

A Brief History, Challenges and Types of the Experimental Bone Transplantation

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Abstract

Bone transplantation refers to the process of transferring bone tissue from one location to another, either within the same individual or between different individuals. There are different types of bone transplantation procedures, such as autografts, allografts, and xenografts. Autografts involve harvesting bone tissue from one part of the patient's body and transplanting it to another part, while allografts involve obtaining bone tissue from another individual of the same species. Xenografts, on the other hand, involve using bone tissue from a different species, usually for experimental purposes. Bone transplantation is commonly used for treating bone defects caused by trauma, cancer, infections, or congenital abnormalities. This research article seeks to explore the current state of bone transplantation research, including its history, techniques, challenges, and potential applications.

Keywords: Transplantation; Bone Transplantation; Autograf; Allograft; Trichoscopy; Xenografts

Introduction

History of Bone Transplantation

Bone transplantation has a long history dating back to ancient civilizations, where it was used for treating various health conditions. The earliest known evidence of bone transplantation comes from the Inca civilization in South America, where trepanation, a surgical procedure involving drilling holes in the skull, was performed to treat head injuries, seizures, and mental illness [1]. The Incas used bone fragments from deceased individuals to fill the trepanation cavities, suggesting that they understood the concept of bone healing and replacement.

In modern times, bone transplantation was first performed in the 19th century by Ollier, who used bone chips to correct bone deformities in animals. However, it was not until the early 20th century that bone transplantation became a widely accepted medical practice. In 1909, Lexer was the first to describe the use of autologous bone grafts for reconstructive surgery, followed by Albee, who introduced the concept of cortical bone grafting in 1915. Since then, bone transplantation has become a common procedure for treating various bone disorders [2].

Techniques of Bone Transplantation

There are different techniques of bone transplantation, depending on the type of graft, the size of the defect, and the location of the transplant. Autografts are the most commonly used technique because they have the lowest risk of rejection and can offer the most reliable source of bone tissue. Autografts can be harvested from various sites, such as the iliac crest, fibula, radius, tibia, or humerus, depending on the size and shape of the defect. Autografts can be solid or morselized, depending on the size of the defect and the desired outcome [3]. Morselized bone grafts can be mixed with bone marrow aspirate or platelet-rich plasma to enhance their osteogenic potential. Allografts are another common technique, especially for large bone defects that cannot be reconstructed using autografts alone. Allografts can be obtained from living or deceased individuals, depending on the type of transplant. Living donors are usually family members or close relatives who donate bone tissue voluntarily for medical reasons. Living donation is preferred over deceased donation because it has a lower risk of disease transmission and rejection. However, living donation

also carries some risks, such as pain, infection, and nerve damage [4].

Deceased donors are individuals who have donated their organs and tissues upon death for transplantation purposes. Deceased bone donation is regulated by national and international laws and protocols to ensure safety and ethical standards. Deceased bone tissue can be stored in tissue banks for later use or used immediately for emergency cases.

Xenografts are the least used technique because of their high risk of rejection, infection, and other complications. Xenografts involve using bone tissue from a different species, usually for experimental purposes. Xenografts are used to study bone biology, implant design, and tissue engineering. However, they are not suitable for clinical use because of the poor outcomes and ethical concerns [5].

Challenges of Bone Transplantation

Bone transplantation is not without challenges, despite its many benefits. Some of the challenges facing bone transplantation include:

- **Rejection:** Bone tissue can be rejected by the recipient's immune system, leading to graft failure and other complications. Rejection can occur in autografts, allografts, and xenografts, although the risk is higher in allografts and xenografts. Rejection can be minimized by matching the donor and recipient's blood and tissue types, using immunosuppressive drugs, and selecting the best donor site.
- **Infection:** Bone tissue can be infected during harvesting, processing, or transplantation, leading to bone necrosis, sepsis, and other complications. Infections can be prevented by adhering to strict aseptic

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protocols, using sterile instruments and equipment, and treating infections promptly.

- Resorption: Bone tissue can be resorbed by the body over time, leading to loss of graft volume and function. Resorption can be minimized by using osteoconductive and osteoinductive materials, such as growth factors, scaffolds, and biomaterials [6].

Bone transplantation is a medical procedure that involves the transfer of bone tissue from one individual to another, or from one part of the body to another. This procedure is commonly used to treat a variety of medical conditions, including bone fractures, joint replacements, and bone defects. There are several types of bone transplantation that can be performed, each with its own advantages and disadvantages [7].

Autograft transplantation:

Autograft transplantation involves the transfer of bone tissue from one part of the patient's body to another. This type of transplantation is considered the gold standard for bone grafting because it offers several advantages, including the absence of immune system rejection and a low risk of disease transmission. The most common sites from which bone tissue is harvested include the iliac crest, tibia, and femur. The bone tissue is typically harvested using a small incision, and the donor site is then closed using sutures. The bone tissue is then processed to remove any contaminants and implanted into the recipient site [8].

Autograft transplantation is typically used to treat bone defects, spinal fusion, and joint replacement surgeries. However, this procedure has several disadvantages, including the need for additional surgery to harvest the bone tissue, increased risk of infection, and longer healing time [9].

Allograft transplantation:

Allograft transplantation involves the transfer of bone tissue from a donor to a recipient. This type of transplantation is commonly used when a patient does not have enough viable bone tissue for autograft transplantation. Allograft transplantation is generally considered safe, but there is a risk of immune system rejection and disease transmission. The risk of disease transmission can be reduced by screening the donor for infectious diseases and processing the bone tissue using radiation or chemicals to eliminate any contaminants. Allograft transplantation is typically used to treat bone defects, spinal fusion, and joint replacement surgeries. However, the use of allografts has decreased in recent years due to the risk of disease transmission and the availability of alternative materials, such as synthetic bone grafts.

Xenograft transplantation:

Xenograft transplantation involves the transfer of bone tissue from an animal to a human. This type of transplantation is rarely used in human medicine due to the risk of immune system rejection and disease transmission. The most commonly used animal species for xenograft transplantation are cows and pigs. The bone tissue is typically processed using radiation or chemicals to eliminate any contaminants and reduce the risk of immune system rejection. However, even with processing, there is still a risk of disease transmission. Xenograft transplantation is typically only used in cases where there are no other options available for bone grafting. This procedure is often used in dental implant surgeries, where small amounts of bone tissue are required.

Synthetic bone grafts:

Synthetic bone grafts are a relatively new type of bone

transplantation that involves the use of artificial materials to replace or augment natural bone tissue. Synthetic bone grafts are made from a variety of materials, including calcium phosphate, hydroxyapatite, and polycaprolactone. Synthetic bone grafts offer several advantages over traditional bone grafting procedures, including a reduced risk of infection and the ability to be customized to fit the patient's specific needs. Additionally, synthetic bone grafts do not require a donor site, eliminating the need for additional surgery. Synthetic bone grafts are typically used to treat bone defects, spinal fusion, and joint replacement surgeries. However, these grafts may not be as effective as natural bone tissue and may require additional surgeries in the future [10].

Stem cell-based transplantation:

Stem cell-based transplantation involves the use of stem cells to generate new bone tissue. This type of transplantation is a relatively new procedure and is still being studied in clinical trials. Mesenchymal stem cell (MSC)-based stem cell-based therapies have emerged as a regenerative approach to treating renal diseases. MSCs secrete a wide range of bioactive molecules like chemokines, cytokines, and growth factors that can mediate anti-scarring and regenerative processes in addition to immune regulation and can be easily isolated in clinically useful numbers from various tissue sources like bone marrow and adipose tissue. In the two-kidney, oneclip (2K1C) CKD preclinical model, our group and others have previously demonstrated that bone marrow-derived MSCs transplantation reduces proteinuria and urea concentration, increases protein plasma levels, and tends to reduce creatinine, thereby enhancing the function of the ischemic kidney.

Discussion

In 2K1C model, fractional impediment of the renal supply route (stenosis) prompts decreased blood stream and perfusion pressure, causing renovascular hypertension (RVH), a sickness viewed as an optional hypertension structure in people. The renineangiotensinaldosterone system (RAAS) is triggered when renal artery stenosis occurs. This causes oxidative stress, inflammation, microvascular loss, severe interstitial fibrosis, and tubular atrophy. This leads to functional kidney deterioration and further progression to chronic kidney disease (CKD) and renal failure. We recently demonstrated that MSC renal subcapsular administration resulted in a significant drop in blood pressure, supporting the hypothesis of a significant influence on renin release through actions on the juxtaglomerular apparatus. In addition, GFP MSCs were found in fibrotic regions and close to infiltration of inflammatory cells throughout the kidney.

Conclusion

However, the mechanisms by which MSCs improve renal function in renal artery stenosis induced-CKD models, reverse tissue fibrosis, and regenerate renal parenchyma are not completely understood. Taking into account the immunosuppressive and regenerative properties of MSCs, we speculated that these cells could play a key part in organizing fibrotic cut kidney parenchyma redesigning by focusing on and tweaking the occupant cell types engaged with incendiary and fibrogenic occasions, as well as the Outflow of fiery and tissue rebuilding middle people. Thusly, in the current review, we expected to decide if MSCs transplantation could regulate the presence of macrophages and myofibroblasts, and the declaration of growth rot factor-a (TNF-a) and interleukin-10 (IL-10) in cut kidneys of 2K1C rodents. The articulation example of the tissue Redesigning proteins MMP-2, MMP-9 and its individual inhibitors TIMP-2 and TIMP-1, was additionally examined.

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