Scientific Journal of Economics and Management Research Volume 4 Issue 2, 2022
ISSN: 2688-9323

Application of Biomedical Polymer Polyethylene Lactide in Medical Devices

Xinyuan Chen, Haiyang Sun, Junxiang Li

North China University of Science and Technology School of Pharmacy, Tangshan, Hebei 063210, China

Abstract

Due to the exclusion and incompatibility of medical devices themselves and the body, when medical treatment into the human body will cause bacterial infection or equipment consumption, attack phenomenon, due to carrying bacteria, post-infection will induce catastrophic infection, bring great physical pain and economic pressure to patients. In order to avoid affecting the patient's life safety, the research has put forward the antibacterial surface construction strategy for medical instruments based on the analysis of the unique advantages of polymer material properties. Among them, poly (ethyl lactide) stands out as a key, which is widely used in medical materials due to its excellent degradability, biocompatibility, gas barrier and excellent mechanical properties. Starting from the popularity of medical polymer, according to the research hotspot of medical polymer materials, application analysis, combined with the current specific tools, from the recent decade of literature to search for the topic of this literature: polyethylene lactide. From its specific application in medical devices to the synthesis process, and the corresponding literature was searched on CNKI. Starting from its specific application examples in medical devices, it analyzes and summarizes one by one, hoping to provide help for clinical treatment.

Keywords

Medical Polymers; Polyglycollide(PGA); Medical Apparatus and Instruments.

1. Foreword

Under the trend of the high development of science and technology and the rapid improvement of living standards, the requirements of human beings for physical health are gradually increasing, which leads to the demand for many new aspects, such as artificial organs, artificial joints, slow-release drugs, degradable Materials and regenerative tissue materials and other emerging products that are exposed to future technology. The creation of high technological demands facilitates the possible interdisciplinary integration of various disciplines such as biology, medicine, chemistry, physics and materials science. Biomedical polymer materials are a typical strategic emerging industry. They have the characteristics of energy saving and environmental protection, stable mechanical properties, good biocompatibility, economical materials, and high technical added value. They have very broad development value. Medical polymer materials mainly include natural biopolymer materials and synthetic biopolymer materials. Natural medical polymer materials come from nature, including cellulose, chitin, hyaluronic acid, collagen, gelatin and sodium alginate and other common substances in nature; synthetic medical polymer materials are medical polymer materials synthesized by chemical methods. Currently commonly used are polyurethane (PU), silicone rubber, polyester (PET), polyglycolide (PGA), polymethyl methacrylate (PMMA), polyvinyl alcohol (PVA), polylactic acid (PLA), poly Ethylene (PE) etc. This paper starts the research direction of this review by studying the superiority of medical polymer materials in terms of performance: the application of medical polymer materials in specific medical devices.

2. Status Quo

In today's medical machinery, the most common material is plastic. Its advantages are not only low cost, easy processing and high quality, but due to the resistance of the body, the use of this material and equipment has a process of rejection and destruction. Therefore, in practical application, should be fully considered from multiple perspectives, such as through the analysis of environmental needs and reasonable selection of appropriate materials.

Since polymer materials have the advantages of multi-structure, high activity, and strong performance at the same time, the technicality of medicine can be significantly improved by incorporating polymer materials in the preparation of medical devices. Through the modification method, the flexibility of the polymer chain can be controlled to meet the requirements of tensile strength in various machines, and the actual situation can be fully considered. For example, the polymer polycarbonate has great toughness and heat resistance. It can be used for disinfection. Combined with the blood filter, the filter belt is prepared to enhance the blood effect, reduce the carbon dioxide in the blood, and increase the effect of the amount of oxygen. At the same time, polycarbonate PC can also be used in needle-free injection systems to observe the internal structure of the human body through the characteristics of high transparency. Through the analysis in HowNet, according to the polymers mentioned many times by the keywords in the selected papers and the number of citations in the papers, it is determined that the subject direction of the polymer studied in this paper is polyglycolide.

3. Application

The synthetic degradable polymer material breaks the molecular chain of the polymer through hydrolysis, and turns the macromolecules into small molecules, so as to achieve the effect of degradation. In the late 1960s, surgical sutures polymerized from glycolide (GA) were successfully used in clinical practice, opening the door to the application of synthetic degradable polymer materials in medicine.

PGA is a crystalline polymer with a melting point above 200°C and good processability. It is a degradable polymer material that has been used in medical applications early on. Due to the superior fiber-forming properties of this material, it was first used in sutures in medical devices, and its strength is greater than that of cannula threads. The advantage of this material is that it can be completely absorbed by human tissues after surgery, avoiding manual secondary suture removal, reducing the risk of postoperative infection and reducing patient pain. At the same time, the polyglycolic acid (PGA) braided thread has good biocompatibility and biodegradability, and can be applied to the buried suture technique, that is, it can self-degrade in the body after surgery without the need for secondary suture removal. However, in current applications, the lack of antibacterial properties of the device surface and the impact of its biological properties are obstacles to its further application in therapy. Today, in clinical practice, PGA braided wires functionally lack some structural properties due to the relatively smooth surface of the threads. In the experiment, it was found that the quality and diameter of the PGA filaments treated by the polymer coating changed greatly. From the test results of mechanical properties, the tensile properties and flexibility of the PGA samples were slightly improved, and the swelling behavior was also improved accordingly. The prepared samples were all non-toxic, and the cell survival rate was above 75%, among which the M-PGA-B sample had the highest cell adhesion rate. The mechanical properties of the coatings (strength at break, elongation at break and flexibility) are also greatly improved after interaction. In biological experiments, modified PGA threads had better cell viability and antibacterial activity than unmodified PGA threads.

Polyglycolide (PGA) surgical sutures are absorbed by the body. To avoid surgical site infection, the drug is usually loaded on the PGA suture and then released directly into the wound. In order

ISSN: 2688-9323

to control the speed and period of drug release from PGA sutures, a pga-pcl biopolymer was discovered, and this polymer was mixed with the drug to make a mixed liquid. The mixture was then applied to the surface of the polylactic acid suture by soaking and rolling. Finally, PLA suture coatings of PGA, PCL, and drugs were prepared to control the drug release properties of polyglycolide (PGA) sutures. By adjusting the ratio of the PGA carrier, the release rate and release time of the PLA sutures can be tuned. The results showed that after 25 weeks, some pores appeared on the surface of the polyglycolide suture. During the degradation process, the strength of the suture gradually decreased, and the effective strength time of different proportions of PGA suture was different. The drug release rate of the suture was faster in the early stage and slower in the later stage. The higher the ratio of PGA, the faster the drug release from the suture. At present, PGA is more and more widely used in hospital surgical sutures.

PGA nonwovens have been widely used as scaffolds for tissue regeneration due to their excellent degradability, bioactivity, and mechanical properties. In terms of tissue engineering repair, by constructing porous polymer scaffolds, cells can attach and grow within the scaffolds, and new tissue growth can be induced after a period of in vitro culture. Significant results have been achieved in clinical trials. In addition, PGA dura mater substitutes are beneficial for tissue regeneration, enabling innovative applications of skin closure under seamless sutures. PGA can be degraded by the hydrolysis of the ester group in the chain segment, is well absorbed by the human body, and has high initial flexural strength and initial flexural modulus. Experiments proved that under hydrolysis conditions, the mechanical properties of PGA decreased within 1-2 months, and the mass loss occurred within 6-12 months. In humans, PGA can be degraded to glycine and excreted in the urine, or metabolized to carbon dioxide or water during exercise consumption. The copolymerization method can solve the shortcomings of high degradation rate of PGA, acidity and insolubility of degradation products.

PGA can be used as a drug-controlled release carrier for the release of polypeptides and protein products. The drug made by combining the drug and PGA material into the body can release the drug in a specific environment to achieve the purpose of "precise strike".

References

[1] Zhang Jie, Zhang Yuanjing, Ding Yuqin, Ma Jin. Research Hotspots of Biomedical Polymer Materials [J/OL]. Polymer Materials Science and Engineering: 1-13 [2021-12-08]. https://doi.org /10.16865 /j.cnki.1000-7555.2021.0229.

[2] Zhang Chuanzhong, Xiao Qing, Shan Changli. Research progress on the surface mechanical antibacterial of medical polymer materials [J]. Liaoning Chemical Industry, 2021, 50(09): 1333-1336. DOI: 10.14029/j.cnki.issn1004-0935.2021 .09.016.

[3] Lu Shoutao, Shen Xuehong, Zhou Chao, Duan Cuihai, Zhang Haijun. Application of degradable polymer materials in medical devices [J]. Application of Engineering Plastics, 2014, 42(07): 109-113.

[4] Shen Lisi, Lin Weicong. Application of medical polymers in medical devices [J]. China Medical Device Information, 2018, 24(03): 32+148. DOI: 10.15971/j.cnki.cmdi.2018.03. 013.

[5] Fu Shaoju, Zhang Peihua. Chitosan–gelatin enhanced antibacterial and biological properties of PLA and PGA braided threads for juvenile pseudomyopia treatment[J]. Textile Research Journal, 2021, 91 (17-18).

[6] Paresh Kumar Samantaray, Alastair Little, David M. Haddleton, Tony McNally,Bowen Tan,Zhaoyang Sun,Weijie Huang, Yang Ji,Chaoying Wan. Poly (glycolic acid) (PGA): a versatile building block expanding high performance and sustainable bioplastic applications[J]. Green Chemistry, 2020, 22 (13).

[7] Malik Muhammad Umair, Zhiming Jiang, Waseem Safdar, Zhiwei Xie, Xuehong Ren. N-halamine-modified polyglycolide (PGA) multifilament as a potential bactericidal surgical suture: In vitro study[J]. Journal of Applied Polymer Science, 2015, 132(35).

ISSN: 2688-9323

[8] Madan Rohit, Mohan Ranjana, Bains Vivek K, Gupta Vivek, Singh G P,Madan Mani. Analysis of socket preservation using polylactide and polyglycolide (PLA-PGA) sponge: a clinical, radiographic, and histologic study. [J]. The International journal of periodontics & restorative dentistry,2014,34(2).