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The Impact of Vaping on Human Esophageal Keratinocytes

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Abstract

The electronic cigarette (e-cigarette; vape) is considered by many as a safe alternative to conventional cigarettes. Because of this, vapes have been revolutionizing the tobacco industry. With millions of minors and young adults across the country vaping on a regular basis without knowing the full effects of e-cigarettes, studies must be conducted to determine the health risks associated with vaping. Very little is known about the potential effects of vaping on any organ system, and almost nothing is known about possible effects on the esophagus, which connects the mouth to the stomach. We hypothesize that vaping will negatively impact factors such as cell appearance, survivability, motion, and disease progression in the esophagus as well. By examining these effects on human esophageal keratinocytes after vape aerosol exposure, our study will begin to fill a significant gap in knowledge about vaping and will serve to educate minors and young adults.

Introduction

E-cigarette use and vaping practices have become commonplace within adolescent and teenage populations as of late; national surveys demonstrated a 10% increase in e-cigarette use by adolescents from 2017 to 2018 (Jones & Salzman, 2020). Social media and peer pressure influences have shifted popular smoking products among youth from nicotinic cigarettes to e-cigarette devices, and simultaneously resulted in an increased willingness to participate in smoking-related activities (Vogel et. al., 2021). The biological and physiological effects of these vaping products are not fully understood due to a lack of longstanding, peer-reviewed data and sustained variation of vape fluid chemical composition. Conversely, the link between conventional cigarettes and lung cancer is inextricable, supported by numerous studies over the 19th century (Proctor, 2012). Given the lack of data regarding the effects of e-cigarette vapor on human tissues, we attempted to determine whether or not a relationship exists between inhalation of vape products and changes in physical and behavioral cellular characteristics (i.e., appearance, survival rate/viability, motility, etc.). Study reviews suggest the possibility that vape fluid aerosol can have adverse effects on oral

mucosal (mucus-producing) tissues that result in drug-induced hyposalivation (decrease in saliva production) and consequent throat irritation, where the tissues lining the mouth and throat become dry and inflamed due to the decreased saliva production (Ebersole et. al., 2020). We hypothesized that exposure of e-cigarette vapor to tissues proximal to the respiratory tract (i.e., the esophagus) would result in altered cell appearance/phenotype and decreased cell viability. Our data analysis can be extrapolated to predict the potential effects of a chemical stimulus in esophageal tissues.

Methods

The specific strain of cells used in these experiments, EPC1-hTERT human esophageal keratinocytes (esophageal cells), were supplied by Dr. Douglas Stairs of the Penn State College of Medicine in Hershey, PA. These esophageal cells were grown in keratinocyte serum-free medium that facilitates the healthy growth of the cells. They were maintained in an environment of 37 degree Celsius and 5% carbon dioxide. Once the colony was ready, cells were exposed to vapor from a Smok Vape Pen V2 containing NJOY cool menthol vape juice with 5% nicotine. The vaping apparatus consisted of four components connected continuously with flexible plastic tubing: the vape pen, two glass impingers containing keratinocyte media, and a flow meter to maintain a constant flow rate. To conduct trials, the vape pen was engaged at the power button and aerosol was pulled into the impinger via vacuum where it was then collected by the media. Later, this infused media was placed onto plated esophageal cells (called a cell culture) to examine the effects on their physical appearance and function.

Results

The vape-treated esophageal cells showed a drastic decrease in viability/survivorship and a shift in shape from circular to elongated relative to untreated cells. The confluency of the treated cell cultures (the percentage of surface area covered by esophageal cells after the incubation period) decreased from approximately 90% to 5%. In contrast, the confluency of the untreated cell cultures remained relatively stable at approximately 85-90%.

Discussion

The results from our study of vaping and its effects on human esophageal cells supported our initial hypothesis. Our findings indicated an observable difference between untreated and treated human esophageal cells. After three days, cell cultures treated with vape-aerosol experienced a significant reduction in number of cells and a change in shape, potentially to adapt to the chemical stressor; this change in shape to an elongated cellular appearance is not uncommon in migratory epithelial cells and is sometimes used by metastatic cancer cells (i.e., melanoma cells) to improve survivorship (Yin et. al., 2013). However, further testing would have to be performed to definitively conclude if our treated epithelial cells become cancerous, as we do not currently have enough evidence to support this. Generally, the lack of published research on vaping-related topics allows for many potential research studies in the future.

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