

Vaping and E-Cigarettes in Orthopaedic Surgery Outcomes: A Systematic Review

Asmi Babu¹, Paige Harper MD², Emma Kosowski³, Damon Ross MD³, Tegshjargal Baasansukh MD³, Lakin Hatcher MD³, Rolanda Willacy MD^{4*} and Marvin Dingle MD⁵

¹David Tvidlani Medical University of Georgia, Tblisi, GEO, USA

²Morehouse General Surgery Residency Program, Atlanta, GA, USA

³Howard University College of Medicine, Washington, DC, USA

⁴Orthopaedic Surgery Research Collective, New York, NY, USA

⁵Uniformed Services University of Health Sciences, Washington, DC, USA

*Corresponding author

Rolanda Willacy MD, Orthopaedic Surgery Research Collective, New York, NY, USA.

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ABSTRACT

Introduction: The detrimental impact of traditional tobacco smoking on orthopedic surgical outcomes has been extensively documented, with evidence linking smoking to impaired bone healing, delayed union, higher infection rates, and poorer functional recovery. In recent years, electronic cigarettes (e-cigarettes) and vaping have emerged as increasingly popular alternatives, often perceived as safer substitutes for conventional smoking. Despite their widespread use, the biological effects of e-cigarettes on musculoskeletal health and surgical recovery remain insufficiently understood. Preclinical studies suggest that exposure to nicotine and other aerosolized chemicals may disrupt bone metabolism, angiogenesis, and wound healing, thereby raising concerns for orthopedic patients. Given the rapid rise in e-cigarette consumption among adults and the critical importance of optimal recovery after orthopedic surgery, a systematic evaluation of existing evidence is warranted.

Methods: A systematic review was conducted using the PRISMA method to evaluate the association between e-cigarette/vaping use and non-tobacco nicotine dependence in common orthopaedic procedures. This includes rotator cuff repair, spine surgeries, foot and ankle procedures, total knee arthroplasty, total hip arthroplasty, femur intertrochanteric nailing etc. We focused on studies written in the last 10 years, between 2015 and 2025. Perioperative complications include impaired wound healing, bone healing.

Results: We identified 23 unique studies that met the inclusion criteria: seven clinical cohort/database studies, nine systematic reviews, one meta-analysis, and six preclinical or in vitro investigations. Clinical cohorts (aggregate >175,000 patients) consistently associated vaping or non-tobacco nicotine exposure with worse orthopaedic outcomes. In arthroplasty, exclusive vape or nicotine users had longer operative times, increased length of stay, and higher readmission or complication rates. Large datasets showed that nicotine exposure including e-cigarettes and smokeless forms was associated with elevated perioperative medical complications and, at two years, higher prosthetic joint events. Additionally, preclinical and cellular studies concluded that e-cigarette vapor exposure reduced osteoblast viability, promoted pro-inflammatory and cytotoxic effects, and impaired tendon and bone healing.

Conclusion: The growing body of literature highlights that e-cigarette use is not a safer alternative to traditional cigarette smoking in the context of orthopedic surgery. Data is consistently showing that vaping may impair bone healing, impact fracture union, and contribute to higher postoperative complication rates. These risks are especially concerning in adolescent populations, where vaping use continues to rise at alarming rates due to social media platforms promoting vaping as a healthier alternative to traditional smoking. Despite this evidence, current research remains limited by small sample sizes and inconsistent definitions of vaping. Larger prospective studies are necessary to better define the independent effects of e-cigarettes on orthopedic outcomes and to clarify their long-term impact.

Keywords: Vaping, E-Cigarettes, Joint Replacement, Orthopaedic Surgery, Orthopaedic Trauma

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Introduction

The use of e-cigarettes in the United States has been increasing rapidly. E-cigarette use is being targeted at younger audiences on social media platforms such as Instagram and TikTok as a healthier alternative to traditional smoking. According to literature, young adults who have viewed influencer videos on healthy lifestyle and e-cigarette use report lower harm perceptions and high susceptibility to e-cigarette use [1]. However, many of the chemicals contained in the vapor of e-cigarettes are unregulated and have paralleled levels of toxic metals found in traditional cigarettes [2]. It is well documented in literature that both e-cigarettes and traditional cigarettes have adverse effects on multiple organ systems and correlations to poor surgical wound healing. E-cigarettes have shown to have a toxic effect on osteoblast cells, therefore implicating orthopedic surgery outcomes [3]. Electronic cigarettes release nicotine in an inconsistent manner, resulting in many negative consequences for bone health [4]. It is difficult to assess the impact of e-cigarettes on orthopedic surgery outcomes as many brands with varying components exist on the market. As the diversity of e-cigarette products increases, more research needs to be done on the effects of e-cigarette products on adolescent orthopedic surgery outcomes.

According to the Center for Disease Control (CDC), the use of electronic cigarettes has increased from 1.5% in 2011 to 20.8% in 2018 [5]. This nearly 14-fold increase can be attributed to a host of factors including discreet usage, various flavors, and increasing popularity among peers. While initially marketed to aid in the decreased usage of tobacco products, it ultimately had the opposite effect. While the literature indicates that as of 2023 the largest proportion of users fall into the 21-24 age group (15.5%), ages 25-34 (12.6%) and 18-20 (10.3%) are not far behind [6]. While our understanding of electronic cigarette use on health outcomes is continuously evolving, there is a paucity of data regarding electronic cigarette usage and Orthopedic outcomes. Our understanding of nicotine usage and increased length of hospital stays, or surgical site infections have been well documented in the literature; the question remains whether electronic cigarettes can fall into that category. While patients that vape have, on average, longer surgical times and higher readmission rates, the data is limited [7]. Given the rapid rise in electronic cigarette usage and limited data on Orthopedic Outcomes, more research is necessary to evaluate for infection rates, perioperative outcomes, and long-term implant success. Clarifying these associations will be critical in guiding preoperative risk assessment and developing tailored patient counseling and perioperative management strategies.

Methods

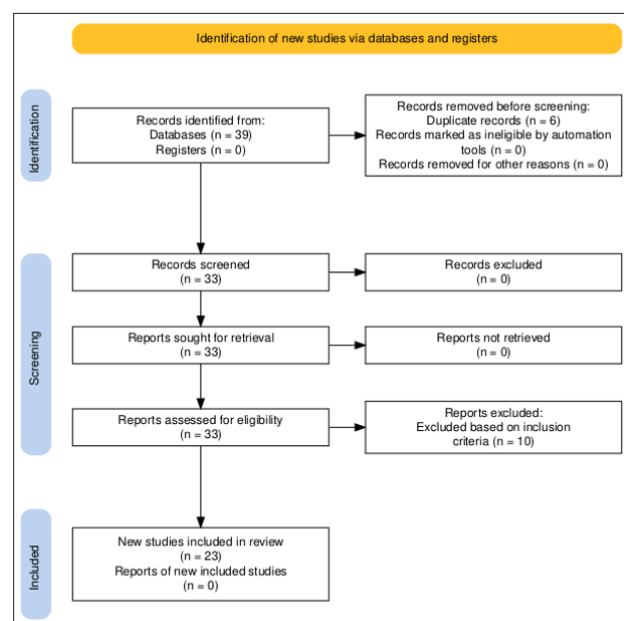
The systematic search was conducted following the PRISMA 2020 guidelines to evaluate the impact of Vaping and E-cigarettes and orthopaedic surgery outcomes. The following sources from 2015-2025 were reviewed: PubMed/MEDLINE, Embase, Web of Science Core Collection, and Cochrane CENTRAL. Key terms used were “vaping”, “e-cigarettes”, “orthopaedics”, “orthopaedic surgery” and “outcomes”. Two independent reviewers assessed the abstracts and full studies based on the following criteria: peer-reviewed original research involving adult patients aged 18 years or older, evaluation of e-cigarette or non-tobacco vaporized nicotine product use in the perioperative

or orthopaedic surgical context, and reporting of at least one relevant musculoskeletal or surgical outcome. Studies that were published in a non-English language were excluded along with studies with pediatric patients and papers that were not related to orthopedics.

Two reviewers independently extracted data from the included studies and placed it into an online spreadsheet. For each paper, the title, authors' names, publication year, paper title, publication journal, and page numbers were documented. The sample size of each study was documented along with the type of study that was conducted (prospective, case study, retrospective, systematic review, etc.). The reviewers then extracted data from these studies including early (within 90 days) and long-term postoperative complications, including surgical site infection, prosthetic joint infection, wound dehiscence, readmission, revision surgery, nonunion or pseudoarthrosis, and mortality. Any disagreements between the two reviewers were resolved through a third-party consensus.

Results

We identified 23 unique studies that met the inclusion criteria: seven clinical cohort/database studies, nine systematic reviews, one meta-analysis, and six preclinical or in vitro investigations. (Figure 1) Clinical cohorts (aggregate >175,000 patients) consistently associated vaping or non-tobacco nicotine exposure with worse orthopaedic outcomes. In arthroplasty, exclusive vape or nicotine users had longer operative times, increased length of stay, and higher readmission or complication rates [7]. In rotator cuff repair, non-tobacco nicotine dependence was linked to higher 90-day opioid use and emergency visits [8]. Following intertrochanteric nailing, non-tobacco nicotine dependence was associated with greater risks of mortality and pulmonary or infectious complications [9]. Similarly, in cervical disc arthroplasty, nicotine product use correlated with increased infections and prolonged hospitalization [10].



Across arthroplasty specifically, large datasets showed that nicotine exposure including e-cigarettes and smokeless forms was associated with elevated perioperative medical complications and, at two years, higher prosthetic joint events. Co-use of tobacco and cannabis further amplified infection and revision risk

compared with single-substance use, with periprosthetic joint infection odds ratios of 1.60 for cannabis, 2.14 for tobacco, and 3.39 for co-users [11,12]. Preclinical and cellular studies aligned with these clinical signals. E-cigarette vapor exposure reduced osteoblast viability, promoted pro-inflammatory and cytotoxic effects, and impaired tendon and bone healing [13,14]. In animal models, Achilles tendon repairs demonstrated the lowest tensile strength with vaping compared to smoking and control groups, and rat femur fracture models showed trends toward impaired bone regeneration with vaporized nicotine exposure [15,16]. With regards to wound-healing, the literature demonstrated that vaping impairs tissue regeneration and should be managed perioperatively with the same caution as combustible smoking [17].

Discussion

The growing body of literature highlights that e-cigarette use is not a safer alternative to traditional cigarette smoking in the context of orthopedic surgery. Data is consistently showing that vaping may impair bone healing, impact fracture union, and contribute to higher postoperative complication rates [8-11,17]. Those complications include infection, wound healing problems, and increased hospital stays. Both animal and human studies reveal that exposure to nicotine and other unregulated e-cigarette constituents negatively affects osteoblast health and bone regeneration [13,14]. Despite this evidence, current research remains limited by small sample sizes and inconsistent definitions of vaping. Larger prospective studies are necessary to better define the independent effects of e-cigarettes on orthopedic outcomes and to clarify their long-term impact. Until then, orthopaedic surgeons should counsel patients on the potential risks of vaping and consider these behaviors in preoperative planning. Ultimately, treating e-cigarette use with the same caution as traditional smoking may help optimize patient recovery and surgical success.

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