Fusion, Foraminotomy, and Arthroplasty of the Cervical Spine in Elite Athletes: A Systematic Review and Meta-Analysis Evaluating Return to Play
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INTRODUCTION:
Cervical spine surgery in elite athletes, including anterior cervical discectomy and fusion (ACDF), posterior cervical foraminotomy (PCF), and cervical disc arthroplasty (CDA) are all potential treatment options for cervical spine disease (CSD) including disc herniation and neuropraxia. No prior systematic reviews have examined the full breadth of these cervical surgical interventions in a professional athlete population. While ACDF, PCF, and increasingly CDA are the primary treatments for CSD in the general population, less is known regarding the outcomes of these surgeries in elite athletes as the biomechanical demands on an elite athlete’s cervical spine are far different from the general population. There are limited studies comparing ACDF, CDA, and PCF in an elite athlete population, consisting primarily of small retrospective cohort or case studies, making it difficult to draw conclusions. Therefore, the purpose of this systematic review and meta-analysis was to compare these surgical modalities in an elite athlete population with studied outcome variables including return to play (RTP) rate, time to RTP, duration of RTP, reoperation rate, and other postoperative complications.

METHODS:
Utilizing PRISMA guidelines, we queried four databases to identify all clinical studies involving ACDF, PCF, and CDA in elite or professional athletes. Review articles, expert opinions, editorials, and biomechanical/animal studies were excluded. A logit transformation was applied to the observed proportions to calculate effect sizes and then a meta-analysis of proportions pooling together all studies that included RTP rates for elite athletes undergoing surgery was performed using a random effects model.

RESULTS:
After full-text review, 13 clinical studies in total were deemed eligible for analysis. (Figure I) In total, 263 patients were treated operatively, with ACDF the most common (N=236, 89.7%), followed by PCF (N=22, 8.4%), and CDA (N=5, 1.9%). National football league (NFL) players were the most common (N=177, 67.3%), followed by major league baseball (MLB, N=34, 13.0%), with the remainder of patients consisting of professional wrestlers, lugers, and rugby, basketball, and soccer players. All studies had a low LoE consisting of IV (N=12, 92.3%) and V studies (N=1, 7.7%).

On meta-analysis, the pooled RTP rate was 74.1% (95% confidence interval 68.2%, 79.1%) for all surgical procedures in elite athletes. (Figure II) There was minimal study heterogeneity with a Q-value of 9.70 and an I² of 0%. Reported RTP rates for ACDF (N=12 studies) were between 25-100% at 6-13.1 months after surgery, 60-100% at 7.9 months for PCF (N=3), and 87.5-100% at 6.3-13.1 months for CDA (N=3). ACDF revision rate was 8.3% (range 0-25%), PCF ranged between 5.3-50%, and there were no reported revisions in the CDA cohort.

DISCUSSION AND CONCLUSION:
This current review of cervical spine surgery in elite, professional athletes is the largest to date and performs a comprehensive review of all surgical procedures performed (ACDF, PCF, and CDA). On meta-analysis, we identified a RTP rate of 74.1% among all procedures. Currently, ACDF continues to be the most commonly reported procedure in this patient population, however, PCF and CDA were also found to have high rates of RTP. However, PCF may be plagued by high conversions to a fusion procedure (5.3 to 50%). This study may be useful for patient counseling and to guide surgical decision making, however, future high quality and prospective studies are warranted.