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Emerging Trends in The Study of Natal Teeth: A Review of Clinical Findings and Predictive Modelling Using Machine Learning

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ABSTRACT

Natal teeth, present at birth, are rare developmental anomalies that pose both clinical and diagnostic challenges. These teeth are often associated with complications such as feeding difficulties, oral trauma, and in some cases, systemic syndromes. Traditional understanding of natal teeth is based primarily on case reports and small-scale clinical studies, which offer limited insight into broader patterns and predictive factors. With the advent of machine learning (ML) in healthcare, there is growing interest in using computational approaches to identify predictive indicators and enhance early diagnosis. This review synthesizes recent clinical literature on natal teeth and explores the potential application of ML techniques for predictive modeling. The integration of clinical findings with AI-based tools could pave the way for improved diagnostics and proactive neonatal care.

Keywords: *Natal, Teeth, Machine Learning*

1. INTRODUCTION

Natal teeth—defined as teeth present in a newborn at birth—are infrequent yet clinically significant occurrences. There is one more type of Natal teeth which is termed as neonatal teeth that are teeth erupted within the first month of life, i.e. within the first 30 days [1]. The term natal and neonatal teeth was first documented by Titus Livius in 59 BC [2]. However, if we compare the two, Natal teeth are three times more common than neonatal teeth [3].

Though often harmless, they may cause a range of complications, including breastfeeding difficulties, oral ulcerations (e.g., Riga-Fede disease), and in rare cases, aspiration. The exact cause of natal teeth is still not fully understood, although hereditary factors, nutritional deficiencies, and syndromic associations have been proposed.

Historically, research on natal teeth has been anecdotal and fragmented, leading to inconsistent clinical guidelines. Recently, the intersection of health informatics and pediatric care has opened up the possibility of applying machine learning to rare neonatal conditions. This paper reviews clinical literature on natal teeth and explores how emerging machine learning techniques can be leveraged to predict their occurrence, enhance diagnosis, and guide clinical decision-making.

Clinical Characteristics of Natal Teeth

Natal teeth are typically found in the lower central incisor region and are most often part of the normal deciduous dentition, although they can sometimes be supernumerary. They can be classified into:

- Natal teeth: Present at birth.
- Neonatal teeth: Erupt within the first 30 days after birth.

Common Clinical Features:

- Small, discolored or hypoplastic crown
- Poor root development
- Mobility due to inadequate periodontal support

Complications:

- Breastfeeding discomfort for the mother
- Ulceration of the infant's tongue (Riga-Fede disease)
- Risk of aspiration if the tooth is excessively mobile

Management depends on clinical assessment; extraction may be necessary in cases of extreme mobility or trauma risk.

2. LITERATURE REVIEW

1. Aetiology of Neonatal Teeth

Though the aetiology of neonatal teeth cannot be determined with certainty, but the reasons have been attributed to several factors such as superposition of germ [4,5], infection or malnutrition [6], eruption accelerated by febrile incidents or hormonal stimulation [7], hereditary transmission of a dominant autosomal gene [8], osteoblastic activity which is the process of building new bone tissues by cells called osteoblasts inside the germ area related to the remodeling phenomenon [9] and hypovitaminosis [10]

2. Prevalence and Clinical Characteristics of Natal Teeth

A systematic review and meta-analysis published in Pediatric Dentistry in 2023 examined the global prevalence of natal and neonatal teeth. The study found that natal teeth occurred in approximately 1 in 289 newborns, while neonatal teeth were present in about 1 in 2,212 live births. The incidence of natal and neonatal is 1:2000 to 1: 3500 and the prevalence is 1:700 to 1:30,000 depending on the type of study [11]. Notably, the prevalence varied significantly across continents, with North America reporting the highest rates. The review emphasized the clinical significance of natal teeth, particularly in relation to feeding difficulties and potential aspiration risks, underscoring the need for vigilant clinical assessment and management.

3. Complications arising from Natal Teeth

A significant complication arising from natal or neonatal teeth is the development of ulcers on the underside (ventral surface) of the tongue, due to irritation from the tooth's sharp incisal edge. This condition is referred to as Riga-Fede disease or syndrome [12, 13]. Persistent ulceration can interfere with effective suckling and feeding, potentially leading to nutritional deficiencies and poor weight gain in infants [14]. Another serious risk associated with natal teeth is the possibility of the infant accidentally swallowing or aspirating (inhaling) the tooth. Additional complications include trauma to the mother’s breast during breastfeeding and general discomfort or difficulty for the infant while suckling [3].

Natal teeth have also been linked with several genetic or congenital syndromes, such as

a) Ellis-van Creveld syndrome which is a rare genetic disorder characterized by short stature, extra fingers or toes (polydactyly), dental abnormalities, and heart defects.

b) Jackson-Lawler syndrome which is a form of ectodermal dysplasia marked by skin cysts (steatocystomas), nail abnormalities, and dental anomalies.

c) Hallermann-Streiff syndrome which is another rare condition involving distinctive facial features, dental defects, hair abnormalities, and proportionate dwarfism.

d) Steatocystoma multiplex which is a skin disorder involving the development of multiple benign cysts, often associated with other abnormalities including natal teeth in some cases.[15]

4. Clinical Management and Case Reports

Several recent case reports have highlighted the clinical management of natal teeth in newborns. A case report published in the International Journal of Contemporary Pediatrics in 2024 described the management of a 2-month-old infant with a natal tooth present in the mandibular arch. The tooth exhibited mobility, and due to the risk of aspiration and breastfeeding difficulties, extraction was performed under local anaesthesia. The procedure was uneventful, and the infant recovered without complications.

Another case report from the same journal in 2024 detailed the management of a 22-day-old infant with a natal tooth causing breastfeeding difficulties. The tooth was extracted after ensuring adequate vitamin K levels to prevent bleeding complications. The procedure was successful, and the infant's feeding improved post-extraction.

5. Histological and Radiographic Features

A study published in MDPI Children in 2022 conducted a qualitative and quantitative micro-CT analysis of natal and neonatal teeth. The study found that these teeth often exhibit underdeveloped roots, irregular enamel formation, and reduced mineralization compared to normal deciduous teeth. These findings suggest that natal and neonatal teeth are developmental anomalies that may require careful clinical attention to prevent complications such as trauma to the oral tissues.

6. Cultural Beliefs and Misconceptions

In 23 BC, Gaius Plinius Secundus (Pliny the Elder) believed that male infants born with natal teeth were destined for a promising future. However, in various cultures around the world—including India, Poland, and parts of Africa — superstitions surrounding natal teeth were common. In some African communities, infants born with teeth were tragically killed shortly after birth, as they were thought to bring misfortune. Similarly, in Chinese culture, the presence of natal teeth was traditionally viewed as a bad omen [2].

A scoping review published in Health Science Reports in 2023 examined the cultural beliefs and misconceptions surrounding natal and neonatal teeth in Africa. The review found that many healthcare providers and caregivers held misconceptions about the significance and management of these teeth, leading to potential delays in appropriate care. The authors emphasized the need for educational interventions to correct these misconceptions and improve the management of natal and neonatal teeth in affected populations.

7. Predictive Modelling Using Machine Learning

While there is limited research on the application of machine learning (ML) in the study of natal teeth, recent advancements in ML techniques offer potential avenues for future research. ML models have been successfully applied in various aspects of pediatric dentistry, such as age estimation and tooth development assessment. Future studies could explore the use of ML algorithms to predict the occurrence of natal teeth based on maternal and neonatal health data, potentially leading to earlier detection and management strategies.

8. Percentage of population with such complications

A study was conducted with1851 patients at Saveetha Dental College, Chennai. The table represents the gender distribution of study population for natal/neonatal teeth where in a total of 1,851 patients only 3 patients with natal/neonatal teeth were seen of which 2 were male and 1 was female.

Gender of patient	Presence of Neonatal or Natal teeth		Total
	No	Yes	
Female	833	1	834
Male	1015	2	1017
Total	1848	3	1851

The pie chart represents the frequency distribution of the study subjects based on presences of natal/neonatal teeth. Violet represents patients without any natal teeth and blue represents patients with natal/neonatal teeth. The pie chart reveals the prevalence of natal/neonatal teeth to be 0.16% (blue) in the study population.[16]

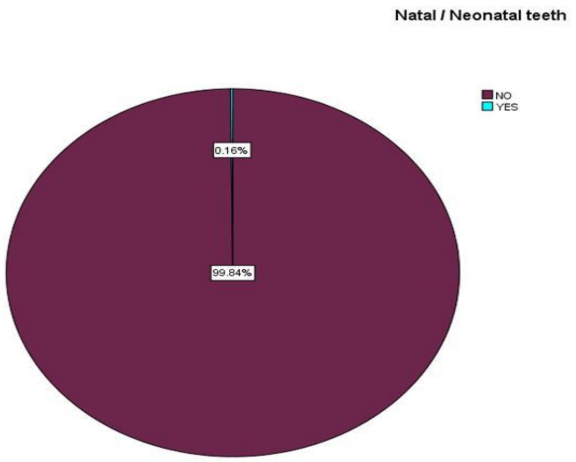

Fig 1: Percentage of population with natal teeth is only 0.16% [16]

Case Study:

A case of neonatal teeth was found by Dr. Rudra Prasad Chakraborty in Agartala, Tripura. A 26 days old male new born baby was referred to my clinic by one pediatrician with a chief complain of presence of "foreign body" or bone in lower anterior jaw, which was causing difficulty for the baby while breast feeding. As well as the mother was also feeling discomforte while feeding the baby.

On examination a Tooth like structure was found in lower anterior jaw which was present since the baby's birth, hence diagnosed as "Natal Tooth". The tooth was mobile and was under risk of dislodgement followed by airway obstruction if not taken care of. Under aseptic condition the tooth was extracted under surface anaesthesia and the baby was discharged with satisfactory condition. No further intervention was required

As per the opinion given by Dr. Chakraborty, in neonates under the age of 10 days vitamin K levels should be evaluated or prophylactic vitamin K injection should be given before extracting the tooth. The extraction can be done if the tooth is supernumerary, loose or associated with a cleft lip. Most of the time, the doctors prefer conservative management that includes grinding/smoothening of sharp edges of the tooth, changes in feeding technique, composite resin to form a dome shape over the edge of the tooth so the tongue glides over the tooth [15]. Knowing how to manage natal teeth is important for proper well being of a child.

Epidemiology and Global Perspectives

The prevalence of natal teeth ranges from 1 in 2,000 to 1 in 3,500 live births. Regional differences in prevalence suggest a possible influence of environmental, genetic, or cultural factors. A recent meta-analysis highlighted higher occurrences in Asian and African populations, although the reasons remain speculative.

In many cultures, the presence of natal teeth is shrouded in superstition. In some African and Asian societies, they are viewed as bad omens, which can delay or complicate treatment. In contrast, some traditions consider them signs of fortune. These cultural perceptions influence parental responses and healthcare-seeking behavior.

Challenges in Clinical Diagnosis and Data Collection

Despite their clinical importance, natal teeth are under-researched due to:

- Rarity of cases
- Lack of standardized documentation
- Inconsistent follow-up in case reports
- Poor data availability across populations

Most available studies are retrospective and involve fewer than 10 patients. The absence of structured, population-wide neonatal dental databases hampers efforts to conduct predictive analytics or establish definitive etiological patterns.

Role of Machine Learning in Pediatric and Dental Research

Machine learning has gained traction in pediatric medicine, especially in areas like birth defect prediction, gestational risk assessments, and dental age estimation. ML models such as:

- Decision Trees
- Support Vector Machines (SVM)
- Random Forests
- Convolutional Neural Networks (CNNs)

have been applied in dental imaging and developmental anomaly detection with encouraging results.

For instance, CNNs have been used to classify dental radiographs, and ML classifiers have predicted outcomes like early tooth decay and enamel hypoplasia. The integration of such tools in neonatal dentistry could significantly enhance early diagnostics.[17]

Feature Engineering for Natal Teeth Prediction

Though predictive modelling of natal teeth is not yet mainstream, the following parameters could serve as input features in ML algorithms:

Domain	Potential Features
Maternal Health	Diabetes, gestational age, anaemia, infections
Neonatal Data	Gender, birth weight, APGAR score
Genetics	Family history of dental anomalies or syndromes
Nutrition	Vitamin D, calcium, folic acid intake
Environmental	Exposure to fluoride, toxins, rural vs. urban settings

Pre-processing techniques such as normalization, handling missing values, and encoding categorical variables will be essential to prepare this data for ML algorithms.

A supervised learning approach could be implemented to classify cases as high- or low-risk based on these features. However, data limitations currently pose a significant barrier. Ethical data sourcing and integration with Electronic Health Records (EHRs) are crucial next steps.

Model Evaluation Metrics

Evaluating ML models in neonatal health requires a balance between accuracy and clinical relevance. Suitable metrics include:

- Accuracy: Proportion of correct predictions
- Precision & Recall: Important in medical screening to avoid false negatives
- F1 Score: Harmonic mean of precision and recall
- AUC-ROC: Area under the curve; evaluates model performance across thresholds
- Confusion Matrix: For visualizing true vs. false positives and negatives

These metrics provide insights into how well a model might perform in a real clinical setting, especially when dealing with imbalanced datasets where positive cases (natal teeth) are rare.

Integration of ML Models into Clinical Workflow

To ensure real-world impact, ML models must be integrated into existing paediatric healthcare systems. Considerations include:

- Electronic Health Record (EHR) Integration: Automated flagging of high-risk neonates
- Mobile Health Applications: For rural or remote health workers
- Clinical Decision Support Systems (CDSS): Assist in deciding whether extraction is necessary

These tools can augment, not replace, clinical judgment, and must be tested in real-world pilot studies before wide deployment.[18, 19]

Limitations and Barriers to ML Adoption

Data-Related Challenges:

- Small sample sizes for rare conditions like natal teeth
- Lack of labelled datasets
- Variability in diagnostic practices

Technical Limitations:

- Overfitting due to imbalanced data
- Generalization to diverse populations

Clinical and Ethical Concerns:

- Interpretability of AI systems
- Resistance from clinicians due to lack of training
- Risk of automation bias

Impact of Digital Imaging and Machine Learning on Natal Teeth Detection

Role of Imaging in Early Detection

In clinical practice, digital imaging (such as X-rays, intraoral photos, or micro-CT scans) plays a pivotal role in diagnosing dental anomalies. ML can significantly augment imaging techniques, automating the detection of natal teeth in neonates, particularly when they are hard to spot with the naked eye.

Recent research has shown that ML techniques like Convolutional Neural Networks (CNNs) can be applied to dental imaging to:

- Automatically detect and classify dental anomalies from X-rays or photos.
- Determine tooth morphology and eruption stages.
- Predict the likelihood of natal teeth based on subtle radiographic features (e.g., tooth calcification patterns, root development).

Enhancing Diagnostic Accuracy with Image-Based ML Models

For example, in the case of neonatal teeth eruption patterns, machine learning models trained on radiographs can aid in predicting whether a small projection is indeed a natal tooth or merely an anomaly that requires further observation. These image-based models help reduce human error and speed up diagnosis, which is crucial in neonatal care where time-sensitive decisions are often required.

Multimodal Approaches in Natal Teeth Prediction

Combining Clinical Data with Imaging and Genetic Information

An exciting frontier in the use of machine learning is the multimodal approach, which combines various types of data sources to improve predictions. This could involve integrating:

- **Clinical data:** Patient health history, maternal conditions, birth weight, etc.
- **Imaging data:** Radiographs, photos, or 3D scans of the infant's oral cavity.
- **Genetic data:** Known markers or syndromic associations linked to tooth development.

By combining these diverse datasets into one cohesive model, the predictive power of the system increases significantly. For example, Deep Neural Networks (DNNs), which are adept at handling multimodal data, can analyze the interactions between clinical, genetic, and imaging data, offering insights that are beyond the capabilities of any single dataset alone.

Challenges in Multimodal Data Integration

While multimodal models hold great potential, they also come with their own set of challenges:

- Data synchronization: Aligning temporal and spatial data from multiple sources (e.g., clinical records and imaging)
- Data heterogeneity: Different formats and measurement scales for clinical, imaging, and genetic data
- Model interpretability: As the complexity of the model increases, understanding how different data types influence predictions can become challenging, making it difficult for clinicians to trust the system’s decisions.

Despite these challenges, the potential benefits of multimodal ML systems are immense, especially in rare conditions like natal teeth, where the interaction of genetic, prenatal, and postnatal factors plays a significant role.

Clinical Implementation and Real-World Applications of ML Models for Natal Teeth

Implementation in Healthcare Systems

Successfully translating machine learning research into real-world clinical settings requires careful consideration of infrastructure, software tools, and clinician training. Here are some potential implementation strategies:

- **Clinical Decision Support Systems (CDSS):** Machine learning models could be integrated into CDSS, where they alert clinicians to the possibility of natal teeth based on data input from patient records and images.
- **Mobile Health Platforms:** For healthcare providers in remote areas with limited access to advanced diagnostic equipment, ML-powered mobile apps could provide immediate analysis of neonatal oral health and assist in decision-making.

Collaborative Ecosystem

Developing these tools requires collaboration between healthcare providers, data scientists, AI developers, and regulators. Some of the steps involved include:

- **Collaborative databases:** Building large, cross-institutional databases to create more robust ML models.
- **Clinical trials:** Testing the clinical utility of ML tools in real-world settings to validate their accuracy and usability.
- **Training programs:** Teaching clinicians how to interpret ML predictions and integrate them into their daily workflow.

Ethical and Practical Considerations for Integrating ML

1) Data Privacy and Security

When integrating machine learning into clinical practice, it is critical to ensure the privacy and security of neonatal health data. Due to the sensitive nature of patient information, especially for infants, ML systems must comply with health data regulations like HIPAA (Health Insurance Portability and Accountability Act) in the U.S. or GDPR (General Data Protection Regulation) in Europe. Data should be anonymized and encrypted to safeguard patient privacy.

2) Bias and Fairness

One significant challenge in applying ML models in healthcare is the risk of bias**.** If the training dataset is not diverse enough, there is a risk that the model may underperform for certain populations (e.g., different ethnicities, socio-economic backgrounds). Ensuring that datasets are representative of diverse populations is essential to developing fair and unbiased ML tools. Bias reduction strategies, such as stratified sampling, should be implemented during the training phase.

3) Interpretability and Trust in AI

In clinical settings, trust in AI-driven recommendations is crucial for successful implementation. Explainable AI (XAI) techniques should be prioritized when developing ML models for natal teeth prediction. These techniques ensure that clinicians can understand the reasoning behind the model's decisions. For instance, a decision tree model might show that an infant's maternal health history, birth weight, and a previous history of dental anomalies were the primary factors influencing the model's prediction. This transparency allows clinicians to assess the model's decision and make informed choices based on it.

4) Clinician Training and Integration

For ML tools to be effective, clinicians must be adequately trained in using and interpreting them. Training programs should be developed to ensure that healthcare providers understand how the ML model works, how to use it in practice, and how to incorporate its predictions into patient management. These programs should emphasize the complementary role of AI in assisting—not replacing—clinical decision-making.[20]

Future Directions and Recommendations

To facilitate machine learning research and improve clinical outcomes:

- Create centralized neonatal dental databases capturing comprehensive perinatal and postnatal data.
- Promote multicentre collaborations among paediatricians, dentists, and data scientists.
- Develop explainable ML models to assist in risk stratification.

- Encourage public health interventions that include oral screenings in neonatal care.
- Conduct prospective studies to track outcomes in infants with natal teeth.

3. CONCLUSION

The integration of machine learning into clinical practice for natal teeth prediction holds immense promise for enhancing early detection, improving diagnosis, and personalizing care. With the ability to analyze diverse data sources, including maternal health, neonatal features, and imaging, ML models can assist clinicians in identifying at-risk infants, preventing complications, and offering timely interventions. However, to realize this potential, challenges related to data privacy, model interpretability, and bias reduction must be addressed. Ultimately, by incorporating machine learning into neonatal care workflows, we can improve both immediate and long-term outcomes for newborns with natal teeth, ensuring better health and development for these infants.

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