The Effect of E-cigarette Vapor Extracts on Spine Fusion Capacity in a Rodent Arthrodesis Model

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INTRODUCTION: The CDC reported that approximately 5% of adults in the United States use e-cigarette vapes (ECV), with the most popular flavors being tobacco and menthol. Though studies have demonstrated its toxic effects on multiple organ systems, none have evaluated potential effects on spinal fusion. The objective of this study is to evaluate how ECV use affects spinal fusion capacity in a rat posterolateral arthrodesis model.

METHODS: E-cigarette vapor (ECV) was extracted from commercially available pods by bubbling through PBS. The solution was diluted to predetermined concentrations before delivery to rats. Optimal dose of ECV extract was determined to be 300µL from dose escalation trial. 35 female Sprague Dawley rats were treated with either PBS (control), menthol-ECV (M-ECV), or tobacco-ECV (T-ECV) extract five times per week. As this is a pilot study, only female rats were used to preliminarily estimate the effect of ECV on spinal fusion. This study was approved by IACUC. During week 2 of ECV exposure, rats underwent a previously described L4-5 posterolateral spine fusion, with absorbable collagen sponges loaded with 0.50µg BMP-2 per side. Weekly X-rays were obtained, beginning 2 weeks post-operatively, to evaluate bone fusion. After five weeks, rats were euthanized, and organs were harvested and weighed for each animal. Spine fusion was assessed using manual palpation, micro-CT analysis, and histology. Imaging analysis was conducted in ImageJ using the BoneJ plugin to evaluate trabecular thickness of fusion segments. Statistical analyses including Mann-Whitney tests were conducted in GraphPad Prism.

RESULTS SECTION: There was no significant difference in major organ weight between control, T-ECV, and M-ECV exposed rats. There was no significant difference between manual palpation scores for fusion in control and experimental rats (Figure 1). There were no significant differences between trabecular thickness or trabecular spacing measurements (Figure 2, Figure 3).

DISCUSSION: Exposure to T-ECV and M-ECV extract did not significantly impair spinal fusion in the selected rat posterolateral fusion model. The effect of ECV exposure on spinal fusion may need further investigation in a more stringent model, or with human clinical data. A limitation of this study is a reliance on intraperitoneal extract delivery rather than inhalation, which may not fully replicate human ECV use.

SIGNIFICANCE/CLINICAL RELEVANCE: The increasing prevalence of ECV use raises concern about its impact on musculoskeletal health, particularly in patients undergoing spinal fusion, where smoking has been shown to impair outcomes. This study gives preliminary data that can be further investigated in human clinical studies to guide perioperative recommendation for patients using ECVs.

IMAGES AND TABLES:

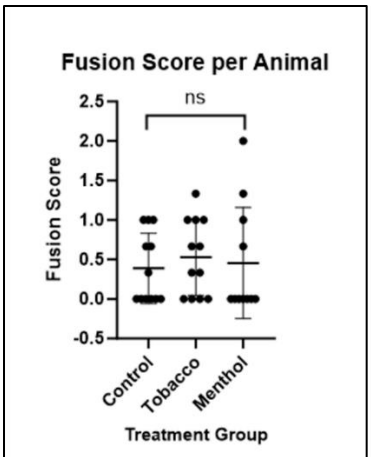

Figure 1. Bilateral manual palpation scores for all rats undergoing PLF, including control, tobacco-, and menthol-ECV exposed rats.

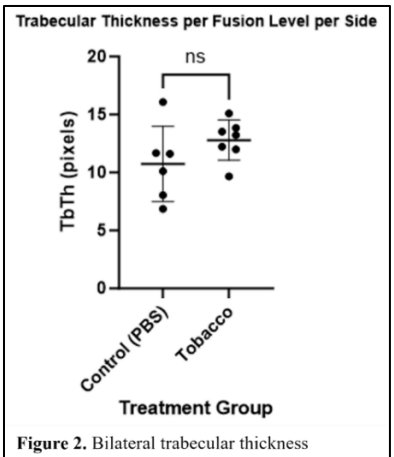

Figure 2. Bilateral trabecular thickness measurements at fusion levels from micro-CT scans for control and tobacco-ECV exposed rats undergoing PLF.

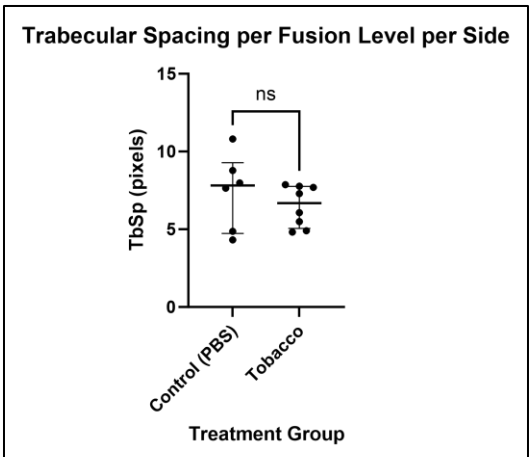

Figure 3. Bilateral trabecular spacing measurements at fusion levels from micro-CT scans for control and tobacco-ECV exposed rats undergoing PLF.