DOI: https://doi.org/10.53350/pjmhs2115102501

EDITORIAL

Biopolymers advances in Medical Sciences: An Editorial Review

TAIMOOR HASSAN[1], XIAOJIA HUANG[2], SANA SAEED[3]
[1]School of Pharmacy, Changzhou University, China & Lecturer, Department of Health Professional Technologies, University of Lahore.
[2]Associate Professor, School of Pharmacy, Changzhou University, China
[3]School of Allied Health Sciences, Children Hospital, Lahore & Lecturer, Department of Health Professional Technologies, UOL
Correspondence to: Taimoor Hassan, Email: taimoorhassan408.th@gmail.com, Contact: 0321-9400508

INTRODUCTION

Biomaterials a term is used to describe the materials which are typically derived from any biological source. In generally it is said that these are the materials which are used within the human body to perform certain functions such as therapies[1]. The applications of polymers in the field of medicine have already gave birth to polymer science as a field. As we can see today, almost every polymer have been reported for use in any kind of clinical intervention, they are inseparable part of us now. Polymers are key players in clinical medicine as they are fundamental components of permanent prosthetic devices such as diameter vascular grafts, artificial lenses, catheters, hip implants etc., and the research is continued to perfect the performance and stability of polymers in vitro and in vivo[2]. However, the use of polymers in surgery is somewhat confined to connective tissue replacements. Interestingly, polymers have opened new horizons for drug delivery and gene therapy treatments such as nucleic-acid based drugs and protein-based drugs which cannot be taken up as typical pills, are providing impulsion for contemporary implantable polymers. The applications of polymers in tissue engineering are also gaining spotlight as these materials helps in the regeneration of 3D- (three-dimensional) organ and tissue structures[1].

A plethora of polymers such as polyethyleneterepthalate (PET), polymethylmethacrylate (PMMA), Polytetrafluorethylene (PTFE), Polyurethance (PU), Polyethylene (PE), polyethereetherketone (PEEK), Polysulfone (PS), Poly lactic acid (PLA), polyacetal (PA), poly glycolic acid (PGA) and silicone rubber (SR) etc., are widely being used in biomedical sciences. Carbon fiber/epoxy, silica/silicone rubber, carbon epoxy/polyetheretherketone are some examples of composite polymers[3].The applications of biopolymers in medical sciences are very wide and rapid. Possessing a unique property of biocompatibility, polymers are extensively used in tissue engineering, artificial organs, bone repair, prosthesis, implantation of medical devices, dentistry and the list goes on. In gene therapy, polymers provide a safest route for gene delivery as compared to use of certain viruses as vectors. Polymeric materials are broadly used as biosensors typically in medical testing devices and for bio-regulations[4].

Applications of Polymers in biomedical field: Polymers are very important contenders in medical supplications. Polymers have no any other competitors in this domain because of possessing several unique properties such as[5].

- Resistance against any biochemical ambush
- Fine biocompatibility
- High flexibility
- Flimsy weight
- Good tensile strength
- Easy handling in synthesis and characterization
- Change in properties according to environment

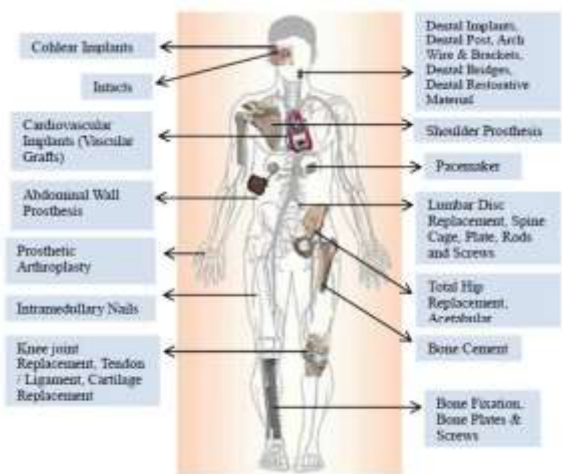
Medical devices implantation: Man-made biodegradable polymers have got attention for being used in medical devices, and will continue to play their phenomenal role in functioning and designing of medical equipments and devices. Scientists have reported the use of Drug Eluting Stents (DES) in the treatment of coronary artery disease among patients. Biodegradable polymers are also used as bioresorbable coatings on stents to monitor the drugs release[5]. The orthopedic devices which are manufactured from biodegradable polymers are more advantageous over metal or other non-degradable materials as they are able to transfer stress to damaged site as it heals, and its worth-mentioning that we do not need a second surgery to remove these polymeric implanted devices. Engineers have prepared many orthopedic devices such as screws, maxillofacial repair plates, pins, rods, bone fixation wires etc., from Polyglycolide, Polylactic acid and other degradable materials. Number of medical equipments such as pads, gloves, drapes, injection pipes, syringes, blood and urine bags etc., are primarily made from plastics, which are non-degradable materials and pose a great threat to our environment. Therefore, while taking this challenge into account, the scientists have started manufacturing these products from Polyglycolide, Polycaprolactone (PCL), Polylactic acid (PLA). These materials are environmentally friendly and easily degrades easily and more importantly these materials are cost effective as well[6].

Dentistry: In medical sciences, the most frequent treatment which is performed today is dental treatment which ranges from simple cavities fillings to replacement of rotten teeth. Diverse range of materials are being used in dental procedures such as fluting, endodontic, prosthetic, and orthodontic etc., these materials are typically termed as biomaterials[7].

The choice of polymer which is prepared to be used in treatment totally depends upon its self-characteristics and resemblance with the tooth morphology. The dental composite resins such as BIS-GMA are made up of barium glass, quartz and colloidal silica are widely used to restore the anterior and posterior structures of the teeth and also used in fillings. Dental implants are prepared from a variety of metals (Stainless steel, silver, titanium, Co-Cr-Mo alloys etc.,) Polymers (PMMA, PET, PS, PTFE UHMPE), composites (CF/Carbon and SiC/Carbon) and ceramics (Carbon, glass, alumina, zirconia etc.,)[8].

Drug delivery system: Polymers gave a new dimension to medical sciences when scientist find out their use in drug delivery system as carriers. Since then, wide range of experiments is being performed to find out the best possibilities to treat lethal diseases such as cancer. The typical methods of drug delivery by injections or tablets are well understood, the major impediment that triggered the thinking of scientists to look for other ways was the bioavailability, solubility of drugs. Number of biopolymeric materials are used as drug delivery agents such as Chitosan, Cellulose, Polymeric micelles, Dendrimers, Metallic nanoparticles, Alginate[9].

Figure 1: Significance of implants according to human anatomy[4].



Chitosan elicits muco-adhesive properties which can be used as an effective agent in tight epithelial junctions. Therefore, scientist have reported the extensive use of chitosan-based nanoparticles for drugs release in nasal, intestinal, pulmonary epithelia[4]. One research reported that researchers have prepared a chitosan-based solution named Hydroxypropyl methylcellulose to deliver antibiotic named ceftazidime into eye. Alginate is used to release a drug named venlafaxine via intra-nasal route which helps in the treatment of depression. Cellulose is used to release an anti-hyperglycemic drug named repaglinide. Dendrimers are mainly developed for pulmonary, oral, transdermal and ocular drug delivery systems[1,7].

Manifestations in Tissue Engineering: Biopolymers plays a dynamic role in tissue engineering, they work as a feigned extracellular matrix, provides 3D- (three-dimensional) support to cells in viva and in vitro to revitalize at wound site. Polymers, which are close to structural characteristics of tissues and mechanical versatility are well-liked aspirants for tissue engineering. Polylactic acid (PLA), Polycaprolactone (PCL), Polyglycolic acid (PGA), their copolymers and blends are the most widely polymers used in tissue engineering[10].

Polymeric heart valves: Artificial heart valves are typically of two main types; mechanical constructs of pyrolytic carbon or metal or bioprosthetic valves and next is cross-linked porcine heart valves. The stability of mechanical valves is much better than bioprosthetic valves, but the main concern is that they require permanent anticoagulation of the patient. It might be because only few studies reported the efficacy of bioprosthetic heart valves[6]. Scientists have reported that polycarbonate urethanes, thermoplastic polyurethanes and polysiloxane-based polyurethanes heart valves provide high resistance to calcification or degradation and fine flexibility at a low thrombogenicity. Hence, they are widely accepted and used in cardiac surgeries[11].

CONCLUSION

Biomaterial (other than drugs) is any substance which could be synthetic or natural in nature, that replaces, corrects, corrects, augments any diseased tissue, organ or body. Besides friendly, it is also one of the most challenging concern is today's arena. This editorial specifically focuses on the applications and blessings of polymers which are tremendously used in medical sciences, polymers are widely available in almost every field of medical sciences whether its surgery, ophthalmology, dentistry, research etc., They elicits peculiar properties such as biocompatibility, good tensile strength, and flexibility which makes them strong aspirants to be used. The availability of enormous range of polymers highly influenced controlled drug delivery systems, controlled tissue engineering. For successful implications of polymers researchers are convinced with their durability, reliability. Medical sciences with the help of polymers is quite determined to explore the contemporary frontiers in diagnosis, curing, treatment and prevention of diseases at genetic levels.

Conflict of interest: Nil

REFERENCES

1. RameshKumar S, Shaiju P, O'Connor KE. Bio-based and biodegradable polymers-State-of-the-art, challenges and emerging trends. Current Opinion in Green and Sustainable Chemistry. **2020** Feb 1;21:75-81. https://doi.org/10.1016/j.cogsc.2019.12.005
2. Hong M, Chen EY. Future directions for sustainable polymers. Trends in Chemistry. **2019** May 1;1(2)https://doi.org/10.1016/j.trechm.2019.03.004:148-51.
3. Lutz JF. Can Life Emerge from Synthetic Polymers?. Israel Journal of Chemistry. **2020** Jan;60(1-2):151-9. https://doi.org/10.1002/ijch.201900110
4. Zhang X, Zhang H, Wu Z, Wang Z, Niu H, Li C. Nasal absorption enhancement of insulin using PEG-grafted chitosan nanoparticles. European Journal of Pharmaceutics and Biopharmaceutics. **2008** Mar 1;68(3):526-34.
5. Badia JD, Gil-Castell O, Ribes-Greus A. Long-term properties and end-of-life of polymers from renewable resources. Polymer Degradation and Stability. **2017** Mar 1;137:35-57. https://doi.org/10.1016/j.polymdegradstab.2017.01.002
6. Tian H, Tang Z, Zhuang X, Chen X, Jing X. Biodegradable synthetic polymers: Preparation, functionalization and biomedical application. Progress in Polymer Science. **2012** Feb 1;37(2):237-80.
7. Ma X, Wen G. Development history and synthesis of super-absorbent polymers: a review. Journal of Polymer Research. **2020** Jun;27(6):1-2. DOI:10.1007/s10965-020-02097-2
8. Ramesh P, Vinodh S. State of art review on Life Cycle Assessment of polymers. International Journal of Sustainable Engineering. **2020** Nov 1;13(6):411-22. https://doi.org/10.1080/19397038.2020.1802623
9. Patel NR, Gohil PP. A review on biomaterials: scope, applications & human anatomy significance. International Journal of Emerging Technology and Advanced Engineering. **2012** Apr;2(4):91-101.
10. Mahkam M. Modified chitosan cross-linked starch polymers for oral insulin delivery. Journal of Bioactive and Compatible polymers. **2010** Jul;25(4):406-18.
11. El Oakley R, Kleine P, Bach DS. Choice of prosthetic heart valve in today's practice. Circulation. **2008** Jan 15;117(2):253-6.