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Evolutionary Changes in Oral Regions (Temporomandibular Joint)

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Abstract

Background: Evolution represents a gradual developmental process that forms the foundation of modern science, widely recognized as a scientific theory supported by various fields of research. One observable example of evolution in the oral cavity is the third molar (molar 3). In ancient times, third molars erupted normally due to larger jaw sizes. However, as human jaws evolved and became smaller, third molar impaction—a pathological condition where a tooth fails to erupt properly—has become increasingly common. Impaction occurs due to limited space and improper jaw angulation, which create gaps between teeth that trap food debris and increase the risk of dental complications. Odontectomy is a surgical procedure used to remove unerupted, partially erupted teeth, or retained roots that cannot be extracted using conventional techniques.

Materials and Methods: This study employed a systematic literature review method, gathering data from PubMed, ScienceDirect, Google Scholar, and ResearchGate. Keywords included "Evaluation of teeth," "Temporomandibular Joint Evolution," "Impacted Third Molars," and "Human Dentition Evolution." Relevant studies published between 1991 and 2023 were selected based on inclusion criteria that focused on the evolution of teeth and temporomandibular joint (TMJ).

Results and Conclusion: The study identifies significant evolutionary changes in the oral region, particularly in the TMJ, influenced by shifts in dietary habits, environmental factors, and human adaptability. The reduction in jaw size and altered chewing mechanics have contributed to the increased prevalence of impacted third molars (M3s), resulting in complications such as pericoronitis, cyst formation, and neuralgic pain [19,20]. Evolutionary adaptations in the TMJ enabled functional demands like speaking, chewing, and swallowing, but also increased susceptibility to disorders such as temporomandibular joint dysfunction (TMD) [1,11]. These findings highlight the critical role of evolutionary biology in understanding and addressing contemporary oral health issues. Future research should focus on developing targeted treatment strategies and preventive measures to mitigate challenges associated with these evolutionary adaptations.

Keywords: Evaluation of Teeth; Temporomandibular Joint Evolution; Impacted Third Molars; Human Dentition Evolution; Molar Impaction Complications

1. Introduction

Evolution is a gradual process of biological development that forms the foundation of modern science, widely recognized as a theory supported by extensive research in various fields. According to Charles Darwin, natural selection drives evolution, allowing organisms with favorable traits to survive, adapt, and reproduce effectively within their environments [4,5]. This process has shaped not only general anatomy but also specific regions of the human body, such as the oral cavity, which includes the jaw, teeth, and temporomandibular joint (TMJ).

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The oral region, particularly the temporomandibular joint (TMJ), has undergone significant evolutionary changes in response to dietary shifts. In early human history, dietary patterns involved coarse and fibrous foods, necessitating strong masticatory forces supported by large jaws and robust TMJs [1,6,7,16,20]. Over time, the transition to softer and more processed diets, along with the advent of food preparation tools, reduced the functional demands on the oral region, leading to significant adaptations such as smaller jaws, reduced chewing stress, and altered TMJ biomechanics [8,13,16,20].

The TMJ, a pivotal joint enabling chewing, speaking, and swallowing, reflects these evolutionary changes. While these adaptations facilitated human flexibility, they also contributed to modern clinical challenges such as temporomandibular joint disorders (TMD) and third molar impaction [9,10]. These conditions arise from insufficient jaw space and altered biomechanics associated with evolutionary trends [2,3,18].

Despite advancements in understanding craniofacial evolution, the interplay between TMJ adaptations, dietary changes, and associated clinical conditions remains underexplored. This study aims to examine the evolutionary modifications in the TMJ and their implications for oral health, emphasizing how these adaptations contribute to contemporary dental challenges and highlighting potential preventive strategies

2. Material and methods

2.1. Study Design

This study utilized a descriptive research method with data collected through a systematic literature review. The purpose of this method was to gather comprehensive information regarding the evolution of teeth, jaw morphology, and the temporomandibular joint (TMJ). The study aimed to analyze the differences and impacts of evolutionary changes on oral health and their clinical implications.

2.2. Search Strategy

A literature search was conducted in both English and Indonesian using electronic databases, including PubMed, ScienceDirect, Google Scholar, and ResearchGate. The search focused on studies and reviews published between 1991 and 2023. Keywords used included:

- "Evaluation of teeth"
- "Temporomandibular Joint Evolution"
- "Impacted Third Molars"
- "Human Dentition Evolution"
- "Molar Impaction Complications"

2.3. Inclusion and Exclusion Criteria

2.3.1. Inclusion Criteria

- Studies published in peer-reviewed journals related to the evolution of teeth, jaw morphology, and TMJ.
- Articles addressing the clinical implications of evolutionary changes in the oral cavity, including impacted third molars and TMJ disorders.
- Literature reviews, observational studies, and experimental studies published between 1991 and 2023.

2.3.2. Exclusion Criteria

- Articles lacking quantitative or qualitative data related to the evolution of the oral region.
- Studies with incomplete or unavailable full texts.
- Non-peer-reviewed articles or those with insufficient methodological details.

2.4. Data Extraction

The selected articles were analyzed based on relevance to the study objectives, with a focus on identifying trends in dental and TMJ evolution, changes in biomechanics, and associated clinical outcomes. Key information, such as study design, sample characteristics, and findings, was extracted and synthesized to provide a comprehensive understanding of the topic.

3. Results and discussion

In the field of dental anthropology, evolutionary processes have profoundly shaped the oral cavity, influencing jaw size, tooth morphology, and the temporomandibular joint (TMJ). The characteristics of human teeth vary across populations due to evolutionary factors such as natural selection and environmental adaptations. For instance, shorter tooth roots and larger crowns are common in Asians compared to Europeans, indicating population-specific adaptations [9,10]. These changes reflect broader evolutionary trends tied to dietary shifts and genetic inheritance.

3.1. Impact of Evolution on Orofacial Structures

Human evolution has resulted in significant modifications to the orofacial region, including the jaw and TMJ. Early human ancestors had larger jaws to accommodate their coarse diet, which required strong mastication. Over time, as food processing techniques improved and diets softened, jaw sizes decreased. These changes reduced masticatory demands, leading to less prominent jaws and smaller teeth, a trend evident in modern *Homo sapiens* [12]. Additionally, the TMJ adapted to these functional changes, with reduced stresses on the joint due to the diminished need for powerful chewing [13,14].

Yamada and Kimmel's study in rats demonstrated that softer diets slowed bone growth in the mandibular condyle, correlating with decreased functional force application. This finding underscores the role of muscle function in influencing jaw development and highlights how dietary changes impact both bone and joint morphology [15].

3.2. Impacted Third Molars as an Evolutionary Consequence

A notable outcome of reduced jaw size is the prevalence of impacted third molars (M3s). Impaction occurs when insufficient space in the jaw prevents the tooth from erupting properly, often resulting in complications such as pericoronitis, cyst formation, and adjacent tooth resorption [17]. Studies indicate that impacted third molars are more common in females due to earlier cessation of jaw growth compared to males, where growth persists beyond M3 eruption [21]. This phenomenon reflects evolutionary constraints imposed by shrinking jaws.

3.3. Clinical Implications of Evolutionary Adaptations

A decrease in jaw size and alterations in the biomechanics of the temporomandibular joint (TMJ) present significant clinical considerations, especially in addressing oral health issues such as temporomandibular joint disorders (TMD). The TMJ's adjustment to less demanding chewing activities increases its vulnerability to dysfunction, particularly in modern settings influenced by stress and lifestyle choices. Additionally, the growing occurrence of impacted molars often requires surgical procedures like odontectomy to extract unerupted or partially erupted teeth, preventing potential complications [3].

Effective management of these conditions requires an understanding of the evolutionary factors contributing to their prevalence. For example, coronectomy is emerging as a viable alternative to full tooth extraction for preserving the inferior alveolar nerve in cases of impacted lower third molars [2].

3.4. Interplay Between Evolution and Modern Dentistry

The study of evolutionary changes in the oral region provides valuable insights into the underlying causes of contemporary dental issues. By bridging evolutionary biology and clinical practice, dental professionals can better address challenges such as TMD and third molar impaction. Future research should focus on developing preventive strategies and minimally invasive treatments tailored to the unique anatomical and functional changes shaped by evolution.

4. Conclusion

This study provides a comprehensive analysis of the evolutionary changes in the temporomandibular joint (TMJ) and their implications for oral health. It highlights how dietary adaptations and environmental factors have contributed to reduced jaw sizes, altered TMJ biomechanics, and the prevalence of impacted third molars (M3s). These evolutionary modifications underline the adaptability of the human oral region but also contribute to modern clinical challenges, including temporomandibular joint disorders (TMD) and complications arising from M3 impaction. The findings of this study address existing gaps in the understanding of the evolutionary origins of these conditions, providing insights into their etiology and progression. By integrating evolutionary biology with clinical practice, dental professionals can better anticipate and manage oral health challenges, particularly those related to TMD and molar impaction. This study also

emphasizes the importance of developing preventive strategies and innovative treatments that align with the evolutionary adaptations of the oral region. Future research should explore the genetic and biomechanical underpinnings of these changes and investigate their impact across diverse populations to enhance the precision of clinical interventions.

Compliance with ethical standards

Disclosure of Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Statement of ethical approval

This study was conducted in compliance with ethical standards for research and publication. All data utilized in this research were obtained from publicly available sources, and no ethical approval was required as no human participants, animals, or clinical trials were involved.

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