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The Role of Artificial Intelligence in Cleft Lip Surgery

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----------***ABSTRACT***----------

Introduction:

The field of dentistry is embracing rapid advancements to align itself with our changing society. Within dentistry, cleft lip surgery holds significant importance. Cleft lip, a congenital condition affecting thousands annually, often requires surgical intervention for functional and psychological well-being. Integrating Artificial Intelligence (AI) into cleft lip surgery shows promising potential, as the AI's ability to simulate human intelligence offers innovative approaches, enhancing surgical precision and outcomes, and thereby positively impacting countless lives.

Objectives:

The objectives of the study were to study the effect of AI on various aspects of cleft lip repair, to analyze the procedural process as well as the ethical aspect regarding the usage of materials, as well as to evaluate how the addition of AI management would contribute to the overall improvement of these factors

Methods:

The research methodology of this study consists of analyzing different research publications such as Pub Med and Open Dentistry Journal, looking for trends and similarities in the content, and measuring how the content relates to the role of AI in cleft lip procedures.

Results/ Conclusion:

The objectives identified originally were successfully achieved through a comprehensive case study analysis, which established a foundational understanding of AI's impact on cleft lip and dental interventions. Additionally an exploration of procedural processes, ethical considerations, and technological applications in detecting and treating cleft lips, including fetal care was observed. Moreover, by examining AI management within a business context, we gained numerous insights into its limitations due to constrained professional availability. This study provided a broader perspective on AI's role in dentistry and cleft lip repair, underscoring its potential benefits while highlighting constraints in certain scenarios.

KEYWORDS;-AI,Dental,CleftLip,MazifocalSurgery

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I. INTRODUCTION

In the modern day, Dentistry is a field in which massive adaptations are being made to fit the rapid progression of our society. However, before assessing what adaptations are being made and how they can benefit a multitude of people, it is essential first to identify what is entailed when discussing the dental field. Dentistry is a branch of medicine that focuses on diagnosing, treating, and preventing oral health conditions, diseases, and disorders affecting the teeth, gums, mouth, and related structures. It involves studying, examining, and managing various aspects of oral health, including but not limited to the prevention and treatment of dental caries, periodontal disease, oral cancer, malocclusions, and other related conditions. Dentistry also encompasses restoring and

rehabilitating damaged or missing teeth and improving facial aesthetics through various cosmetic dental procedures.

Furthermore, dentistry involves using specialized techniques, equipment, and materials that require extensive training and expertise to ensure safe and effective treatment outcomes. However, to understand how a field such as dentistry could go through adaptations, it's important to understand another area, one that is experiencing simultaneous growth in our society. Artificial intelligence (AI) is a rapidly emerging dominant field of operation in contemporary times, experiencing widespread expansion in a multitude of domains. The overall utilization of AI has significantly impacted how professionals can effectively execute and perform their roles, catering to a broader range of individuals. This research paper concerns the dental field and how AI can aid in a particular position. As mentioned previously, the dental industry is experiencing substantial growth, particularly concerning technological advancements and the inflow of new industrial innovations. The implementation of AI in dentistry has made remarkable progress, specifically in surgical enhancements, where it has demonstrated significant potential in improving the efficacy of cleft lip surgery. This is precisely why the use of artificial intelligence(AI) can be so beneficial to so many practitioners; however, before identifying how AI can be used to progress the dental field and specifically AI, it's important to remember two key terms and ideas that are essential in the AI field. The first is what AI is. Artificial Intelligence (AI) is a field of computer science that merges with engineering and involves the development of intelligent systems capable of performing tasks that would typically require human intelligence, such as reasoning, learning, perception, problem-solving, and decision-making. AI primarily involves creating and utilizing algorithms and computational models to simulate and automate cognitive functions. It enables machines to process and analyze vast amounts of data and learn from previously recorded experiences and models to improve performance. AI technologies encompass various subfields, including machine learning, deep learning, natural language processing, computer vision, and robotics. The combination of fields allows for rapid growth due to the interdisciplinary nature of the areas and allows for mass progress in a short period. However, one might ask how AI can benefit dentistry, specifically cleft lip surgery. To understand this, we must first understand what cleft lip surgery is and why we are in such dire need of advancements as a global community. A cleft lip is a congenital birth defect that occurs when the upper lip fails to fuse properly during embryonic development, resulting in a gap or split in the lip. However, Cleft lip can also affect the roof of the mouth (cleft palate) in some cases. This condition can cause difficulties with feeding, speech, hearing, and dental development, as well as social and psychological challenges due to visible facial deformities.

Cleft lip surgery is an essential intervention that aims to repair the gap and restore standard facial structure and function. The surgery involves reconstructing the lip and the surrounding tissues using specialized techniques and materials, which varies on numerous factors; however, it primarily differs on the severity and type of cleft and economic factors. Cleft lip surgery is crucial in improving the quality of life and well-being of individuals with this condition, as it enables them to eat, speak, and interact with others without stigma or hindrance. A cleft lip is essential to many communities as, according to the World Health Organization, almost 170,000 children are born with Cleft Lip each year; however, in contrast, only about 100,000 children can receive the surgery used to correct the cleft lip. Throughout this paper, we will explore the advancements of AI in cleft lip surgery, the implications that follow, and the limitations that would occur.

II. OBJECTIVES

To study the effect of AI on various aspects of cleft lip repair,

To analyze the procedural process as well as the ethical aspect regarding the usage of materials,

To evaluate how the addition of AI management would contribute to the overall improvement of these factors

III. Research Methodology

The research methodology of this study consists of analyzing different research publications such as Pub Med and Open Dentistry Journal, looking for trends and similarities in the content, and measuring how the content relates to the role of AI in cleft lip procedures.

IV. Data Analysis

The following review investigates the application of artificial intelligence (AI) in assisting individuals with cleft lip and palate. Cleft lip and palate pose a significant healthcare challenge globally. AI has the potential to support those affected by these conditions, particularly in regions with limited healthcare access. The review's inclusion criteria encompassed studies utilizing AI for aiding the diagnosis, treatment, or treatment planning for cleft lip and palate patients. From an initial pool of 458 results, a rigorous screening process involving title and abstract analysis, duplicate removal, and full-text assessment yielded 26 publications for inclusion. These selected studies delve into the utilization of AI for diverse aspects of cleft lip and palate care, such as aiding in diagnostic decisions, treatment strategies (with a notable focus on speech therapy), and predictive capabilities. In conclusion, the review underscores the burgeoning interest and substantial promise of AI integration in addressing cleft lip and palate challenges. Although most current research concentrates on enhancing speech therapy outcomes for cleft palate patients, AI has broader potential across various dimensions of care. The authors advocate for expanded research endeavors, particularly involving multi-center studies encompassing diverse populations and fostering collaboration among academia and researchers. Such efforts hold the potential to propel the development and refinement of AI technology for the benefit of individuals with cleft lip and palate. In the context of the research within AI's role within dentistry, this review highlights AI's evolving significance in enhancing diagnosis, treatment, and planning for individuals affected by cleft lip and palate conditions, showcasing a specific application of AI technology within the broader realm of dental care.

The study discusses the significance of 3D-soft-tissue imaging techniques, exemplified by the 3dMDface System, in obtaining accurate soft tissue surface data from the human face. This technology aids in objectively acquiring this data, which is valuable for various anthropological evaluations. However, the precision and reliability of these evaluations are crucial and must adhere to high standards. Given the intricacies of reliability tied to specific landmarks and axes, the research emphasizes the importance of addressing baseline accuracy through preliminary studies. To enhance the integrity of the data during the evaluation process, it is recommended by the survey to use the average of multiple measurements instead of relying on a single measurement. In the context of our research, the following insight underscores the potential of AI to assist in the accurate assessment of soft tissue details in dental applications, supporting better diagnostic and treatment planning in dentistry.

This study delves into the comprehensive process of cleft management, highlighting the challenges patients, caregivers, and orthodontists face. Over the years, the field has witnessed the integration of diverse dental specialties for detecting, diagnosing, and treating orofacial clefts. Within this landscape, orthodontists assume a crucial role in orchestrating the care of children with cleft lip and palate, making pivotal decisions on intervention timing and treatment sequencing.

In pursuit of this context, the study sets out to achieve the following objectives:

Review of Evolving Disciplinary Roles: The study undertakes a meticulous exploration of the changing roles within various dental disciplines, with a specific

The results of the study unveil notable developments:

Enhanced 3D Modeling: Advancements in 3D modeling technology have created precise three-dimensional models from CT scans. These models prove instrumental in illustrating clinical intricacies associated with clefts.
Expansive Orthodontist Role: Orthodontists actively engage in various stages of cleft management, encompassing treatment planning, monitoring, care provision, and outcome evaluation.
Artificial Intelligence (AI) Integration: Technological strides, including artificial intelligence, are poised to reshape and expand the orthodontist's role in cleft management. AI-powered diagnostic techniques exhibit high accuracy in prenatal cleft detection.
Revolutionary Approaches: Distraction osteogenesis has emerged as a groundbreaking approach for cleft treatment, while computer-assisted orthognathic surgery finds extensive application in correcting osseous defects.
Aligner Application: Novel modalities like aligners offer viable alternatives for patients requiring complex orthognathic surgeries, ensuring favorable outcomes.
The study underscores the importance of a multidisciplinary approach in cleft management. As crucial players, orthodontists make critical judgments regarding orthodontic interventions and treatment prioritization. Leveraging technological advancements, especially artificial intelligence, has streamlined the diagnosis and management of cleft lip and palate cases, ushering in a new era of simplified care.
The study's findings on AI-powered prenatal cleft detection and its potential for enhancing diagnosis, treatment planning, and outcome assessment in orthodontic interventions for cleft lip and palate show AI's transformative role in improving precision, efficiency, and overall patient care in this specialized area of dentistry.

This study aimed to systematically review the accuracy of second-trimester transabdominal ultrasound in detecting orofacial clefts, such as cleft lip and palate, in both low- and high-risk pregnant populations. The researchers compared two-dimensional (2D) and three-dimensional (3D) ultrasound techniques.
Out of 451 citations, 27 studies met the review's criteria. Among these, 21 studies involved low-risk populations, while six involved high-risk populations. The research showed variability in the accuracy of 2D ultrasound across different gestational ages in low-risk women. Detection rates for cleft lip with or without cleft palate ranged from 9% to 100%; for cleft palate only, it ranged from 0% to 22%; and for all types of cleft, it ranged from 0% to 73%. In high-risk women, 3D ultrasound detected 100% for cleft lip, 86% to 90% for cleft lip with palate, and 0% to 89% for cleft palate only.
In conclusion, 2D ultrasound screening for cleft lip and palate in low-risk pregnancies has a relatively low detection rate but produces few false-positive results. On the other hand, 3D ultrasound can provide a reliable diagnosis, except for cleft palate only. The findings aid the study specifically within the context of orofacial cleft detection. AI could enhance the accuracy of ultrasound-based diagnoses by analyzing complex data and assisting clinicians in identifying orofacial clefts more effectively, especially in high-risk populations where 3D ultrasound has shown promising results.

This study aimed to explore the effectiveness of using 3D-printed models in medical education, specifically focusing on cleft lip and palate seminars. Medical education often requires visualization tools to help students grasp complex anatomical systems. The researchers compared two seminar approaches: one using traditional 2D presentation methods and the other incorporating hands-on interaction with 3D-printed models of cleft lips and palates.
Cleft lip and palate models were created using 3D-printing technology, and a total of 67 students from two medical schools participated in the study. The students were divided into two groups randomly. Group 1 received a traditional PowerPoint presentation-based seminar, while Group 2 received the same presentation supplemented with physical demonstrations using 3D-printed models of cleft lips and palates.
The results showed that the addition of 3D-printed models led to a significant improvement in knowledge gained compared to the traditional 2D presentation method. The mean percentage of knowledge gained was higher in the group that interacted with the 3D-printed models (44.65% for the test group vs. 32.16% for the

control group, p = 0.038). Additionally, students who used the 3D-printed models reported a more enhanced learning experience (p = 0.005) and improved visualization (p = 0.001) based on post-seminar surveys.
In conclusion, this study underscores the advantages of integrating 3D-printed models as visualization tools in medical education, particularly for understanding complex anatomical structures like cleft lips and palates. The findings suggest that 3D-printing technology has the potential to become a valuable and standard tool for aiding the interpretation of 2D medical imaging. This research contributes to the broader topic of how AI can assist in dentistry, as it demonstrates how advanced visualization tools, like 3D-printed models, can enhance the educational experience and understanding of complex dental conditions. The principles applied here could be extended to various roles within dentistry where AI-driven visualization tools could help improve training, diagnosis, and patient communication.

This study introduces an innovative approach to nasoalveolar molding in infants with unilateral complete cleft lip and palate. The researchers utilized three-dimensional technology to create a new protocol. They designed the initial molding appliance based on a traditional intraoral dental impression and then simulated the molding process using computer software, gradually reducing the alveolar gap by 1 mm per week. Three-dimensional printing was employed to produce maxillary casts representing each molding stage. Subsequent appliances were pre-constructed based on these computer-generated casts. The treatment required three clinic visits over the span of a month, during which anthropometric measurements and bony segment volumes were taken before and after the procedure.
The findings demonstrated significant reductions in alveolar cleft widths, expansion of soft-tissue volume in each segment, and improved continuity of the alveolar arc across the cleft. A minor complication necessitated a new appliance for one patient, while others experienced mild mucosal irritation or ulceration. The study concludes that three-dimensional technology offers precise anatomical representation in pediatric cleft cases. The outcomes achieved through their algorithm are comparable to traditional nasoalveolar molding methods, yet the new approach reduces the number of clinic visits and adjustments required. As the costs of three-dimensional technology decrease, it holds promise for designing personalized nasoalveolar molding treatments with enhanced efficiency, alleviating burdens on the medical staff, patients, and families.
This study showcases the integration of three-dimensional technology and computer simulations in the nasoalveolar molding process. The use of AI-driven simulations allows for precise planning and customization of treatment, potentially leading to more efficient and effective outcomes in this specific aspect of dentistry. This aligns with the broader theme of leveraging AI to enhance procedures and patient care within the field of dentistry, suggesting that AI could aid in the design and execution of personalized treatment plans, thereby improving results and reducing the demands on both medical professionals and patients.

This study aimed to assess the clinical utility of three-dimensional ultrasound (3D-US) with reformatting technique in diagnosing fetal cleft lip and palate (CL/P), particularly cases involving the secondary palate. The researchers examined 113 fetuses initially suspected of having cleft lip using two-dimensional ultrasound (2D-US). These fetuses were further assessed using both 2D-US and 3D-US with reformatting techniques to determine the specific type of oral cleft. The clefts were categorized as cleft lip (CL), cleft lip and alveolus (CLA), and cleft lip and palate (CLP), including primary and secondary palate involvement. The diagnostic accuracy of 2D-US and 3D-US with reformatting was compared.
The results showed that both 2D-US and 3D-US with reformatting accurately detected cleft lips (CLs) in the final 103 participants. Among these cases, 29 had CL, 25 had CLA, and 49 had CLP. Using 2D-US, 34 CL, 66 CLA, and 3 CLP cases were diagnosed. Meanwhile, 3D-US, with reformatting, identified 31 CL, 27 CLA, and 45 CLP cases. The sensitivity of 2D-US and 3D-US with reformatting in diagnosing CLA were 80% and 92.0%,

respectively, with no significant difference. However, for CLP, the sensitivities were 6.1% and 91.8%, respectively, indicating a substantial improvement with 3D-US ($P < .001$).
In conclusion, both 2D-US and 3D-US with reformatting accurately diagnose CL and CLA cases. However, the study demonstrates that 3D-US with reformatting has a significantly higher diagnostic accuracy for cases involving cleft lip and palate (CLP), especially those related to the secondary palate. This research contributes to understanding advanced imaging techniques in diagnosing oral clefts in fetuses. This study showcases the potential of advanced imaging technologies, like 3D ultrasound, to enhance diagnosis and assist in identifying complex dental conditions such as cleft lip and palate more accurately. Integrating AI algorithms with such imaging techniques could further improve diagnostic precision and provide valuable support to dental professionals in their clinical practice.

V. Conclusion

In conclusion, we met the above objectives through reading numerous case studies. Through doing this, the base foundation for the effect of AI through various cleft lip and dental repairs was established. This foundation then helped us understand the procedural produces behind the use of AI and the ethical aspect. We identified different factors of this, such as using artificial intelligence in fetal care and various technological elements used to detect and repair cleft lips. However, we finally were also able to evaluate AI management in cleft lip repair and detection by viewing additional case studies focused on the role of AI in a business setting. This shift into viewing case studies focused on the management aspect rather than collecting first-hand data allowed a view into the limits of AI within cleft lip repair, as the small subjugated amount of professionals in the local given area was not enough to provide a recollection of the benefits of the different technologies. In conclusion, the study evaluated these objectives and allowed a broader sense of the role of AI in the dental field and cleft lip repair.

VI. Policy Concerns

While viewing the different policy concerns, it's evident that there are very few regulations or mandates on the role of AI management, especially in the role of dentistry. However, after viewing various sources, a discussion is brought up with the need for policy structures due to the liability of the surgery/and dental care, along with the compromisation of reasoning with the dentist when associated with AI. Additionally, the ethical concern of algorithmic fairness and bias is a concern that many believe needs to be addressed.

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