52 patients were performed and 247 PMMA augmented fenestrated screws were placed. According to the Heary classification, 96.21% resulted Grade I, 1.8% Grade II, 2% Grade IV. A total of 17 complications occurred. Fenestrated screw augmentation should be performed in selected patients in whom the bone quality is insufficient to guarantee implant stability. These screws may result useful in complex cases as revision surgeries, osteoporosis and tumour affections where bone quality is highly compromised [1)].

Ropper AE, Groff MW. Cervical spine reconstruction in cases of compromised bone quality. World Neurosurg. 2012 Jul;78(1-2):85-7. doi: 10.1016/j.wneu.2011.12.061. Epub 2011 Dec 17. PubMed PMID: 22381296.

Bone Quality Score

A low bone quality score indicates a higher risk for fracture, while a high bone quality score indicates a lower risk. It's important to note that bone quality is different from bone density, which is a measure of the amount of bone mineral in a specific area of the skeleton.

Surgeons can preoperatively assess bone quality using Dual-energy X-ray absorptiometry or computed tomography; however, this is not feasible for all patients. Recently, an MRI-based scoring system was used to evaluate the lumbar spine's vertebral bone quality.

To create a similar MRI-based scoring system for the cervical spine (C-VBQ), correlate C-VBQ scores

with computed tomography-Hounsfield units (HU), and evaluate the utility of this scoring system to independently predict cage subsidence after single-level anterior cervical diskectomy and fusion (ACDF).

Demographic, procedure-related, and radiographic data were collected for patients. Pearson correlation test was used to determine the correlation between C-VBQ and HU. Cage subsidence was defined as ≥3 mm loss of fusion segmental height. A multivariate logistic regression model was built to determine the correlation between potential risk factors for subsidence.

Of 59 patients who underwent single-level ACDF, subsidence was found in 17 (28.8%). Mean C-VBQ scores were 2.22 ± 0.36 for no subsidence levels and 2.83 ± 0.38 (P < .001) for subsidence levels. On multivariate analysis, a higher C-VBQ score was significantly associated with subsidence (odds ratio = 1.85, 95% CI = 1.39-2.46, P < .001) and was the only significant independent predictor of subsidence after ACDF. There was a significant negative correlation between HU and C-VBQ (r2 = -0.49, P < .001).

Soliman et al. found that a higher C-VBQ score was significantly associated with cage subsidence after ACDF. Furthermore, there was a significant negative correlation between C-VBQ and HU. The C-VBQ score may be a valuable tool for assessing preoperative bone quality and independently predicting cage subsidence after ACDF [2)].

To create a simple MRI-based score to evaluate the bone quality and evaluate the degree to which it correlates with conventional DEXA scores Ehresman et al. published a retrospective cohort of Patients ≥ 18 years of age undergoing spine surgery for degenerative conditions between 2013 and 2018.

Correlation of the Vertebral Bone Quality (VBQ) scores with DEXA T-scores and association between VBQ score and presence of osteopenia/osteoporosis.

Using non-contrast T1-weighted magnetic resonance images (MRIs) of the lumbar spine, the novel VBQ score was calculated for each patient. DEXA T-scores of the femoral neck and total hip were obtained and were compared to patient VBQ scores using linear regression and Pearson's correlation.

Among the 68 patients included in this study, 37 were found to have osteopenia/osteoporosis (T-score < -1.0) based on DEXA. A greater VBQ score was significantly associated with the presence of osteopenia/osteoporosis with a predictive accuracy of 81%. VBQ scores correlated moderately with femoral neck T-scores, the lowest overall T-scores of each patient, and correlated fairly with total hip T-scores.

This is the first study to correlate the novel VBQ score obtained from MRIs with DEXA T-score. We found this score to be a significant predictor of healthy versus osteopenic/osteoporotic bone with an accuracy of 81%, and found that VBQ score was moderately correlated with femoral neck and overall lowest T-score [3)].

1)
Ghermandi R, Pipola V, Colangeli S, Parchi P, Andreani L, Capanna R, Gasbarrini A. Polymethylmethacrylate-augmented fenestreted pedicle-screw fixation in low bone quality patients: a case series and literature review. J Biol Regul Homeost Agents. 2018 Nov-Dec;32(6 Suppl. 1):71-76. PubMed PMID: 30644285.
2)
Soliman MAR, Aguirre AO, Kuo CC, Ruggiero N, Khan A, Ghannam MM, Rho K, Jowdy PK, Mullin JP, Pollina J. A Novel Cervical Vertebral Bone Quality Score Independently Predicts Cage Subsidence After

Anterior Cervical Diskectomy and Fusion. Neurosurgery. 2022 Dec 14. doi: 10.1227/neu.0000000000002269. Epub ahead of print. PMID: 36729684.
3)
Ehresman J, Pennington Z, Schilling A, Lubelski D, Ahmed AK, Cottrill E, Khan M, Sciubba DM. Novel MRI-based score for assessment of bone density in operative spine patients. Spine J. 2019 Nov 1. pii: S1529-9430(19)31064-2. doi: 10.1016/j.spinee.2019.10.018. [Epub ahead of print] PubMed PMID: 31683066.