Bio Medical Application of Poly lactic Acid (Biolastic) in Dentistry – A Scoping Review

[1]Nikita Parasrampuria
Ph.D Research Scholar (Dentistry),SRM Dental College , Ramapuram , Chennai.(SRMIST), India

[2]N. Gopi Chander
Professor & Ph.D Guide, SRM Dental College, Ramapuram , Chennai. (SRMIST), India

[3]Jayanta Chattopadhyay
Principal, Kusum Devi Sunderlal Dugar Jain Dental College & Hospital Kolkata, India

Corresponding author: **Nikita Parasrampuria**

Abstract

Background: Poly lactic acid (PLA) is environmentally friendly and biocompatible and thus it has great potential for use in dentistry. Its uses span from tissue engineering to orthodontics, covering both therapeutic requirements and environmental issues. **Aim:** This scoping review aims to comprehensively explore PLA's dental applications, examining its advantages, limitations, and prospects. **Methodology:** Using a systematic search across numerous databases, including PubMed, Google Scholar, and Web of Science, we were able to present a thorough review. The initial search from the electronic databases produced a total of about 30 articles. There were about 28 unique items left after duplicates were eliminated. Following a proper screening and thorough review, about 18 papers were determined to be admissible because they specifically addressed PLA's biological uses in dentistry. **Results:** PLA has a lot of potential for dentistry because it can be used as a scaffold material, facilitate directed tissue regeneration, and offer long-lasting orthodontic options. Controlled release is provided by PLA-based drug delivery devices for better periodontal disease treatment. But it is critical to handle production costs and mechanical constraints. **Conclusion:** PLA is proving to be a game-changing material for dentistry, supporting the global movement toward sustainable healthcare solutions. It is a noteworthy option because to its biodegradability, biocompatibility, and adaptability. To fully realize its potential and pave the path for sustainable dental healthcare, however, optimizing mechanical properties and production costs remain major obstacles.

Key words: Biodegradable Polymers, Guided Tissue Regeneration, Poly(Lactic Acid)

Introduction

The use of novel materials in dentistry has significantly advanced recently, especially in the search for more environmentally friendly and biocompatible alternatives. Poly(lactic acid), also known as PLA, is one such material that has attracted a lot of attention in biomedical applications, including dentistry. PLA is a bioplastic made from renewable resources. The biodegradable and adaptable PLA material presents a viable way to improve different facets of dental treatment, from restorative procedures to prosthetic devices. As can be seen from the literature, there has been a great deal of investigation into the use of PLA in dentistry. In order to develop more patient- and environmentally-friendly solutions, researchers have investigated its potential in resolving dental health issues. For instance, a thorough analysis by Virlan et al.

(2015)[1] emphasizes Poly(lactic-co-glycolic acid)'s present applications in the dentistry industry, illuminating its varied function in dental therapies and materials. This review demonstrates the increased interest in utilizing PLA's special qualities to help dental patients.

The study of Pawar et al. (2014)[2], who examined PLA's larger importance in the medical field, provides additional insights into the biomedical uses of PLA. They highlighted PLA's potential for use in a range of biological fields, including dentistry, where its biocompatibility and controlled degradation may be crucial in improving patient outcomes.

DeStefano et al. (2020)[3] also explored the contemporary medical uses of PLA, providing insightful thoughts on how this bioplastic can develop dental materials and procedures. Insights into PLA synthesis and biomedical uses are provided by Singhvi et al. (2019)[4], with a focus on the material's importance in the dental field.

Furthermore, PLA's propensity to be converted into microplastics and its environmental implications have drawn much attention (Ali et al., 2023)[5], showing a growing demand for sustainable dental materials. Ilyas et al. (2021)[6] have investigated the use of PLA biocomposites, including their processing and additive manufacturing, highlighting the changing landscape of PLA-based dental materials and their cutting-edge applications.

This scoping review gives an overview of the vast amount of research pertaining to the biomedical use of poly(lactic acid) in dentistry. As more knowledge is acquiredabout the subject, the special qualities, and exciting potential uses of PLA in addressing various issues facing the dental industry would be explored ranging from restorative materials to tissue engineering, while also taking into account the wider implications for sustainability and patient well-being.The authors of this review seek to provide an in-depth and detailed overview of the biological applications of poly(lactic acid) (PLA) in dentistry. The review outlines specific goals, such as investigating various PLA applications to address dental health issues, evaluating the biocompatibility and environmental effects of PLA, and emphasizing the potential of PLA to advance dental materials and procedures for better patient outcomes and sustainability.

Methodology

Objective of the Scoping Review:

- The overarching research question or objective of the narrative review, was *"To comprehensively assess the biomedical applications of Poly(lactic acid) (PLA) in the field of dentistry."*

Timeline:

- The present narrative review was conducted between January 2023 to September 2023.

Search Strategy:

- Relevant studies were identified and searched accordingly.
- Specific databases and electronic resources that were searched included PubMed, Scopus, Web of Science, Google Scholar etc.
- Language restriction was confined to articles that were published in English only.
- Cross references were also searched to meet the specific characteristic of the present narrative review.

Search Keywords and Terms:

- A specific list of search terms and keywords were used to identify relevant studies[“Poly Lactic Acid OR PLA”, “Biodegradable polymers”, “Dental applications”, “Dentistry”, “Dental materials”,”Biomedical applications”, “Dental implants”, “Guided tissue regeneration”, “Periodontal treatment”, “Bone regeneration”, “Dental surgery”, “Orthodontic materials”, “Intrapocket devices”, “PLA-based nanoparticles”, “Tissue engineering”, “Tooth restoration”, “PLA composites”.]

- Included both general terms (e.g., "Poly(lactic acid) in dentistry") and specific terms related to different biomedical applications of PLA in dentistry (e.g., "PLA in dental implants," "PLA in periodontal treatment").

Inclusion and Exclusion Criteria:

- Specify criteria related to the study design (e.g., primary research studies, reviews), types of samples or subjects (e.g., human patients, animal models), and types of interventions or applications of PLA in dentistry were included.
- Any article with only abstracts or such manuscripts in any other languages other than English were excluded.

Data Extraction:

- The data extraction process was conducted including the variables and information pertaining to the title of the review.

Data obtained:

To find pertinent papers about the biological uses of poly lactic acid (PLA) in dentistry, a thorough systematic search was carried out in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) standards. Electronic databases like PubMed, Scopus, Google Scholar and Web of Science were searched using a set of keywords and inclusion criteria.

The initial search from the electronic databases produced a total of about 30 articles. There were about 28 unique items left after duplicates were eliminated. Following title and abstract screening, roughly 10 of these articles were eliminated since they did not fulfil the planned inclusion criteria.

The remaining papers were then subjected to a full-text evaluation to determine if they qualified for inclusion in the review. Following this thorough review, about 18 papers were determined to be admissible because they specifically addressed PLA's biological uses in dentistry.

Articles were excluded during the full-text assessment phase for a variety of reasons, including their lack of relevance to the subject, their lack of information, language barriers, or their focus on subjects that were outside the purview of this narrative review. These exclusions are accessible for reference and were meticulously documented.

A variety of study types, including clinical assessments, clinical trials, formulation studies, and reviews were included in the final collection of about 18 publications, which helped to provide a thorough overview of PLA's function in diverse dental applications. These chosen publications served as the foundation for the narrative study, enabling a thorough examination of PLA's various dental uses. Although the search approach and inclusion/exclusion standards are thoroughly described in the methods section, there is no formal quality assessment of the papers that were included. Given the variety of research types included in this narrative review, it was decided to concentrate on synthesizing and summarizing the current literature so that readers may assess the validity of individual studies in their particular contexts.

Results

Table 1. Summary of previous literature explaining the applications of Poly(lactic acid in dentistry)

Author/ year	Purpose/ materials....	Sample used	Methodology	Chief outcome of study
Stavropoulos A et al. (2004)[7]	Clinical Evaluation	Patients with intrabony defects	GTR treatment of intrabony defects with PLA/PGA copolymer or collagen bioresorbable membranes in combination with deproteinized bovine bone (Bio-Oss)	Evaluation of GTR treatment in intrabony defects
MinennaL et al. (2005)[8]	Clinical Trial	Patients with deep periodontal intra-osseous defects	Adjunctive effect of a polylactide/polyglycolide copolymer in the treatment of deep periodontal intra-osseous defects: a randomized clinical trial	Evaluation of adjunctive use of PLGA in periodontal defect treatment
Ahuja et al. (2006)[9]	Formulation and Characterization	Intrapocket devices containing metronidazole and amoxycillin	Formulation and characterization of biodegradable periodontal intrapocket devices containing metronidazole and amoxycillin	Development and characterization of intrapocket devices
AimettiJ et al. (2007)[10]	Clinical Evaluation	Patients with impacted mandibular third molars	Clinical and radiographic evaluation of guided tissue regeneration using resorbable membranes after extraction of impacted mandibular third molars	Evaluation of guided tissue regeneration in impacted molars
Ferretti C (2008)[11]	Prospective Trial	Patients with mandibular fractures	Poly-L-lactic/polyglycolic acid co-polymer plates and screws for internal fixation of mandibular fractures	Evaluation of Poly-L-lactic/polyglycolic acid in mandibular fractures
Molly L et al. (2008)[12]	Bone Biomaterial Implants	Patients with bone defects	Implantation of bone biomaterials into extraction sites	Bone formation following implantation of biomaterials
Zhang et al. (2008)[13]	Tertiary Dentin Formation	Dental pulp cells	Formation of tertiary dentin after pulp capping with a calcium phosphate cement loaded with PLGA microparticles containing TGF-β1	Tertiary dentin formation after pulp capping
Park W et al. (2009)[14]	Bone Fixation	Patients with bone fractures	Guided bone regeneration by poly(lactic-co-glycolic acid) grafted hyaluronic acid bi-layer films for periodontal barrier applications	Evaluation of guided bone regeneration with PLGA-hyaluronic acid films

Kim IA et al. (2010)[15]	Effects on Apatite Formation	Electrospun PLGA/SiO2-CaO nonwoven composite fabrics	Effects of PLGA degradability on the apatite-forming capacity of electrospun PLGA/SiO2-CaO nonwoven composite fabrics	Apatite-forming capacity of electrospun PLGA/SiO2-CaO fabrics
Stockmann P et al. (2010)[16]	Randomized Clinical Study	Patients with mandibular fractures	Resorbable vs. titanium osteosynthesis devices in bilateral sagittal split ramus osteotomy of the mandible	Comparison of resorbable vs. titanium osteosynthesis devices
TamazawaG et al. (2011)[17]	Osteomyelitis Treatment	Patients with osteomyelitis	Gatifloxacine-loaded PLGA and β-tricalcium phosphate composite for treating osteomyelitis	Treatment of osteomyelitis with PLGA composite
Selim M et al. (2011)[18]	Tissue Engineering	Tissue engineering of the urethra	Developing biodegradable scaffolds for tissue engineering of the urethra	Tissue engineering of the urethra
Lee FY et al. (2011)[19]	Drug eluting implants	Patients with periodontal disease	Investigation of drug-eluting implants for the treatment of periodontal disease.	Drug-eluting implants for periodontal disease.
TerrizaA et al. (2014)[20]	Osteoconductive potential	Osteoblast like cells	Osteoconductive potential of barrier NanoSiO2 PLGA membranes functionalized by plasma-enhanced chemical vapor deposition	Osteoconductive potential of PLGA membranes
BallaE et al. (2021)[21]	Polymer properties and applications	Polymer synthesis	Poly(lactic Acid): A Versatile Biobased Polymer for the Future with Multifunctional Properties—From Monomer Synthesis, Polymerization Techniques and Molecular Weight Increase to PLA Applications	Versatility of poly(lactic acid) as a biobased polymer
Naveed N et al. (2022)[22]		Orthodontic base plate	Oil incorporated poly(lactic acid) as an alternative material for orthodontic base plate (3D printing approach)	Alternative material for orthodontic base plates
Ali W et al. (2023)[5]	Synthesis, biodegradability and toxicity	Poly-lactic acid synthesis	Polylactic acid synthesis, biodegradability, conversion to microplastics and toxicity: a review	Synthesis, biodegradability, and toxicity of polylactic acid

Result summation

The scoping review on the Poly Lactic Acid (PLA) or bioplastic in biomedical applications in dentistry includes a wide range of papers that investigate many facets of PLA utilization in the industry. The cited research' primary conclusions and trends are as follows:

- ***Intrabony Defects and Guided Tissue Regeneration (GTR):-*** A clinical assessment of GTR therapy for intrabony defects was carried out by Stavropoulos A et al. in 2004.[7] According to the study, correcting such problems may be possible using deproteinized bovine bone (Bio-Oss), collagen bioresorbable membranes, and PLA/PGA copolymers.
- ***Adjunctive Use in Periodontal Treatment:-*** In a clinical experiment, MinennaL et al. (2005)[8] examined the adjunctive impact of a polylactide/polyglycolide copolymer in the treatment of profound periodontal intra-osseous defects. The findings suggested that using PLA-based materials can improve the way periodontal defect cases are treated.
- ***Formulation and characterisation of Intrapocket Device:-*** Ahuja J et al. (2006)[9] concentrated on the formulation and characterisation of biodegradable periodontal intrapocket devices that included metronidazole and amoxycillin. The paper shows how such devices for targeted treatment are developed and characterized.
- ***Guided Tissue Regeneration in Impacted Molars:-*** A clinical study of guided tissue regeneration employing resorbable membranes following the extraction of impacted mandibular third molars was carried out by AimettiM et al. in 2007.[10] Resorbable membranes made of PLA seemed to be excellent at encouraging tissue regeneration post-surgery.
- ***Mandibular Fractures with Poly-L-Lactic/Polyglycolic Acid:-*** Ferretti C (2008)[11] performed a prospective experiment with a focus on patients who had mandibular fractures and were given Poly-L-Lactic/Polyglycolic Acid Co-Polymer plates and screws. The use of PLA-based materials for internal stabilization of mandibular fractures has shown promising results.
- ***Bone formation with Biomaterial Implants:-*** Molly L et al. (2008)[12] investigated the implantation of bone biomaterials into extraction sites and showed that successful bone development occurred with the use of these materials, which may include composites based on PLA.
- ***Tertiary dentin formation:-*** The production of tertiary dentin following pulp capping with a calcium phosphate cement filled with PLGA microparticles carrying TGF-1 was examined by Zhang W et al. (2008).[13] The work raises the possibility of using PLA-based composites in treatments for tooth pulp.
- ***Bone fixation with PLGA-Hyaluronic acid films:-***Park JK et al. (2009)[14]did a study on bone fixation employing PLGA-grafted, bilayer hyaluronic acid films for periodontal barrier applications. In periodontal instances, these films proved helpful with directed bone regeneration.
- ***Apetite Formation on Electrospun Fabrics:-*** Kim IA et al. (2010)[15] investigated the impact of PLGA degradation on the ability of electrospun PLGA/SiO2-CaO nonwoven composite fabrics to generate apatite, highlighting the promise of these materials in dental implantology.
- ***Resorbable vs. Titanium Osteosynthesis Devices:-***StockmannP et al. (2010)[16] conducted a randomized clinical trial contrasting resorbable and titanium osteosynthesis devices in bilateral sagittal split ramus osteotomy of the mandible, shedding light on the best option for the procedure.

These findings show how Poly Lactic Acid (PLA) can be used in dentistry for a variety of purposes, including periodontal therapy, guided tissue regeneration, fracture repair, dental pulp therapy, and implantology. Materials made of PLA show biocompatibility and can be customized for certain dental requirements. They also promise to advance dental practices and provide potential substitutes for conventional materials.The narrative review's results section offers a thorough synopsis of numerous studies that investigate the uses of poly lactic acid (PLA) in dentistry. This research provides important information about the potential use of PLA in periodontal therapy, tissue regeneration, fracture healing, dental pulp treatment, and implantology.The unique approaches used in each of this research, which range from clinical evaluations and trials to formulation studies, are what make them strong. This variety makes it possible to have a comprehensive understanding of PLA's potential in dentistry. Clinical evaluations and experiments, for instance, like the one completed by Stavropoulos A et al. in 2004[7] show how PLA is effectively used to cure intrabony abnormalities and promote directed tissue regeneration. Similarly, Minenna L et al. (2005)[8] demonstrated the therapeutic applicability of PLA-based materials by highlighting the adjunctive use of a polylactide/polyglycolide copolymer in the treatment of periodontal defects.Furthermore, investigations into the formulation and characterization of biodegradable periodontal intrapocket devices, such as the one conducted by Ahuja J et al. (2006)[9], shed light on the creation and characterization of targeted therapy options. Understanding how PLA might be customized to meet certain dental needs requires an understanding of these formulation studies. Despite these advantages, it is necessary to point out a critical flaw in the review: the lack of a systematic evaluation of the included studies' quality. The dependability of the evidence offered in the narrative review must be assessed in terms of quality. It becomes difficult to evaluate the overall quality of the evidence and any potential biases in the included research without such an assessment. As a result, even though the individual studies provide insightful information, the absence of a quality evaluation is a restriction that should be considered when interpreting the review's conclusions.

Discussion

The biodegradable and biocompatible polymer poly(lactic acid) (PLA) has drawn a lot of interest in a variety of biomedical applications.[23,24] This adaptable material has been studied in the field of dentistry and may provide solutions for a variety of dental procedures and uses. The treatment of intrabony defects and guided tissue regeneration (GTR) are two areas of dentistry that are of particular interest. When combined with deproteinized bovine bone (Bio-Oss), PLA/PGA copolymer or collagen bioresorbable membranes, GTR treatment for intrabony defects was evaluated clinically by Stavropoulos A et al. in 2004.[7]This work brought attention to the potential of PLA-based materials to encourage the regeneration of periodontal tissue. These regenerative techniques are essential for repairing the integrity of periodontal tissues, and PLA-based membranes have demonstrated potential in accelerating this procedure.In a similar vein, Minenna L et al. (2005)[8] investigated the adjunctive use of a polyglycolide/polylactide copolymer in the treatment of deep periodontal intra-osseous abnormalities, suggesting its potential as a periodontics treatment alternative. Given that periodontal disease is still a major issue for oral health, the capacity of PLA-based materials to assist in the regeneration of periodontal tissues is a significant development in the field.In addition to periodontal applications, mandibular fracture treatment with PLA has showed promise. For the internal fixation of mandibular fractures, Ferretti C (2008)[11] conducted a prospective trial using Poly-L-Lactic/Polyglycolic Acid Co-Polymer plates and screws. The biocompatibility and mechanical qualities of PLA-based materials are highlighted by this application, which are crucial factors to consider when creating materials for maxillofacial surgery.

Furthermore, in a bilateral sagittal split ramus osteotomy of the mandibular, StockmannP et al. (2010)[16] performed randomized clinical research comparing titanium and resorbable osteosynthesis devices. This study showed that PLA-based osteosynthesis devices can provide effective substitutes for conventional titanium implants, eliminating the need for additional procedures for hardware removal. The use of PLA in maxillofacial surgery is consistent with the general medical trend toward bioresorbable materials, which reduce the potential for long-term issues from fixed implants.The use of PLA-based polymers for the treatment of periodontitis, a widespread dental ailment, has also been investigated. For the treatment of periodontitis, Do M et al. (2014)[25] created in situ forming implants with better adhesive characteristics. These implants provided a localized drug delivery mechanism that can improve periodontal therapy effectiveness. Local medication delivery utilizing PEG-PLA nanoparticles loaded with minocycline has been researched for the treatment of periodontitis.[26] With this strategy, periodontal therapy is more effective, and PLA is essential to the nanoparticle system.

PLA is a good contender for this application because to its biodegradability and drug delivery qualities, which may enhance patient outcomes in the treatment of periodontal disease.Materials made of PLA have been utilized in dental pulp treatment to promote the production of tertiary dentin. Additionally, the biodegradability of PLA-based materials helps to reduce the negative environmental effects of dental procedures and products. As the dentistry business develops, PLA-based materials have the potential to greatly advance dental procedures, enhance patient care, and promote sustainability initiatives. Successful results were seen when Zhang W et al. (2008) explored the implantation of calcium phosphate cement filled with PLGA microparticles carrying TGF-1 for pulp capping.[13] This strategy has the potential to lessen the need for invasive root canal surgeries by maintaining the vitality of the tooth pulp and encouraging tissue healing following injury.Nanodrugs have become a potential option for dental medicine delivery.[24] The significance of choosing the appropriate materials for controlled drug release systems is shown by the critical assessment of biodegradable polymers used in nanodrugs. The biodegradability and biocompatibility of PLA make it a desirable choice for these uses.

Another crucial component of dental care is guided bone regeneration (GBR), particularly in the context of dental implantology. Another study focused on the material's significance in supporting bone regeneration when they examined the impact of PLA degradability on the ability of electrospun PLA/SiO2-CaO nonwoven composite fabrics to generate apatite. Dental implants must be able to direct bone regeneration if they are to last over the long term, and PLA-based materials provide a platform for doing so.[15]Ahuja J et al. (2006) highlighted the potential of PLA in localized medication delivery for the therapy of periodontal disease by concentrating on the design and characterisation of biodegradable periodontal intrapocket devices containing metronidazole and amoxycillin.[9] Antimicrobial drugs can be used more effectively to treat periodontal diseases with targeted drug delivery systems that use PLA-based carriers while limiting systemic side effects.[9]

After the extraction of impacted mandibular third molars some authors performed a clinical study of guided tissue regeneration utilizing resorbable membranes, demonstrating the usefulness of PLA-based membranes in promoting post-surgical healing and tissue regeneration.[10]The use of PLA-based polymers has also been observed in the orthodontics industry. The potential for PLA-based materials in orthodontic applications was demonstrated by Nagata K et al. (2023), who investigated the use of recycled poly-L-lactic acid in the fabrication of dental models. A potential material for orthodontic foundation plates and models, PLA is adaptable and simple to 3D print.[27]

In tissue engineering, PLA has demonstrated its versatility. In the case of urethra tissue engineering, the development of biodegradable scaffolds using PLA offers a potential solution.[18] This illustrates PLA's adaptability in creating scaffolds for various tissue engineering applications. Improvements in drug loading and antibacterial activity have been achieved with minocycline-loaded PLGA nanoparticles, a close relative of PLA [Kashi TS et al., 2012].[28] These findings demonstrate the potential of PLA-based nanoparticles in drug delivery applications. Moreover, tissue regeneration strategies involving PLA-based solid scaffolds in combination with adipose-derived stromal cells have been explored [Akita D et al., 2014].[29] These approaches hold promise for regenerating periodontal tissues, potentially revolutionizing the treatment of periodontal diseases. In tooth bud stem cell development, the influence of electrospunfiber scaffold orientation and nano-hydroxyapatite content has been examined using PLA-based material.[30] Understanding how these factors affect stem cell development is crucial for various dental applications, from tissue regeneration to orthodontics. Incorporating tripolyphosphate nanoparticles into fibrous poly(lactide-co-glycolide) scaffolds has been investigated for tissue engineering.[31] While this study used a related polymer, it highlights the versatility of PLA-based materials in scaffold design. The biocompatibility of PLA-based composites has also been explored in calcium phosphate/poly(lactic-co-glycolic acid) composites.[32] These composites show promise in applications where bone regeneration is crucial, such as dental implantology. Clinical trials have compared PLA-based membranes to other materials in guided bone regeneration procedures.[33] Such studies provide valuable insights into the performance of PLA-based materials in real clinical scenarios. Improvements in drug loading and antibacterial activity have been achieved with minocycline-loaded PLGA nanoparticles, a close relative of PLA. These findings demonstrate the potential of PLA-based nanoparticles in drug delivery applications.[28]

The comprehensive evaluation of Poly(lactic acid) (PLA)'s biological uses in dentistry, in particular, reveals a rich and promising landscape. PLA has shown promise in a range of dental applications, including orthodontics, maxillofacial surgery, medication administration, and periodontal regeneration. PLA is an excellent choice for the development of cutting-edge dental materials and therapies because to its biodegradability, biocompatibility, and adaptability. To fully utilize PLA's potential in dentistry, however, and contribute to more environmentally friendly and patient-centered dental treatments, continued research and development is necessary. PLA is positioned to play a bigger and bigger part in determining the direction of dental care as the field continues to develop.

The review highlights the several dental uses of PLA, such as implantology, fracture healing, periodontal therapy, intrabony defect treatment, and fracture repair. These findings highlight PLA's flexibility and biocompatibility as promising alternatives to established techniques. The lack of a quality evaluation for the included studies, which has an impact on the overall validity of the evidence, represents a serious drawback. The PLA's reputation in dentistry would be enhanced by a thorough assessment of study quality. Despite this, the review's synthesis of multiple research techniques offers insightful information about the potential of PLA to improve dentistry procedures and patient care.

Conclusion

In conclusion, this scoping study has shown the crucial part Poly(lactic acid) (PLA) played in fundamentally altering numerous facets of dental treatment. The main takeaways from this investigation highlights the adaptability, biodegradability, and biocompatibility of PLA, which make it a unique material in the dentistry. Applications range from orthodontics, guided tissue regeneration (GTR), and localized drug delivery systems to periodontal therapy, maxillofacial surgery, and GTR, thus exploring the tremendous potential of the material.Despite allthe benefits, it is vital to recognize certain drawbacks also. Although PLA has advantages for sustainability, its production can be energy-intensive. For some dental applications, PLA's mechanical qualities might also need to be improved. Long-term clinical trials are also necessary to fully evaluate the product's performance and safety.

The dental fraternity should investigate and improve PLA-based materials in the future. This entails maximizing PLA's mechanical qualities, making sure about the economic front, and minimizing any environmental issues connected to its manufacturing. To accomplish these goals, dental professionals, material scientists, and environmental specialists must work together.In order to address the unique requirements of dental applications, future research should concentrate on improving the mechanical properties of PLA-based materials. To fully realize PLA's promise for environmentally friendly and patient-focused dental healthcare, interdisciplinary collaboration should place a high priority on the development of cost-effective manufacturing techniques. Hence, it can be concluded that PLA is a viable option for enhancing patient results, reducing environmental impact, and improving dental treatment. Continuous research, innovation, and interdisciplinary collaboration are necessary to realize its full potential. The dentistry community can usher in a sustainable and patient-centric age in dental healthcare, ultimately improving both oral health and the environment, by addressing the issues and building on PLA's strengths.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Virlan MJR, Miricescu D, Totan A, Greabu M, Tanase C, Sabliov CM, Caruntu S, Calenic B. Current Uses of Poly(lactic-co-glycolic acid) in the Dental Field: A Comprehensive Review. J Chemistry. 2015;Article ID 525832:12 pages.
2. Pawar RP, Tekale SU, Shisodia SU, Totre JT, Domb AJ. Biomedical Applications of Poly(Lactic Acid). Recent Patents on Regenerative Medicine. 2014;4(1):40–51.
3. DeStefano V, Khan S, Tabada A. Applications of PLA in modern medicine. Engineered Regeneration.2020;1:76–87.
4. Singhvi MS, Zinjarde SS, Gokhale DV. Polylactic acid: synthesis and biomedical applications. Journal of Applied Microbiology. 2019.
5. Ali W, Ali H, Gillani S, Zinck P, Souissi S. Polylactic acid synthesis, biodegradability, conversion to microplastics and toxicity: a review. Environ Chem Lett.2023;
6. Ilyas RA, Sapuan SM, Harussani MM, Hakimi MYAY, Haziq MZM, Atikah MSN, Asyraf MRM, Ishak MR, Razman MR, Nurazzi NM, Norrrahim MNF, Abral H, Asrofi M. Polylactic Acid (PLA) Biocomposite Processing Additive Manufacturing and Advanced Applications Polymers. 2021;
7. Stavropoulos A, Sculean A, Karring T. GTR treatment of intrabony defects with PLA/PGA copolymer or collagen bioresorbable membranes in combination with deproteinized bovine bone (Bio-Oss). Clinical Oral Investigations.2004;8(4):226–32.
8. Minenna L, Herrero F, Sanz M, Trombelli L. Adjunctive effect of a polylactide/polyglycolide copolymer in the treatment of deep periodontal intra-osseous defects: a randomized clinical trial. J Clin Periodontol. 2005;32(5):456-61.
9. Ahuja, J. Ali, S. Rahman. Biodegradable periodontal intrapocket device containing metronidazole and amoxycillin: formulation and characterisation A. Pharmazie 61. 2006;1:25-29.
10. Aimetti M, Pigella E, Romano F. Clinical and radiographic evaluation of the effects of guided tissue regeneration using resorbable membranes after extraction of impacted mandibular third molars. The International Journal of Periodontics and Restorative Dentistry. 2007;27(1):51–9.
11. 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(3):242-8.
12. Molly L, Vandromme H, Quirynen M, Schepers E, Adams JL, van Steenberghe D. Bone formation following implantation of bone biomaterials into extraction sites. J Periodontol. 2008;79(6):1108-15.
13. Zhang W, Walboomers XF, Jansen JA. The formation of tertiary dentin after pulp capping with a calcium phosphate cement, loaded with PLGA microparticles containing TGF-β1. Journal of Biomedical Materials Research A.2008;85(2):439–44.
14. Park JK, Yeom J, Oh EJ, Reddy M, Kim JY, Cho DW, Lim HP, Kim NS, Park SW, Shin HI, Yang DJ, Park KB, Hahn SK. Guided bone regeneration by poly(lactic-co-glycolic acid) grafted hyaluronic acid bi-layer films for periodontal barrier applications. Acta Biomater. 2009 Nov;5(9):3394-403.
15. Kim IA, Rhee H. Effects of poly(lactic-co-glycolic acid) (PLGA) degradability on the apatite-forming capacity of electrospun PLGA/SiO2-CaO nonwoven composite fabrics. Journal of Biomedical Materials Research Part B: Applied Biomaterials. 2010;93(1):218–26.
16. Stockmann P, Böhm H, Driemel O, Mühling J, Pistner H. Resorbable versus titanium osteosynthesis devices in bilateral sagittal split ramus osteotomy of the mandible - the results of a two-centre randomised clinical study with an eight-year follow-up. J Craniomaxillofac Surg. 2010 Oct;38(7):522-8.
17. Tamazawa G, Ito A, MiyaiT,Matsuno T, Kitahara K, Sogo Y, Kimishima K, Satoh T. Gatifloxacine-loaded PLGA and β-tricalcium phosphate composite for treating osteomyelitis. Dental Materials Journal. 2011;30(3):264– 73.

18. Selim M, Bullock AJ, Blackwood KA, Chapple CR, MacNeil S. Developing biodegradable scaffolds for tissue engineering of the urethra. BJU Int. 2011 Jan;107(2):296-302.
19. Lee FY, Chen DW, Hu CC, et al. In vitro and in vivo investigation of drug-eluting implants for the treatment of periodontal disease. AAPS Pharmscitech. 2011 Dec;12(4):1110-15.
20. Terriza AJ, Vilches-P´erez JI, de la Orden E, Yubero F, Gonzalez-Caballero JL, Gonzalez-Elipe AR, Vilches J, Salido M. Osteoconductive potential of barrier NanoSiO2 PLGA membranes functionalized by plasma enhanced chemical vapour deposition. BioMed Research International. 2014;Article ID 253590:10 pages.
21. Balla E, Daniilidis V, Karlioti G, Kalamas T, Stefanidou M, Bikiaris ND, Vlachopoulos A, Koumentakou I, Bikiaris DN. Poly(lactic Acid): A Versatile Biobased Polymer for the Future with Multifunctional Properties—From Monomer Synthesis, Polymerization Techniques and Molecular Weight Increase to PLA Applications. Polymers. 2021;13(11):1822.
22. Naveed N, Dutta K, Balamurugan D, Haveri AV, Sabapathy K. Oil-incorporated poly(lactic acid) as an alternative material for orthodontic base plate: a 3D printing approach. Adv Polymer Technol. 2022:7448575:16 pages.
23. Danhier F, Ansorena E, Silva JM, Coco R, Le Breton A, Préat V. PLGA-based nanoparticles: an overview of biomedical applications. J Control Release. 2012 Jul 20;161(2):505-22.
24. Marin E, Briceño MI, Caballero-George C. Critical evaluation of biodegradable polymers used in nanodrugs. Int J Nanomedicine. 2013;8:3071-90.
25. DoMP, Neut C, Delcourt E, SeixasCertoT, SiepmannJ, Siepmann F. In situ forming implants for periodontitis treatment with improved adhesive properties. European Journal of Pharmaceutics and Biopharmaceutics 2014;88(2):342–50.
26. Yao W, Xu P, Pang Z, Zhao J, Chai Z, Li X, Li H, Jiang M, Cheng H, Zhang B, Cheng N. Local delivery of minocycline-loaded PEG-PLA nanoparticles for the enhanced treatment of periodontitis in dogs. Int J Nanomedicine. 2014;18(9):3963-70.
27. Nagata K, Inaba K, Kimoto K, Kawana H. Accuracy of Dental Models Fabricated Using Recycled Poly-Lactic Acid. Materials (Basel). 2023;16(7):2620.
28. Kashi TS, Eskandarion S, Esfandyari-Manesh M, Marashi SM, Samadi N, Fatemi SM, Atyabi F, Eshraghi S, Dinarvand R. Improved drug loading and antibacterial activity of minocycline-loaded PLGA nanoparticles prepared by solid/oil/water ion pairing method. Int J Nanomedicine. 2012;7:221-34.
29. Akita D, Morokuma M, Saito Y, Yamanaka K, Akiyama Y, Sato M, Mashimo T, Toriumi T, Arai Y, Kaneko T, Tsukimura N, Isokawa K, Ishigami T, Honda MJ. Periodontal tissue regeneration by transplantation of rat adipose-derived stromal cells in combination with PLGA-based solid scaffolds. Biomed Res. 2014;35(2):91-103.
30. van Manen EH, Zhang W, Walboomers XF, Vazquez B, Yang F, Ji W, Yu N, Spear DJ, Jansen JA, Yelick PC. The influence of electrospun fibre scaffold orientation and nano-hydroxyapatite content on the development of tooth bud stem cells in vitro. Odontology. 2014 Jan;102(1):14-21.
31. Xie S, Zhu Q, Wang B, Gu H, Liu W, Cui L, Cen L, Cao Y. Incorporation of tripolyphosphate nanoparticles into fibrous poly(lactide-co-glycolide) scaffolds for tissue engineering. Biomaterials. 2010 Jul;31(19):5100-9.
32. Gala-García A, Carneiro MB, Silva GA, Ferreira LS, Vieira LQ, Marques MM, Sinisterra RD, Cortes ME. In vitro and in vivo evaluation of the biocompatibility of a calcium phosphate/poly(lactic-co-glycolic acid) composite. J Mater Sci Mater Med. 2012 Jul;23(7):1785-96.
33. Schneider D, Weber FE, Grunder U, Andreoni C, Burkhardt R, Jung RE. A randomized controlled clinical multicenter trial comparing the clinical and histological performance of a new, modified polylactide-co-glycolide acid membrane to an expanded polytetrafluorethylene membrane in guided bone regeneration procedures. Clin Oral Implants Res. 2014 Feb;25(2):150-8.