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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Periodontal Drug Delivery System

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A B S T R A C T

All racial and ethnic groups, as well as both sexes, are affected by periodontitis, a disease that affects the tooth's supporting tissues and causes the degeneration of periodontal ligament. It is commonly known that bacterial plaque contributes to the development of periodontal pockets and resorption of alveolar bone, resulting in the disruption of the supporting structure of teeth. Periodontal infections have been successfully treated using antibacterial medicines. The inaccessibility of periodontopathic organisms in the periodontal pocket limits the efficacy of mechanical debridement of plaque and frequent topical and systemic administration of antibacterial medicines. Drugs administered systemically produce therapeutic concentrations at the infection site, but only for brief intervals, necessitating longer-term, repeated dosage. Drugs administered systemically produce therapeutic concentrations at the infection site, but only for brief intervals, necessitating longer-term, repeated dosage. Antimicrobials delivered locally have been studied as a potential solution to the drawbacks of traditional treatment. Recently, there has been increased interest in using sustained release formulations to deliver antibacterial to the periodontal pocket, the site of infection. At far lower dosages, these solutions offer a long-lasting, efficient treatment at the infection site. Because they are plentiful, non-toxic, and highly compatible with tissue, biodegradable polymers are widely used in periodontal drug delivery systems. The fact that natural polymers have no effect on the regeneration of periodontal tissue, that is one of their main advantages. One of the many natural polymers found in drug delivery devices is chitosan, which is a deacetylated form of chitin. It has received a lot of interest in the pharmaceutical and biomedical industries because to its advantageous biological characteristics, which include nontoxicity, biocompatibility, biodegradability, and wound healing qualities. The traditional course of treatment involves root planning and mechanical cleaning of the tooth surface; these procedures may or may not be linked to the systemic administration of high antibiotic doses, but they have negative side effects and decreased efficacy. Additionally, the patient is advised to follow the treatment plan. With the benefit of delivering the medication to the precise location and maintaining and regulating the drug concentration, the treatment has been refined over the past few decades. Complete eradication of the organisms from the sites was not achieved by using various surgical and mechanical treatment. In order to distribute a range of medications, several polymer-based delivery systems, including fibers, films, chips, strips, microparticles, nanoparticles manufactured from various natural and synthetic materials have been successfully tested. Recently, there has been a lot of interest in using innovative drug delivery techniques. This review addresses the primary drug delivery methods for the periodontal pocket, their applicability, and the development of these methods' efficacy in periodontal therapy.

Keywords: Periodontal diseases, Periodontal pocket, Delivery systems, Periodontal pocket delivery

INTRODUCTION

Periodontal disease of periodontal tissues is an immune-inflammatory disease caused by pathogenic microorganisms results in loss of soft tissue attachment and alveolar bone resorption that leads to pocket formation or gingival recession. The gingival is only affected at the starting phase of the gingivitis. The first phase can be diagnosed as gingivitis in which the gingiva is been affected. It can be reversed if good oral hygiene is maintained. Daily brushing and flossing cannot remove calculus or tartar, which is formed when plaque hardens and becomes unremovable. The deeper tissues are later impacted by the germs. The collagen and periodontal ligaments that support the teeth in place are degenerated and causes the resorption of the alveolar bone. Due to the movement of gingival epithelium along the root surface, a space is formed between the gingival and the teeth. This space that is formed is known as “periodontal pocket” and the disease condition that occurred is known as periodontitis. Following are the therapeutic approaches for the the treatment of periodontitis -anti-infective treatment: that is used to stop the progression of periodontal attachment loss by removing etiological factors and regenerative therapy that includes anti-infective treatment and it helps to restore the demolished structures.

Numerous factors, including bacteria and trauma, can induce periodontal inflammation. However, most forms of gingivitis and periodontitis result from the accumulation of tooth-adherent microorganisms. Diabetes, tobacco use and the presence of certain subgingival bacteria are major risk factors for the development of chronic periodontitis.Additionally, there is proof that the pathophysiology of periodontal disease might be influenced by additional factors : environmental, genetic, and systemic(eg, diabetes).Periodontal pocket provides an effective environment for the growth of anaerobic pathogenic bacteria such as Porphyromonas gingivalis, Treponema denticola, Tannerella forsythia, Aggregatibacter actinomycetemcomitans, Fusobacterium nucleatum.

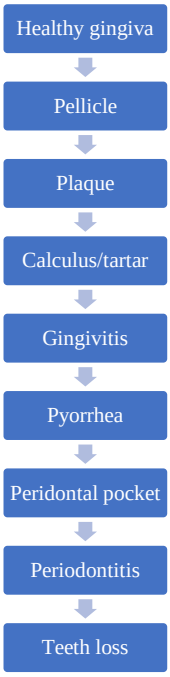

Fig :1 Different stages of periodontal disease

LOCAL DRUG DELIVERY SYSTEM

Although the systemic drug delivery method had demonstrated promising outcomes, it also had certain drawbacks, including dysbiosis and insufficient medication levels when desired. On the other hand, it could result in intoxicity, drug resistance, and gastrointestinal issues. The ideal requirements for a medicine that is applied locally:

Pharmacological drugs applied locally must meet the following requirements:

It must arrive at the targeted place of action and maintain a sufficient level of concentration.

It should endure for a long enough period of time.

Polymers are employed as drug carriers in local drug delivery systems (LDDS). They possess the ability to control the release kinetics and can protect the bioactive substances while they are being delivered into the body. The bioactive principle can be filled by either the polymeric chain or the polymeric matrix. Drug delivery systems allow the control and duration of drug release into a specified location, and drugs can be contained within many target agents simultaneously. This enables reducing the dosage and frequency of drug consumption possible. Compared to systemic administration, the adoption of a local medication delivery method may be more beneficial. Bypassing gastrointestinal issues and the medications and systemic metabolism before they reach the target site and hence it increases the effectiveness of local drug delivery systems. Furthermore, LDDS permits the simultaneous loading of two or more medications from distinct categories into the periodontal pockets. LDDS are produced in the form of fibers, irrigations, membranes, films, nanoparticles, and microparticles. Three primary pharmacological classes are included in the LDDS that provide therapeutic benefits for periodontal diseases: antibacterial, inflammation-modulating, and alveolar and bone-repairing agents.

DRUG DELIVERY SYSTEMS

Various drug delivery systems for treating periodontitis:

- Strip and Films
- Fiber
- Nanosystems
- Scaffolds
- Membranes
- Gels
- Injectable devices

- Microparticles
- Vesicular systems
- Injectable gels
- Ointments
- Periochips
- Smart gel periodontal drug delivery system
- Nanopores with ultrasound for drug delivery
- Quantum dots
- Gene delivery using bubble liposomes for periodontal therapy

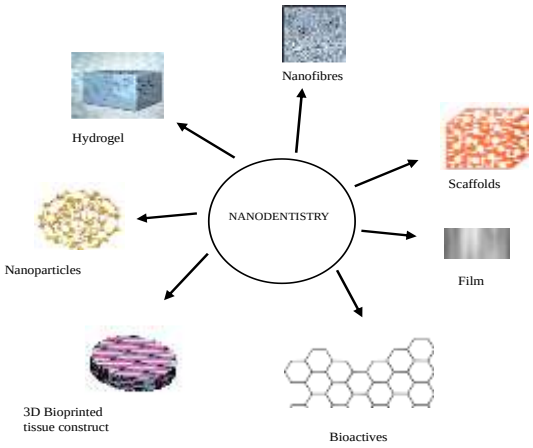

Fig.2-Periodontal drug delivery systems

- STRIP AND FILMS

The drugs dissolve into the polymer in the thin matrix bands, which are the strips and films. In addition to being a great combination in terms of size relative to the periodontal pocket, strips and films are put there. Because of these, they are simple to insert and cause little discomfort for patients. Acrylics loaded with various antibiotics are the first materials suggested for use in the development of strips and films. On the first day after insertion, these materials showed a noticeable drug release, which was followed by an extended release over the next four to five days.

Due to their non- biodegradability, they came with the drawback of requiring a second operation for removal- a challenging process by crevicular fluid softening, which irritates the gums. New bio-absorbable materials, such as polylactic-co-glycolic acid (PLGA), poly-hydroxybutyric acid, atelocollagen, chitosan/PLGA, and gelatin, along with others, were developed to get around this drawback. They underwent testing with positive findings.

Diffusion was used to liberate the medicinal chemical from non-biodegradable Strips and Films.

Researcher has shown that Strip and Films containing antibiotics and antiseptics can effectively maintain concentration over the long run and enhance gingival health clinically. Advanced tetracycline-loaded Scaling and root planning-associated strips over Scaling and root planning alone showed that numerous strips are much more effective in reducing probing depths than a single strip. Despite the fact that other molecules have been linked to a lower efficacy in treating periodontal disease than chlorhexidine-loaded strips there is a notably greater reduction by using the chlorhexidine chips with the probing depths ($p < 0.01$) as opposed to site specific with Scaling and root planning alone.

Lastly, the ingredients used to create strips and films are similar to those used to create fibres. Their diameters, applications, and release rates vary; some are better suited for larger pocket areas than others.

- FIBRE

Fibre is still the inventory delivery device that contains the necessary medication and is administered with an associative within the periodontitis-affected tooth pocket. It is secured in place with a periodontal dressing.

Many polymers, including synthetic ones such as polyurethane, polypropylene, cellulose acetate propionate, and ethyl vinyl acetate, as well as natural polymers such as chitosan, zein, and gelatin, have been used in the development of fibres for local drug delivery. After the development of the fibres, when it comes to the use and their testing each one of it should have antibacterial medications.

The earliest type of fibres was not recyclable, they may cause discomfort as a lower grade interruption was required to withdraw it, and gum redness was linked to wound healing. Biodegradable fibres (collagen fibres) were introduced into the market to prevent this. A fibrous structure like a native extracellular matrix is created with the process of electrospinning and their functions include transportation of chemical medicines, bioactive agents, or inorganic substances.Poly (L-Lactic acid) and collagen are materials with properties that make them appropriate for electrospinning processing which shows the property of biocompatibility and they are biodegradable.

For early to moderate periodontitis, scaling and root planning is very effective. In the case of severe type of the disease, tetracycline Local drug delivery system fibres, in conjunction with Scaling and root planning, represent a viable treatment option. In this we can conclude that one of the earliest types of Local drug delivery systems is fibre. However non-biodegradable fibres must be removed after treatment, they are appropriate for inaccessible locations but can cause gingival redness.

- NANOSYSTEMS

Due to their extremely small sizes, Nanosystems is suited for locations like the pocket area beneath the gum lines where conventional local drug delivery forms are not effective. They are applied directly to the pocket region or by various delivery methods, such as gel. Micellar particles, liposomes, nanofibers, metallic and polymeric nanoparticles are among them. They feature an advantageous surface-volume rate and a large loading capacity, making them ideal. As periodontitis has bacterial etiological aspects, several of them have also demonstrated antibacterial qualities, which may be helpful in treating the condition.

Due to the antimicrobial activity and bone regeneration properties metallic nanoparticles are used in dentistry but due to their cytotoxicity and non-degradability they cannot be used in the periodontal therapy, instead other materials are used. Liposomes can be used as a vehicle for managing patients with periodontal inflammation. Liposomes can modify drug pharmacokinetics and bio distribution, improve drug absorption into cells and release encapsulated medication in a regulated fashion. But statins are an example of a different class of medication that has demonstrated efficacy when administered locally to treat periodontitis.

- SCAFFOLDS

Scaffolds are used in periodontal drug delivery systems to support cell growth and differentiation, and to deliver drugs and genetic materials in a controlled manner. Scaffolds offer a three-dimensional structure that aids and directs periodontal tissue development. Scaffolds can be used to deliver drugs and genetic materials at a controlled rate. For example, chitosan-based scaffolds have been used to deliver meloxicam and aspirin to reduce inflammation after treatment. Scaffolds can be used to reduce inflammation. For example,polycaprolactone (PCL) scaffolds have been used to deliver ibuprofen, which has anti-inflammatory properties. It can be made from biocompatible materials such as polymeric biomaterials which are biodegradable and suitable for a wide range of medical applications. Scaffolds can mimic the extracellular matrix (ECM) of native periodontal tissues, which can help with cell attachment, proliferation and differentiation.

Scaffolds have been provided to treat bone deficiencies with the same goal as membranes. They have an advantage that they do not have the primary drawback of absorbable membranes, which is a weakness that prevents enough spontaneous endurance to outside intensity. Those involved position towards the damaged region to preserve room for the regeneration of periodontal tissue later on. Stem cells can be included in the development of scaffold to facilitate their distribution, as they are becoming more and more important in periodontal regeneration.

Some of the examples of materials used to make scaffolds are: collagen, chitosan, peptide-based hydrogel.

Hydrogel scaffolds designed for tissue engineering must be highly porous with an open interconnected geometry to allow a large surface area relative to the scaffolds volume.

- MEMBRANES

Apical biofilm advancement in periodontitis leads to bone resorption. For the treatment of these it is important to promote bone regeneration. Membranes were developed and employed to make it possible. They function as barriers that helps in the healing of gingival fibre wounds. They can be combined with several therapeutic drugs to strengthen these functions hence named as local drug delivery system. In the early times membranes used were not biodegradable so, a second surgical method were adopted to remove them hence, they were gradually abandoned.

Nowadays ingestible membranes have substituted the older non-resorbable membranes. They have a proliferation influence which was held by an operational film and medications that promote osteogenesis. In periodontal polyglycolide, regeneration, and GTR, collagen, polylactide or their copolymers are now utilized as membranes.

Considering their benefits, which include their capacity to activate and engage gastrointestinal fibroblast cells, they inhibit immunological responses, and possess hemostatic properties.Collagen is the most commonly employed substance Collagen membranes have been reported to induce fibroblast DNA formation and when it compared to the other membrane surfaces, osteoblastsshow increased adhesion towards the collagen membrane surface. A core nanofiber membrane has recently been introduced as a periodontitis treatment.

- GELS

Gels are extensively used in dentistry due to many advantages such as their high compatibility and bioadhesivity, ease of administration and ease of production. They are introduced into the periodontal site using broad port needle syringes. Nowadays liquid to semisolid transition in reaction to the stimuli such as temperature changes or solvent effects would build up the most current developments in gel formulations.

Gels are an efficient drug delivery device but certain disadvantages have been reported such as the medication is released rather quickly after being collected. Due to this scientist have created formulations for a blend of gels and alternative medication administration methods. The development of a tunable and injectable local drug delivery system was carried out following in vitro and in vivo testing conducted on rats. This system was successfully designed, constructed and evaluated for its efficacy.

- INJECTABLE DEVICES

There are many benefits when injecting a delivery system into the pocket. Injecting is a simple procedure which causes no or little discomfort. The initial fluid formation which is necessary for its use with a syringe allows the formulation to gain access to the entire pocket. The formulation would have to transform into a sticky semi-solid or solid in order to stay in the pocket and be shielded from the Gingival crevicular fluid (GCL) cervical fluid flow.

There are two common systems that are commercially available :1.2%Minocycline ointment does not have any sustained release properties .In one study this ointment was applied as an adjunct to scaling and root planning 2.Controlled release delivery system .The liquid phase of this formulation is composed of a water-free mixture of melted glycerol mono-oleate and metronidazole benzoate to which a triglyceride, sesame oil has been added to lower the melting point that is used to enhance the flow properties of the gel in the syringe .

When the mixture comes in contact with water it sets in a liquid crystalline state. The formulation consists of 25% metronidazole as 40% w/w metronidazole benzoate. Both solubility and concentration of the drug affects the release profile. The matrix is degraded by neutrophils and bacterial lipases in the GCF.Clinical studies comparing this therapeutic approach alone, to scaling and root planning, indicate that the metronidazole gel results in reduction in probing pocket depth and bleeding on probing which are not significantly different from the results obtained with scaling and root planning.

- MICROPARTICLES

Microparticles have been introduced using natural materials, natural compounds that had been altered, and synthetic polymers that fall into two classes namely biodegradable and non-biodegradable. Anintrapocket delivery system for minocycline was developed by Wu et al.2018 as an adjuvant to scale and root planning. Through the complexation of minocycline, the ca2+, sulphate-bearing biopolymer, and use of ion pairing examined the potential for further periodontal research employing microparticles. The use of microparticles as a local drug delivery strategy for the treatment of periodontitis has been studied clinically in addition to in vitro. The utilization of solid lipid microparticles in the study is interesting.

Microparticles based system of biodegradable poly alpha hydroxyl acids for example poly lactide(PLA) or poly (lactide-co-glycolide)PLGA containing tetracycline has been developed for periodontal disease therapy.PLGA microspheres containing minocycline have been formulated and have been for the elimination of porphyromonasgingivalis from the periodontal pocket.

- VESICULAR SYSEM

Vesicular liposomal systems are designed to resemble the bio-membranes that is similar to their structure and biobehaviour, and hence they are investigated for targeting periodontal biofilms.

Jones and Kaszuba reported interactions between liposomes that is made up of phosphatidylinositol(PI) and bacterial biofilms. The targeting of liposomes was thought to be because of the interaction of the polyhydroxy groups of liposomes with surface polymers of the bacterial glycol-calyx.SuccinylatedConcanavalin A (lectin) having the liposomes (proteoliposomes)have been found to be productive for the delivery of triclosan to periodontal biofilms. In the case of in vitro and in vivo studies they revealed that, even after a brief exposure, theproteo-liposomes are maintained by the bacteria eventually delivering the triclosan into the cellular interiors.

For a number of liposomal formulations containing both cationic and anionic lipids, the transport of triclosan and chlorhexidine was investigated. Robinson and coworkers had mentioned further on the affinity and specificity of immunoliposomes to reduce dental plaque. Regardless of the quantity of antibodies attached to the liposomal surface or the net charge on the lipid bilayer, the anti-oralisimmunoliposomes exhibited the highest affinity for S. oralis.

- INJECTABLE GELS

For the localized distribution of antibiotics, semisolid formulations are given fair consideration in addition to solid devices. Semisolid or gel formulations exhibit various advantages. In spite of the comparatively faster release of the incorporated drug, gels are more easily prepared and administered. Furthermore, they possess a higher biocompatibility and bioadhesivitythereby allowing adhesion to the mucosa in the dental pocket and eventually it can be rapidly eliminated through normal catabolic pathways there by decreasing the risk of irritative or allergic host reactions at the application site.

The gels comprise of cellulose derivatives such as hydroxypropylmethyl cellulose and hydroxyethyl cellulose do not exhibit sustained release properties. Despite the rapid drug release and poor retention of these gels, positive clinical tests in moderate to deep periodontitis were obtained. A requirement for the drug's extended release at the site is bioadhesion or mucoadhesion. The retention time of these were determined by fluorescein release and it was found to be notably higher for chitosan gel as compared to xanthum gum.

In a gel form (1%, w/w) with or without 15% metronidazole, chitosan, a new biodegradable natural polymer, had shown efficacy in chronic periodontitis treatment. Bio adhesive semisolid, polymeric system can be utilized as an important intra-pocket delivery vehicle due to property of easy pass through a cannula into a periodontal pocket where it solidifies in situ to the therapeutic agent for a prolonged period. These system sexhibit a pseudoplastic flow and thermoreresponsive behaviour, existing as a liquid at room temperature and gel at 34-37°C

- OINTMENTS

The first investigations carried out in the attempt of development of a periodontal intrapocket drug delivery system used ointments that is lipophilic mainly petroleum jelly, containing tetracycline or minocycline. As a result, outcomes are obtained as a significant decrease in the proportions of the number of microorganisms in the depth of the pockets and an advantageous association of the device with the clinical procedures cleaning and root planning is achieved. However, the ointments had shown the properties of extended drug release.

- PERIOCHIPS

To treat periodontal disorders, a novel strategy utilizing local delivery devices including antibiotics has just been presented. A dentist might utilize this sustained release device in different stages of a periodontal treatment plan.

a) In addition to scaling and root planning .

b) Periodontal drug therapy:This device works best when treating recurrent periodontitis which often affects a small number of teeth.

c) Those who refuse surgical treatment or for whom surgery is not an option.

d) Compared to surgery,a sustained release device is a less intrusive therapeutic option that takes less time.

Periochip, a controlled subgingival release of chlorhexidine, is the only product that is sold commercially. It was developed in Jerusalem, Israel, by Perio Products Ltd.This 5×4×0.3 mm film contains 2.5 mg of chlorhexidine gluconate embedded in a biodegradable matrix of glutaraldehyde-crosslinked hydrolyzed gelatin. The matrix also contains glycerin and purified water.

The cationic molecule's attachment to the extramicrobial complex and negatively charged microbial cell walls causes the drug's bacterial impact by changing the osmotic balance of cells. It reduces pellicle formation and plaque colonization by attaching itself to anionic acid groups on salivary glucoproteins. Additionally, it attaches itself to salivary bacteria, preventing them from adhering to the teeth.

Almost 90% of the medicine that is retained is eliminated in the feces, with the remaining portion going through the urinary tract. The drug is poorly absorbed from the gastrointestinal tract.

- SMART GEL PERIODONTAL DRUG DELIVERY SYSTEM

Thery are biocompatible,and biodegradable materials that can respond to stimuli like temperature,light,PH,glucose,enzymes,reactive oxygen species.They can undergo reversible phase transitions and return to their original shape after the trigger is removed.It consist of gellan gum(0.1-0.8%w/v) and ornidazole (1% w/v) were designed for the treatment of periodontal diseases. Each formulations was characterized in terms of in vitro gelling capacity,viscosity,rheology,contentuniformity, in vitro drug release and syringeability.

- NANOPORES WITH ULTRASOUND FOR DRUG DELIVERY

Ultrasound is a mechanical wave with frequencies higher than 20 kHz.Ultrasound's biological effects are frequently ascribed to either cavitationsactivity or temperature rise.[21]To carry out minimally invasive, targeted therapy, ultrasound is utilized to release the medications at the site of interest.Zeolites have a network of nanopores that are smaller than 20 nm.By substituting the nanozeolites, the arbitrary drug is trapped in the zeolite's nanopores, where it can eventually be recovered. The structure of the nano-pore zeolite can then be vibrated by ultrasonic waves to liberate the trapped medication. This makes it possible to predict the negative effects and drug release in the injured pocket. However, clinical data is still required to validate this concept.

- QUANTUM DOTS

To adjust the dental resin's emission color, non-toxic indium phosphide quantum dots were created using the solvothermal technique and subsequently included into the resin. The cadmium-free and lead-free quantum dots used in periodontal therapy help to enhance the repair of periodontal inflammation.

- GENE DELIVERY USING BUBBLE LIPOSOMES FOR PERIODONTAL THERAPY

Plasmid DNA can be effectively delivered into the gingiva by combining bubble liposomes with ultrasound. This method may be a helpful therapy approach for periodontitis and can be used to deliver a range of therapeutic compounds into target tissue.

FUTURE PROSPECTS

Recently, a variety of biomanufacturing methods have made it possible to create increasingly sophisticated scaffolds for regeneration therapy. Despite the introduction of several choices, the biomaterials themselves and their interaction with the production process still have certain limitations. Further research should be done on scaffolds with cell sheets, pre-vascularised scaffolds, nano-design scaffolds, and bio printing scaffolds in order to create the best 3D scaffold for periodontal tissue.

The influx of mesenchymal cells from the surrounding tissue and their differentiation into appropriately specialized cells, such as osteoblasts and cementoblasts, are essential for the tissue regeneration phase. Other methods for encouraging cell response are anticipated in the near future, and a biphasic scaffold with a porous structure has already been developed. In addition to other strategies like extracting vascular bundles for the defect or vascularising sheets of cells before to insertion, pro-angiogenic factors should be seeded into the scaffold prior to implantation, as re-vascularisation is another essential component of rapid regeneration. Human mesenchymal cells and human umbilical vascular endothelial cells are combined to create a vascularised cell sheet. Forexample one such sheet, for instance, demonstrated improved angiogenesis and bone matrix apposition when paired with a β-TCP scaffold. Additional researches are needed to determine promising results with a controlled procedure.

Following the implantation of biomaterials, more sophisticated regeneration targets retain the tissue's natural biology. There are benefits and drawbacks to the polymers . Thus, the future of biomaterials may involve a precise coupling of synthetic polymers with a biologic component. The combo approach has not yet undergone extensive testing, though. A reproducible handbook and optimal manufacturing processes should be finished in the future. Bio printing is the process of creating artificial tissue by combining cells, growth factors, and biomaterials via 3D printing. In most cases, they deposit materials like bioinks layer by layer. Despite their high resemblance to the original tissue, governments ought to approve this technology and standardize the protocol. Lastly, patient-specific tissue could be produced by bio printing for ideal regeneration.

Natural products derived from medicinal plants, which have been demonstrated to be abundant sources of physiologically active compounds, are the source of several innovative pharmaceutical lead chemicals. With only around 1% of the world's plant species having undergone photochemical research, there is plenty of opportunity to discover novel bioactive compounds among the remaining 450,000. The majority of these researches were conducted in preclinical or laboratory settings. These natural compounds' characterisation, cost-effectiveness, safety, and efficacy are all critical topics that require immediate attention and more funding from the scientific community.

Unfortunately, the gastrointestinal system's gastric breakdown and these essential chemicals' poor solubility, instability, and bioavailability restrict their potential therapeutic uses.To get over the drawbacks of herbal extracts, new drug delivery systems have been created as flexible assemblies. Another strategy to getaround resistance mechanisms is to encapsulate antimicrobial action in nanoparticles. Strategyto getaround resistance mechanisms to encapsulate antimicrobial action in nanoparticles.

CONCLUSION

Based on the previous analysis of recent developments in periodontal drug delivery systems, it can be concluded that the technology of antibiotic-free, mucoadhesive, biodegradable nanoparticles offer a great deal of potential for creating a new, low-dose, and efficient treatment approach through the use of an intra-pocket-controlled device. These gadgets are proven to be more practical, user-friendly, and efficient than conventional medications that work on a systemic level. Additionally, these devices are easy to formulate, reasonably priced, readily available, and do not assess the risk of overdose or systemic overload.

Numerous targeted drug delivery methods have been created to treat periodontitis and can enhance the administration of medication. These include films, fibre, chips, strips, microparticles, Nanoparticles, scaffolds, ointmentsetc. The purpose of these is to reduce the adverse effects that antibiotics may have on the body as a whole. In dental treatments, biocompatible, extended-delivery formula utilizing biodegradable polymers have been developed to reduce the danger of antimicrobial resistance, reduce the required doses, improve therapeutic efficacy and minimize adverse systemic effects.

REFERENCES

1. Tarcilio Lima de Sousa,DouglasDourado,Julia Soares Rodrigues,Juliana de Souza Reboucas,MarcosAntanioJapiassu Montes(2024)Treatment of periodontal disease:does delivery matter? Frontiers in Bioengineering and Biotechnology,12-2024,12:1427758.
2. Pratikshya Mohanty, Kalpita Bhatta, Itishree Jogamaya Das et al., (2024). Advances in Periodontal Drug Delivery Systems and the Role of Probiotics in Periodontitis Treatment, Journal of Angiotherapy, 8(3), 1-12, 9543
3. Pragati S, Ashok S. , Kuldeep S,Pragati S (2009). Recent advances in periodontal drug delivery systems, International Journal of drug delivery ,1(2009),1-14.
4. Joshi, D., Garg, T., Goyal, A. K., & Rath, G. (2014). Advanced drug delivery approaches against periodontitis. *Drug Delivery*, *23*(2), 363–377. https://doi.org/10.3109/10717544.2014.935531
5. Dr Rimjhim Sahu.,DrWadagbalkarP.,Dr Eesha.(2017).Applications of local drug delivery in periodontics: areview, International journal of scientific research,6(1),2277-8179.
6. Mariacristina Amato.,Simona Santonocito.,AlesssandroPolizzi.,Gianluca Martino Tartaglia.,VincenzoRonsivalle.,Gaia Viglianisi.,Cristina Grippaudo.,Gaetano Isola.(2023).Local delivery and controlled release drug systems:A new approach for the clinical treatment of periodontitis therapy.15(4).1312.doi: 10.3390/pharmaceutics15041312
7. Viglianisi G, Santonocito S, Lupi SM, et al.(2023) Impact of local drug delivery and natural agents as new target strategies against periodontitis: new challenges for personalized therapeutic approach. Therapeutic Advances in Chronic Disease.14. doi:10.1177/20406223231191043
8. Mandlik VB., Jha AK.(2007) Periochip. Med J Armed Forces India.63(4):368-9

9. Dabhi, M. R., Nagori, S. A., Gohel, M. C., Parikh, R. K., & Sheth, N. R. (2010). Formulation development of smart gel periodontal drug delivery system for local delivery of chemotherapeutic agents with application of experimental design. Drug Delivery,17(7) ,520-531.https://doi.org/10.3109/10717544.2010.490247

10. Lee, H. -S., Byun, S. -H., Cho, S. -W., & Yang, B. -E. (2019). Past, Present, and Future of Regeneration Therapy in Oral and Periodontal Tissue: A Review. Applied Sciences, 9(6), 1046. https://doi.org/10.3390/app9061046

11. Budala, D. G., Martu, M. -A., Maftei, G. -A., Diaconu-Popa, D. A., Danila, V., & Luchian, I. (2023). The Role of Natural Compounds in Optimizing Contemporary Dental Treatment—Current Status and Future Trends. Journal of Functional Biomaterials, 14(5), 273. https://doi.org/10.3390/jfb14050273

12. Natalie J. Medlicott", Michael J. Rathbone a, Ian G. Tucker Doug W. Holborow(1994) .Delivery systems for the administration of drugs to the periodontal pocket.Advanced Drug Delivery Reviews, 13 ,181-203

13. G. Harini, G. Kaarthikeyan.Advanced(2014) Drug Delivery Systems in treating periodontal diseases-A review,IOSR Journal of Dental and Medical Sciences (IOSR-JDMS) 13(1), 27-32.

14. Hau, H., Rohanizadeh, R., Ghadiri, M. et al(2014)A mini-review on novel intraperiodontal pocket drug delivery materials for the treatment of periodontal diseases. Drug Deliv. and Transl. Res. **4**, 295–301 . https://doi.org/10.1007/s13346-013-0171-x