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TREATMENT OF FRACTURES PERFORMED WITH BIOMATERIALS IN THE ARM AND FOREARM

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Abstract

Arm fractures are a common problem in contemporary orthopedics, often requiring surgery to ensure proper healing and restoration of function in the affected limb. Biomaterials have become an essential component in the treatment of these fractures, providing structural support and facilitating bone healing. In this article, we describe the various types of biomaterials used in fixing arm fractures, including metals, polymers, ceramics, and other promising materials. From durable steels and metal alloys to absorbable polymers and innovative carbon-based biomaterials, we examine the pros and cons of each type of material, along with case studies and future perspectives in this field. By synthesizing current knowledge and recent research, this article provides a comprehensive insight into the use of biomaterials in the treatment of arm fractures, facilitating the understanding and continuous development of modern orthopedic practice.

Keywords: polymeric biomaterials; metallic biomaterials, ceramic biomaterials; fractures.

Introduction

Arm fractures are a common problem in orthopedic practice and can have a significant impact on a patient's quality of life. While many fractures can be treated conservatively, there are situations where surgery becomes necessary to ensure proper healing and restoration of function of the affected limb. The use of biomaterials in treating these fractures has become an essential component of modern orthopedic practice, providing innovative solutions for fixing fractures and accelerating the healing process [1-3].

The purpose of this review is to examine the role and importance of biomaterials in the treatment of arm fractures. We will explore the various types of biomaterials used in orthopedic practice, including metals, polymers, ceramics, and other promising materials, looking at the advantages and disadvantages of each type of material [1-3].

The hierarchical structure of the long bone includes compact and spongy bone tissue, periosteum, and endostus. Bone formation involves intramembranous and endochondral ossification. Bone growth occurs through the active division of chondrocytes and the formation of new bone around growth cartilage. Bone remodeling involves constant resorption and formation of bone tissue, maintaining balance, and adapting to mechanical stress [1-3].

The article is structured in four main sections, these being represented by: polymeric biomaterials, metallic biomaterials, ceramic biomaterials, and biogels [1-3].

Polymeric biomaterials: We will explore the use of absorbable polymers and other polymeric materials in the treatment of fractures, analyzing their effectiveness in bone healing and reducing postoperative complications [2-4].

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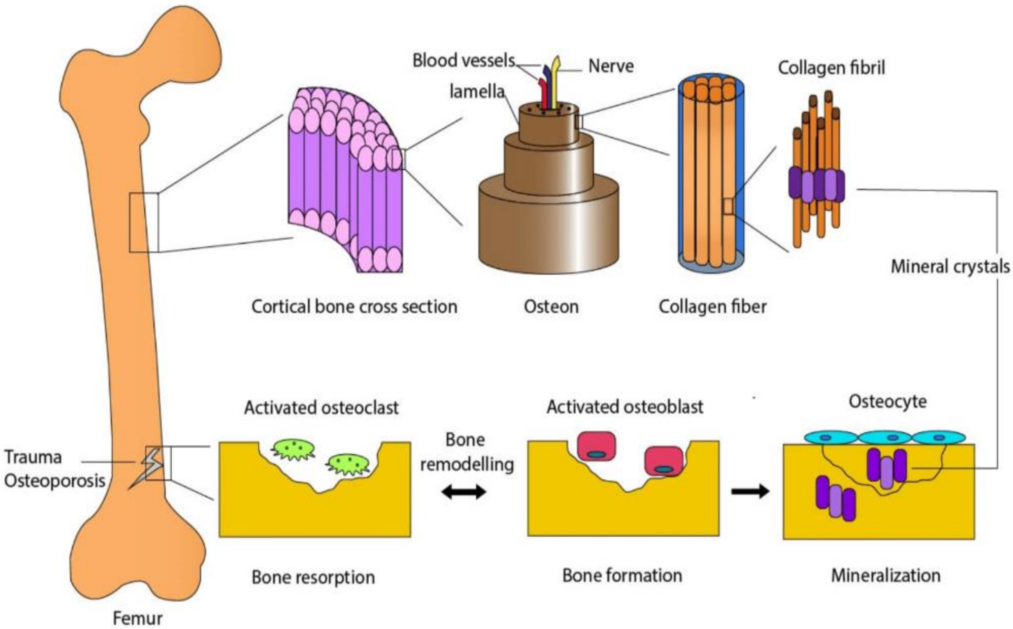

Fig. 1. Hierarchical structure, remodeling, and mechanism of formation of lick bones. [2]

Metallic Biomaterials: This section will examine the use of steels and metal alloys in fixing fractures in the arm, highlighting their mechanical properties and associated advantages [2-4].

Ceramic Biomaterials: This section will investigate the role of ceramics in fixing fractures and the advantages of using these materials in orthopedic practice [1-3].

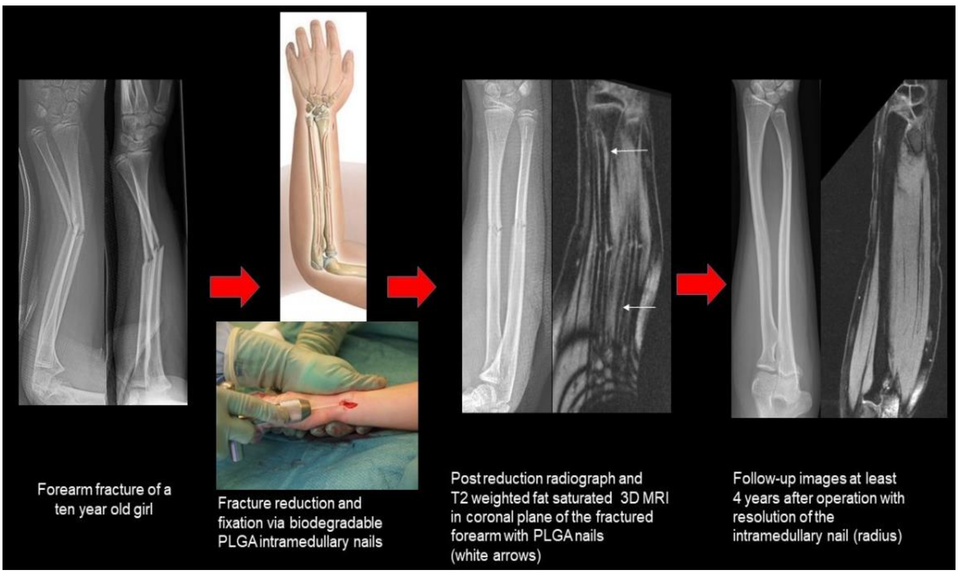

Fig. 2. PLGA biodegradable biomaterials are used for forearm recovery and fixation purposes. [3]

We will examine emerging biomaterials, such as biogels and carbon-based biomaterials, and their potential in the treatment of arm fractures [2-4].

Polymeric biomaterials

Absorbable polymers and other polymeric materials have gained popularity in the treatment of arm fractures due to their ability to provide temporary structural support and facilitate bone healing without the need for subsequent removal of fasteners [3-5].

Absorbable polymers are materials that gradually break down in the human body and are absorbed by the body as bone heals. These polymers are used for the manufacture of screws, plates, and fracture-fixing rods. Their effectiveness in the treatment of fractures is supported by the ability to provide temporary structural support and allow the bone to grow as the resort [3-5].

In addition to resorbable polymers, there are other polymeric materials used in the treatment of fractures, such as polymethylmethacrylate (PMMA) and polyurethane. These materials can be used in procedures such as cementing fractures or fixing unstable fractures [4-6].

Clinical studies and preclinical research have shown that absorbable polymers and other polymeric materials can facilitate bone healing and reduce postoperative complications associated with the treatment of arm fractures. These materials provide a favorable environment for bone growth and remodeling, while gradually breaking down in the human body, thus avoiding the need for further surgery to remove them [5,6].

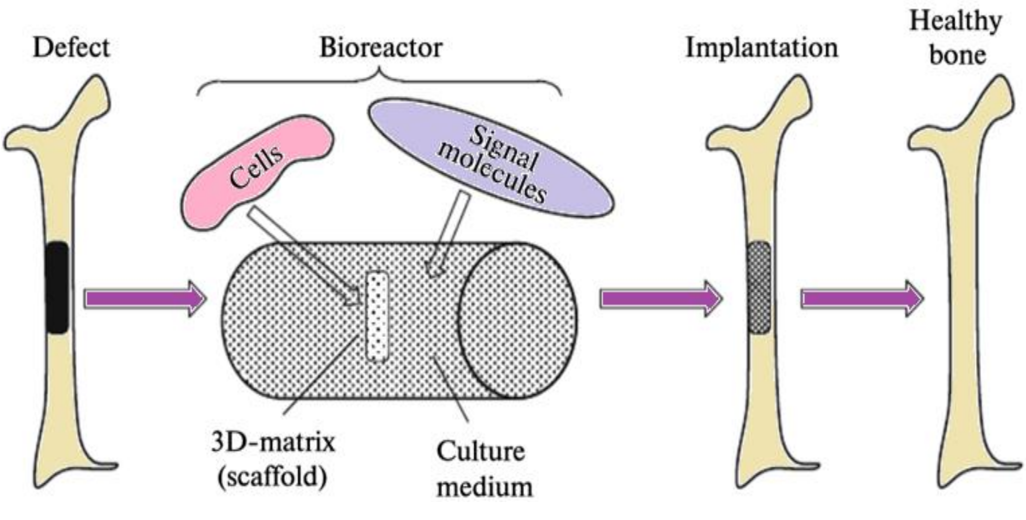

Fig. 3. Polymeric biomaterials provide an environment for bone development and regeneration as they gradually break down in the body, eliminating the need for additional surgery to extract them. [5]

However, it is important to consider that absorbable polymers and other polymeric materials may have some limitations, such as lower mechanical strength than metallic materials and a variable resorption period. Therefore, a careful benefit and risk assessment is required before using these materials in the treatment of arm fractures [6-8].

Absorbable polymers and other polymeric materials are a promising option in the treatment of arm fractures, providing a balance between structural support and resorption capacity, with the potential to reduce postoperative complications and improve outcomes for patients [6-8].

Metallic biomaterials

Steels and metal alloys are widely used in arm fracture fasteners due to their excellent mechanical properties and superior strength. These materials provide solid structural support and stability necessary for proper fracture healing [6-9].

Steels are alloys of carbon-containing iron and other elements, such as chromium, nickel, and molybdenum, which give them mechanical properties and corrosion resistance. They are used in the manufacture of bolts, plates, and rods used to fix fractures. Metal alloys such as titanium and its alloys also have wide applicability in orthopedics due to their excellent strength, biocompatibility, and ability to form solid interfaces with bone [8,9].

Image 4 shows a male patient who suffered a fracture to the distal radius and was treated with a titanium device to repair the fracture. This device helps keep the bones in the correct position to allow healing [7-9].

Treatment with titanium devices for distal radius fractures is quite common and is primarily aimed at stabilizing the fracture to allow the bone to heal properly. The advantage of using titanium in such devices is that this metal is biocompatible, is not susceptible to adverse reactions from the human body, and is also strong enough to support bones during the healing process [7-9].

Fig. 4. A.Titanium skeletal device fixed to a distal radius fracture that helps keep bones in the correct position to allow healing; B.Postoperative radiography; C. Bending the wrist; D. Wrist stretching. [9]

The advantages of using steel and metal alloys are strength, durability, biocompatibility, and flexibility in design. Steels and metal alloys are extremely strong, able to support high loads, and provide solid support to the fracture. Most steels and metal alloys used in orthopedics are biocompatible, minimizing the risk of rejection or adverse reactions from the body. These materials can be molded and adapted to various shapes and sizes, allowing the treatment to be customized according to the individual needs of the patient [8.9].

The disadvantages of using steel and metal alloys are represented by the risk of corrosion and the need for subsequent removal. Over time, steel and some metal alloys may experience corrosion, which can affect the stability of fasteners and lead to complications. Some metal fixtures may require further removal in additional surgery, which can be uncomfortable for the patient and increase the risk of complications [7-10].

In conclusion, steel and metal alloys are important biomaterials in the treatment of arm fractures, offering a combination of strength, biocompatibility, and design flexibility. However, it is important to consider both the advantages and disadvantages of using these materials in planning fracture treatment to achieve the best results for patients [8-10].

Ceramic Biomaterial

Ceramics are an important class of biomaterials used in the treatment of arm fractures. These materials exhibit certain properties that make them suitable for application in orthopedics, providing structural support and contributing to proper fracture healing.

Ceramics are used in orthopedics in various forms, including fracture fixation devices, fillers, and bone implants. Ceramic is valued for its mechanical strength, durability, and biocompatibility, which makes it an attractive option for fixing fractures in the arm [11-12].

The advantages of using ceramics in orthopedic practice are represented by mechanical strength, biocompatibility, and corrosion resistance. Ceramics are known for their compressive strength and tensile forces, providing solid support for fractures. Ceramic materials are often biocompatible, minimizing the risk of rejection or adverse reactions from the body. Ceramics have excellent corrosion resistance, which makes them ideal for use in biological environments [12-14].

Practical applications of ceramics in the treatment of arm fractures are achieved through fracture fixation devices, ceramic fillers, and ceramic implants.

Fracture fasteners represented by ceramic plates and screws are used to fix fractures in the arm, providing solid structural support [14-16].

Ceramic fillers can be used in the form of granules or powders to fill the empty spaces left by fractures, facilitating bone healing and stimulating bone growth [14-16].

Ceramic implants can be used to replace damaged or fractured segments of bone, restoring the structural integrity of the affected limb [15-17].

In conclusion, ceramics are a valuable option in the treatment of arm fractures, offering a unique combination of mechanical strength, biocompatibility, and corrosion resistance [15-17].

Promising biomaterials in treating arm fractures

Apart from traditional biomaterials such as metals, polymers, and ceramics, there are other types of biomaterials under development and evaluation for their use in the treatment of arm fractures. Among these, biogels and biomaterials possess unique properties and have the potential to improve fracture healing and clinical outcomes [18-21].

Biogels are gelatinous materials that can be injected directly into the fractured area to provide structural support and stimulate bone healing. They can be used to fill in empty spaces or stabilize bone fragments during the healing process. Biogels can also be loaded with growth factors or bioactive substances that can accelerate bone healing. The use of bagels in the treatment of fractures can improve bone strengthening and reduce postoperative recovery time [20-22].

Carbon-based biomaterials such as carbon nanotubes and graphene have been investigated for their use in fracture treatment due to their excellent mechanical properties and biocompatibility. These materials have superior strength and rigidity similar to that of natural bone, making them ideal for use in fracture fixation devices or bone implants. In addition, carbon-based biomaterials can also stimulate bone growth and regeneration due to their ability to interact with bone cells. These biomaterials in the treatment of fractures have positive results in terms of bone strengthening and functional recovery of the affected limb [21-24].

In conclusion, biogels and carbon-based biomaterials represent two promising directions in the field of biomaterials for the treatment of arm fractures. However, further research and clinical trials are needed to fully assess the efficacy and safety of these materials in the context of fracture treatment, to provide better and more efficient therapeutic options for patients [21-24].

Conclusion

Biomaterials play a crucial role in the treatment of arm fractures, providing structural support and facilitating bone healing.

A wide range of biomaterials, including metals, polymers, ceramics, and other promising materials, are used in fixing fractures, each of which has specific advantages and disadvantages.

Metallic biomaterials offer strength and durability but may pose corrosion risks. Absorbable polymers are biocompatible and can facilitate healing, but may have less mechanical strength. Ceramics have mechanical strength and biocompatibility but require further research to fully evaluate their effectiveness. Emerging biomaterials such as biogels and carbon-based biomaterials show promise for improving fracture healing.

Steels and metal alloys are widely used in arm fracture fasteners due to their excellent mechanical properties and superior strength. These materials provide solid structural support and stability necessary for proper fracture healing.

Ceramics are an important class of biomaterials used in the treatment of arm fractures. These materials exhibit certain properties that make them suitable for application in orthopedics, providing structural support and contributing to proper fracture healing.

Future research should focus on developing customized biomaterials, using advanced technologies, and investigating adjuvant therapies to improve the treatment of arm fractures and provide better and more effective therapeutic options for patients.

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