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Is there a correlation between Pfirrmann Grade and BMP-Signaling in Degenerative Disc Disease?

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Introduction: Degenerative disc disease (DDD) is a major burden to society. Bone morphogenetic proteins (BMPs) are growth factors and BMP-2 is a known potent osteoinductor. To date no group has evaluated the role of BMP receptor Type I or ALK3 overexpression in the BMP-SMAD signaling pathway within the intervertebral disc as a therapeutic strategy for DDD. Pfirrmann grade is a validated MRI based classification to grade the extent of degenerative disc disease.

Methods: We used degenerative disc specimen (n=37) and control disc specimen (n=13) from patients undergoing spine surgery. We rated the degenerative discs from Grade III to V. We evaluated expression of the SMAD1-5-8 signaling pathway in the disc specimen via immunohistochemistry. A Mann Whitney U test was used for the comparison of quantitative data between groups ($p < .05$).

Results: 20 females and 17 males, average age 43.7 (19-82). Their discs were submitted for histology, stained for phos-SMAD, BMP, and ALK3 then quantified by cell counts. The degenerative group resulted in averages of 14.8%, 13.1%, and 8.1% for pSMAD, BMP, and ALK3 respectively. The average pfirrmann grade was 3.7. An independent samples t test was used to compare expression levels of BMP, pSMAD, and ALK3 in degenerative discs and controls ($p< .05$). BMP and pSMAD resulted in significant differences, however ALK3 showed no significant difference ($p = 0.79$). The Mann Whitney U test showed, a significant relationship between the expression levels of BMP and pSMAD and Pffirmann grade ($p = <.001$).

Discussion: We have demonstrated BMP-2 and pSMAD are increased in patients with disc degeneration. ALK3 levels remained the same and yielded no significant changes. We can now conclude that there is a significant correlation between the expression levels of anabolic proteins BMP/ pSMAD, and degree of degradation in MRI grading based on the Pffirmann classification.