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Exploring the Efficacy of Bio Resorbable Plating in Paediatric Maxillofacial Trauma: A Literature Review

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ABSTRACT

Background: This systematic review evaluates the effectiveness of bioresorbable plating systems in pediatric maxillofacial trauma. These systems, composed of polymers such as polyglycolic acid (PGA) and poly-L-lactic acid (PLLA), degrade over time, eliminating the need for removal surgeries and mitigating growth restriction concerns associated with traditional metallic fixation.

Methods: Following PRISMA guidelines, a systematic search was conducted across Google Scholar, Cochrane Library, PubMed, and Scopus using relevant keywords and MeSH terms. Studies involving pediatric patients treated with bioresorbable plates for facial fractures were included. Independent reviewers performed data extraction and quality assessment to ensure study validity.

Results: The efficacy of bioresorbable plating systems in pediatric maxillofacial trauma is evident, with 92% of patients exhibiting normal facial growth without requiring plate removal. However, some complications were reported, with 6% of patients experiencing inflammatory issues and 2% requiring reoperation due to plate degradation. While these plates generally provided sufficient stability, concerns were raised regarding their effectiveness in high-stress areas, where additional reinforcement may be necessary. Furthermore, high costs and limited material availability were identified as significant barriers to their widespread adoption, potentially limiting access to this promising alternative to metallic fixation systems.

Conclusion: Bioresorbable plating systems present a promising alternative to metallic fixation in pediatric maxillofacial trauma, supporting facial growth and reducing secondary procedures. However, further prospective studies are needed to assess long-term outcomes and comparative effectiveness. Advances in material science may enhance their clinical application.

Keywords: *Bioresorbable plating, Complications, Facial growth, Material limitations, Pediatric maxillofacial trauma.*

1. INTRODUCTION

Pediatric maxillofacial trauma presents unique challenges due to the dynamic nature of facial growth and development [1]. Injuries to the facial skeleton during childhood can have long-term implications affecting aesthetics, functionality, and the overall development of facial structures [2]. While traditional metallic fixation systems are effective in stabilizing fractures, concerns about their use in children have emerged [3]. These include the potential to restrict facial growth, the need for a second surgery to remove the plates after bone healing and interference with imaging techniques such as MRIs and X-rays. The rigidity of metallic plates may hinder the natural growth of the facial skeleton, possibly leading to asymmetry or other developmental abnormalities as the child grows [4].

To address these concerns, bioresorbable plating systems have been developed and introduced into pediatric maxillofacial surgery. These systems made from polymers such as polyglycolic acid, poly-L-lactic acid, or their copolymers, provide an alternative to metallic plates [5]. Their key advantage lies in providing stable fixation during the early postoperative period while gradually degrading and being absorbed by the body [6]. This reduces the risks associated with metallic implants, such as restricted bone growth or permanent scarring, and eliminates the need for a second surgery to remove the hardware [7].

In the past two decades, interest in bioresorbable materials for pediatric maxillofacial surgery has grown. These materials are well-suited to pediatric patients as they offer enough strength to stabilize fractures while allowing for natural growth and remodeling of the facial bones as the child develops [8]. Research suggests that bioresorbable plates and screws do not interfere with facial growth and are less likely to cause long-term complications compared to metallic systems.

However, despite the promise of bioresorbable plating systems, several limitations and complications have been reported. Some patients experience inflammatory reactions or foreign body responses to the degrading materials, and there are cases where the bioresorption process is incomplete or uneven, leading to residual material or granuloma formation [10]. Additionally, bioresorbable plates generally offer less strength than metallic plates, which can be problematic in cases of comminuted or load-bearing osteosynthesis areas requiring strong fixation. The higher cost of bioresorbable systems may also limit their accessibility in certain healthcare settings [11].

We believe our research will offer a thorough grasp of the state of knowledge in this area and provide insight into the prospective use of bio resorbable materials in the future to enhance the care of pediatric trauma patients.

2. METHODOLOGY

This systematic review was carried out in compliance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1). The purpose of the evaluation was to evaluate the resorbable plating systems' effectiveness in treating juvenile maxillofacial injuries.

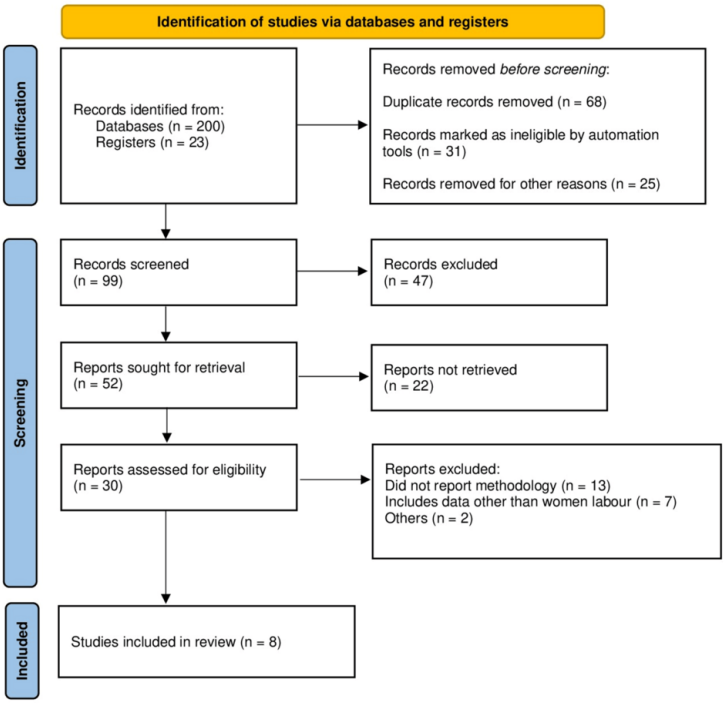

Figure 1: Prisma flowchart of the study

PICO Guidelines: In pediatric patients with maxillofacial trauma requiring surgical fracture fixation, bioresorbable plating systems made from polymers such as polyglycolic acid (PGA), poly-L-lactic acid (PLLA), or their copolymers offer a potential alternative to traditional metallic fixation systems like titanium plates and screws. The primary outcomes of interest include the promotion of normal facial growth, ensuring the stability of fracture fixation, and reducing the need for secondary surgeries, which are often necessary with metallic systems. Secondary outcomes focus on the incidence of complications such as inflammation, infection, and foreign body reactions, along with the strength and suitability of bioresorbable materials for high-stress areas. Additionally, factors such as cost, material availability, and long-term functional and aesthetic results are considered critical in determining the overall success of bioresorbable systems. This comparison aims to assess whether bioresorbable systems can provide effective stabilization while minimizing complications and promoting better long-term outcomes in pediatric maxillofacial trauma cases [TABLE 1].

Table 1: PICO Table:

Component	Details
Population (P)	Pediatric patients (children and adolescents) with maxillofacial trauma requiring surgical fracture fixation.
Intervention (I)	Bioresorbable plating systems made from polymers such as polyglycolic acid (PGA), poly-L-lactic acid (PLLA), or their copolymers used for stabilizing facial fractures.
Comparison (C)	Traditional metallic fixation systems (e.g., titanium plates and screws) used for maxillofacial fracture stabilization in pediatric patients.
Outcomes (O)	**Primary Outcomes:** • Promotion of normal facial growth • Stability of fracture fixation • Reduction in the need for secondary surgeries **Secondary Outcomes:** • Incidence of complications (e.g., inflammation, infection, foreign body reactions) • Material strength and suitability for high-stress areas • Cost and material availability • Long-term functional and aesthetic results

This PICO table summarizes the components involved in evaluating the effectiveness of bioresorbable plating systems in pediatric maxillofacial trauma compared to traditional metallic fixation systems.

Search Strategy: The following digital databases were thoroughly examined: Google Scholar, Cochrane Library, PubMed, and Scopus. The search encompassed studies published from January 2000 to the present, utilizing a combination of keywords and Medical Subject Headings (MeSH) terms such as bioresorbable plating systems, pediatric maxillofacial trauma, poly-L-lactic acid, polyglycolic acid, fracture fixation in children, facial trauma in children, and growth restriction in pediatric facial fractures. Boolean operators (AND, OR, NOT) were applied to refine and optimize the search strategy, ensuring the inclusion of all relevant studies.

Inclusion Criteria: Studies that involve use of bio resorbable plating systems for fracture fixation, English-language articles that included case series, cohort studies, retrospective research, and randomized controlled trials (RCTs), Studies reporting clinical outcomes, complications, and long-term follow-ups.

Exclusion Criteria: Studies using metallic fixation systems or other non-bioresorbable materials, Editorials, letters, conference abstracts, and expert opinions without original data, Studies lacking outcome measures or detailed results.

Data Extraction: Two independent reviewers extracted data from each eligible study to ensure accuracy and minimise bias. The information collected included the study design and population demographics, the sample size, and the specific types of bioresorbable plating material used, such as poly-L-lactic acid (PLLA), polyglycolic acid (PGA), or their copolymers. Additionally, the nature of the maxillofacial injury being treated was recorded. Key outcomes, including the stability of the

fracture post-surgery, any complications such as inflammation, infection, or foreign body reactions, and the effect on facial growth, will be noted. The duration of follow-up for each study was also tracked to assess long-term efficacy and safety. Differences of opinion among both of the reviewers were settled by conversation or, if required, by discussing with a third reviewer.

Quality Assessment: For randomised controlled trials, the methodological quality was evaluated using the Cochrane Risk of Bias Tool; for non-randomised studies. Based on several variables, such as research design, sample representativeness, and outcome evaluation, these tools assessed the likelihood of bias. Based on their overall score, studies were classified as low, moderate, or high quality.

Data Synthesis and Statistical Analysis: Owing to the expected variability in research methods and final measurements, a qualitative synthesis of the results was carried out. These included the type of bioresorbable material used (e.g., poly-L-lactic acid, polyglycolic acid, or their copolymers), which may influence the rate of resorption and efficacy in fracture stabilization. Additionally, the age group of the patients-categorized into infants, young children, and adolescents was considered to account for differences in facial growth rates and recovery potential. The type of maxillofacial injury sustained was also analyzed, as the severity and location of the injury may impact the success of the resorbable plating system.

Outcome Measures: The primary outcome of this review focused on evaluating the efficacy of bioresorbable plates in stabilizing fractures while allowing for normal facial growth without hindrance. Secondary outcomes will include assessing the complication rates, such as infection, foreign body reactions, and any other adverse effects observed post-surgery. Additionally, the need for secondary interventions, such as plate removal or further surgeries, was documented. The review also investigated imaging abnormalities related to the use of bio resorbable plates and assessed long-term functional and aesthetic outcomes based on follow-up data from the included studies.

Ethical Considerations: Since this study involves secondary data analysis, ethical approval is not required. However, all included studies were reviewed for compliance with ethical standards and institutional review board (IRB) approvals.

3. REVIEW

Bio resorbable plating systems offer several benefits in the management of juvenile maxillofacial trauma [12]. One significant benefit is that in contrast to metallic implants, they can tolerate expansion which can restrict facial development, bio resorbable materials gradually deteriorate, potentially allowing for unrestricted facial growth [13]. For instance, Yerit et al. [6] observed normal facial development in an extended follow-up study of children treated with bioresorbable plates for mandibular fractures. Furthermore, these materials reduce patient morbidity and related medical costs by eliminating the need for a follow-up procedure to extract hardware [14,15]. Bioresorbable plates also improve imaging outcomes by minimizing artifacts, which facilitates better visualisation of potential complications and the healing process [16]. Furthermore, these materials may reduce stress shielding by gradually transferring stress to the regenerating bone, which could promote osteogenesis [17,18].

A literature review of the study is shown in TABLE 2.

TABLE 2: Literature Review of the Study

Reference	Key Findings	Study Design	Characteristics of Results	Strengths	Limitations
Yerit KC et al. [6]	Investigated the healing of mandibular fractures with biodegradable plates and screws.	Prospective clinical study	Successful healing in all cases within the follow-up period.	First study to evaluate biodegradable plates for mandibular fractures.	Limited sample size, short-term follow-up.
Bell RB et al. [7]	Positive results using biodegradable plates to fix facial fractures.	Retrospective clinical study	Positive outcomes in stability and healing.	Broad sample, good post-op results.	Lack of long-term data.

Wiltfang J et al. [8]	Safety and effectiveness of biodegradable miniplates demonstrated in baby minipigs and humans.	Animal study with clinical data	Safe and effective for long-term use in animals and humans.	Combined animal study with human clinical data.	Limited to specific plate type (LactoSorb).
Pietrzak WS et al. [9]	Overview of the development and use of absorbable internal fixation.	Literature review	Comprehensive overview of materials used.	Detailed explanation of materials.	No clinical trials.
Eppley BL et al. [10]	Successful use of resorbable PLLA-PGA plates in 1883 pediatric craniofacial cases.	Large cohort study	High success rate in craniofacial stability.	Large sample size.	Results limited to pediatric cases.
Laughlin RM et al. [11]	Positive healing outcomes with resorbable plates for mandibular fractures.	Prospective clinical study	Good fracture healing in all patients.	Prospective design, clear methodology.	Insufficient follow-up for long-term results.
Ahn YS et al. [12]	Comparison of resorbable and non-resorbable plates in orthognathic surgery, with similar results.	Comparative study	Comparable success rates between both types of fixation.	Direct comparison of fixation types.	Lack of randomization in patient selection.
Yang L et al. [14]	Meta-analysis shows fewer complications with absorbable fixation in maxillofacial surgery.	Meta-analysis	Fewer complications observed with absorbable fixation.	Large sample size across multiple studies.	Heterogeneity in study designs and methods.

Evidence supporting the efficacy of bio resorbable plating systems in juvenile maxillofacial trauma is found in several studies. Eppley et al. [17] reported successful repair of 14 mandibular fractures in children using screws and resorbable plates, with favorable extended outcomes and no significant side effects. Similarly, Laughlin et al. [11] demonstrated stable fixation and uncomplicated healing in seven pediatric mandibular fracture cases. For midfacial fractures, a retrospective study by Ahn et al. [12] involving 15 children treated with bioresorbable fixation showed acceptable stability and aesthetics over a mean follow-up of 25 months, with no noteworthy aftereffects. Comparative studies, such as the meta-analysis by Yang et al [14], found no notable variations in postoperative stability or complication rates between titanium and bioresorbable fixation systems in pediatric craniomaxillofacial surgery.

4. DISCUSSION

According to the literature that is currently available, bioresorbable plating systems can be useful in treating different types of fractures in juvenile maxillofacial trauma patients [19]. The main benefits of these systems, such as the ability to accommodate growth and the avoidance of additional removal operations, make them especially appealing for application in the pediatric population [20]. The majority of investigations show good fracture stability, healing and long-term results comparable to conventional metallic fixation [21]. Clinical outcomes described in the literature are typically favorable [10-

14]. For young patients, the ability to attain satisfactory results with the possibility of permitting unrestricted facial growth is a major advantage. Nevertheless, there are several difficulties in using bioresorbable systems. Despite being relatively uncommon, the documented inflammatory consequences call for cautious assessment and patient selection [22]. Because bioresorbable materials have a lower starting strength than titanium, their application in high-load locations or situations requiring prolonged stability may be restricted [23].

The sensitivity of the approach related to bioresorbable systems emphasizes the significance of the training and expertise of the surgeon [24]. Like any new technology, there is a learning curve and as surgeons get more experience with these systems' subtleties, the results might get better. The adoption of bioresorbable technologies is still heavily influenced by cost [25,26]. The increased upfront cost can be a deterrent, especially in places with limited resources, even though the avoidance of repeat removal procedures may somewhat offset the initial expenditures [27].

New technologies including machine learning (ML), Virtual reality (VR), augmented realities (AR), and the metaverse can significantly enhance the application of bioresorbable plating systems in treating juvenile maxillofacial trauma [28]. The metaverse can provide immersive environments for surgical training and global collaboration, allowing surgeons to practice complex procedures and simulate outcomes in a risk-free virtual space. AR can assist during surgeries by overlaying 3D anatomical models and providing real-time visualizations of bone alignment and plate placement, ensuring precise application [29]. VR allows for advanced preoperative planning by immersing surgeons in a 3D model of the patient's anatomy, enabling better preparation. AI, meanwhile, can analyze large datasets to predict patient outcomes, optimize material selection, and personalize treatment plans based on growth patterns, improving both accuracy and long-term results. These technologies have the potential to reduce complications, enhance surgical outcomes, and make bioresorbable systems more accessible and efficient in pediatric care [30-33].

Further research is required to definitely determine the impact of bioresorbable systems on face development over time as there are currently few long-term studies on the outcomes of facial growth. Furthermore, comparative studies with bigger sample numbers and longer follow-up times would yield stronger proof of these systems' effectiveness in comparison to conventional metallic fixation.

Despite their promising results, bioresorbable plating systems are not without complications and limitations. One significant issue is the potential for inflammatory responses; foreign body reactions and delayed inflammatory issues have been reported in some studies. For example, inflammatory complications have been observed in a small percentage of pediatric patients treated with resorbable plates for various maxillofacial conditions. Additionally, bioresorbable materials typically have lower initial mechanical strength compared to metallic implants. This limitation may make them less suitable for applications requiring prolonged stability or in load-bearing areas. The application of bioresorbable devices also demands meticulous technique to avoid complications such as screw head stripping or implant fracture. Moreover, the higher cost of bioresorbable devices relative to metallic alternatives could hinder their broader adoption. These factors must be carefully considered when evaluating the suitability of bioresorbable plating systems for pediatric maxillofacial trauma.

5. LIMITATIONS

The present literature review highlights the potential benefits of bioresorbable plating systems in pediatric maxillofacial trauma but is limited by a few factors. The heterogeneity of the included studies, including variations in methodologies, follow-up durations, and outcome measures, limits the comparability of results. Additionally, the evidence quality varied, with some studies being randomized controlled trials while others were retrospective with small sample sizes, raising concerns about bias. The lack of standardization in bioresorbable materials used, such as PLLA and PGA, further complicates direct comparisons between studies. Geographic and healthcare setting differences also limit generalizability, particularly to low-resource settings where the higher cost of bioresorbable plates may restrict accessibility. Most studies focused on mild to moderate trauma, leaving questions about the adequacy of bioresorbable systems for severe fractures unanswered. Moreover, publication bias may have skewed the results toward positive outcomes, and the exclusion of non-English studies introduces further potential bias. Together, these limitations suggest the need for more standardized, large-scale, and long-term studies to provide more conclusive evidence on the efficacy of bioresorbable plating systems in pediatric trauma.

6. CONCLUSIONS

Bioresorbable plating systems have demonstrated potential benefits in the treatment of pediatric maxillofacial injuries, including the ability to accommodate growth and the avoidance of repeat procedures. The literature reports generally positive clinical outcomes, including good fracture healing and stability across a range of fracture forms.

In summary, bioresorbable plating systems are generally effective in pediatric maxillofacial trauma, especially in promoting normal facial growth and reducing the need for secondary surgeries. However, material strength in high-stress areas and cost considerations are ongoing concerns. Future research and advancements in bioresorbable materials may help address these limitations, further expanding their application in pediatric trauma care.

The drawbacks of these systems, such as potential inflammatory problems, reduced beginning strength, and method

sensitivity, must be carefully considered before using them. The adoption of bioresorbable systems in clinical practice may also be impacted by their higher cost.

Ethical approval: The Institutional Review Board approval is not required.

Declaration of patient consent: Patient's consent not required as there are no patients in this study.

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Conflicts of interest: There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation: The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

[1] Eppley BL, Prevel CD: Nonmetallic fixation in traumatic midfacial fractures. J Craniofac Surg. 1997, 8:103-109. 10.1097/00001665-199703000-00008

[2] Imola MJ, Hamlar DD, Shao W, et al.: Resorbable plate fixation in pediatric craniofacial surgery: long-term outcome. Arch Facial Plast Surg. 2001, 3:79-90. 10.1001/archfaci.3.2.79

[3] Pietrzak WS, Eppley BL: Resorbable polymer fixation for craniomaxillofacial surgery: development and engineering paradigms. J Craniofac Surg. 2000, 11:575-585. 10.1097/00001665-200011060-00011

[4] Eppley BL, Sadove AM. A comparison of resorbable and metallic fixation in healing of calvarial bone grafts. Plast Reconstr Surg. 1995, 96:316-322. 10.1097/00006534-199508000-00009

[5] Marschall MA, Chidyllo SA, Figueroa AA, Cohen M: Long-term effects of rigid fixation on the growing craniomaxillofacial skeleton. J Craniofac Surg. 1991, 2:63-68. 10.1097/00001665-199102020-00005

[6] Yerit KC, Enislidis G, Schopper C, et al.: Fixation of mandibular fractures with biodegradable plates and screws. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002, 94:294-300. 10.1067/moe.2002.122833

[7] Bell RB, Kindsfater CS: The use of biodegradable plates and screws to stabilize facial fractures. J Oral Maxillofac Surg. 2006, 64:31-39. 10.1016/j.joms.2005.09.010

[8] Wiltfang J, Merten HA, Schultze Mosgau S, et al.: Biodegradable miniplates (LactoSorb): long-term results in infant minipigs and clinical results. J Craniofac Surg. 2000, 11:239-245. 10.1097/00001665-200011030-00006

[9] Pietrzak WS: Principles of development and use of absorbable internal fixation. Tissue Eng. 2000, 6:425-433. 10.1089/107632700418128

[10] Eppley BL, Morales L, Wood R, et al.: Resorbable PLLA-PGA plate and screw fixation in pediatric craniofacial surgery: clinical experience in 1883 patients. Plast Reconstr Surg. 2004, 114:850-857. 10.1097/01.prs.0000132856.69391.43

[11] Laughlin RM, Block MS, Wilk R, et al.: Resorbable plates for the fixation of mandibular fractures: a prospective study. J Oral Maxillofac Surg. 2007, 65:89-96. 10.1016/j.joms.2005.10.055

[12] Ahn YS, Kim SG, Baik SM, et al.: Comparative study between resorbable and nonresorbable plates in orthognathic surgery. J Oral Maxillofac Surg. 2010, 68:287-292. 10.1016/j.joms.2009.07.020

[13] Kyutoku S, Inagaki T: Review of past reports and current concepts of surgical management for craniosynostosis. Neurol Med Chir (Tokyo. 2017, 57:217-224. 10.2176/nmc.ra.2017-0006

[14] Yang L, Xu M, Jin X, et al.: Complications of absorbable fixation in maxillofacial surgery: a meta-analysis. PLoS One. 2013:67449-2013. 10.1371/journal.pone.0067449

[15]

[16] Landes CA, Ballon A: Five-year experience comparing resorbable to titanium miniplate osteosynthesis in cleft lip and palate orthognathic surgery. Cleft Palate Craniofac J. 2006, 43:67-74. 10.1597/04-167r1.1

[17] Eppley BL: Use of resorbable plates and screws in pediatric facial fractures. J Oral Maxillofac Surg. 2005, 63:385-391. 10.1016/j.joms.2004.11.011

[18] Eppley BL, Sadove AM, Havlik RJ: Resorbable plate fixation in pediatric craniofacial surgery. Plast Reconstr Surg. 1997, 100:1-13. 10.1097/00006534-199707000-00001

[19] Ferretti C: A prospective trial of poly-L-lactic/polyglycolic acid co-polymer plates and screws for internal fixation of mandibular fractures. Int J Oral Maxillofac Surg. 2008, 37:242-248. 10.1016/j.ijom.2007.11.015

[20] Wittwer G, Adeyemo WL, Yerit K, et al.: Complications after zygoma fracture fixation: is there a difference

between biodegradable materials and how do they compare with titanium osteosynthesis?. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006, 101:419-425. 10.1016/j.tripleo.2005.07.026

[21] On SW, Cho SW, Byun SH, etal.: Bioabsorbable osteofixation materials for maxillofacial bone surgery: A review on polymers and magnesium-based materials.. Biomedicines vol. 8,9 300. 21 Aug. 2020, 10.3390/biomedicines8090300

[22] Wood RJ, Petronio JA, Graupman PC, et al.: New resorbable plate and screw system in pediatric craniofacial surgery. J Craniofac Surg. 2012, 23:845-849. 10.1097/SCS.0b013e31824dbed8

[23] Eppley BL, Reilly M: Degradation characteristics of PLLA-PGA bone fixation devices. J Craniofac Surg. 1997, 8:116-120. 10.1097/00001665-199703000-00010

[24] Suuronen R, Pohjonen T, Hietanen J, Lindqvist C: A 5-year in vitro and in vivo study of the biodegradation of polylactide plates. J Oral Maxillofac Surg. 1998, 56:604-615. 10.1016/s0278-2391(98)90461-x

[25] Petridis AK, Barth H, Doukas A, et al.: Broken bioceramic used in a computer-assisted reconstruction of the frontal skull bone.. Journal of clinical neuroscience: official journal of the Neurosurgical Society of Australasia vol. 16,8. 2009:1089-90. 10.1016/j.jocn.2008.08.006

[26] Eckelt U, Nitsche M, Müller A, et al.: Ultrasound aided pin fixation of biodegradable osteosynthetic materials in cranioplasty for infants with craniosynostosis. J Craniomaxillofac Surg. 2007, 35:218-221. 10.1016/j.jcms.2007.04.005

[27] Yerit KC, Hainich S, Turhani D, et al.: Stability of biodegradable implants in treatment of mandibular fractures. Plast Reconstr Surg. 2005, 115:1863-1870. 10.1097/01.prs.0000165075.51898.6f

[28] Eppley BL, Sadove AM: Effects of resorbable fixation on craniofacial skeletal growth: modifications in plate size. J Craniofac Surg. 1994, 5:110-115. 10.1097/00001665-199405000-00012

[29] Kashwani R, Sawhney H: Dentistry and metaverse: A deep dive into potential of blockchain, NFTs, and crypto in healthcare. Int Dent J Stud Res. 2023, 11:94-98. 10.18231/j.idjsr.2023.021

[30] Kashwani R, Nirankari K, Kasana J, Choudhary P, Ranwa K. Assessing Knowledge, Attitudes, and Practices of Augmented Reality Technology in Dentistry: A Cross-Sectional Survey. Oral Sphere J Dent Health Sci. 2025;1(1):1-10. doi:10.5281/zenodo.14253190

[31] Kashwani Ritik , Ahuja Gurmeet , Narula Vishant, et al.: FUTURE OF DENTAL CARE: INTEGRATING AI, METAVERSE, AR/VR, TELEDENTISTRY, CAD & 3D PRINTING, BLOCKCHAIN AND CRISPR INNOVATIONS. Community practitioner: the journal of the Community Practitioners' & Health Visitors' Association. 21. 123-137. 10.5281/zenodo.11485287

[32] Brar *et al.* Bioinformation 21(2): 262-267 (2025). Doi : 10.6026/973206300210262

[33] Kashwani Ritik ,Kulkarni Vishal , Salam Sajjad, et al.: Virtual vs Augmented Reality in the field of Dentistry. Community practitioner: the journal of the Community Practitioners' & Health Visitors' Association. 21. 597:603.

[34] Vardhe R, Valvi S, Vyavahare S, Shah MA. The Role of Artificial Intelligence in Dentistry: A Comprehensive Review. Oral Sphere J Dent Health Sci. 2025;1(1):41-47. doi:10.5281/zenodo.14278707