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Short Communication

Application of Nanotechnology in Orthopaedics' these days: A review

Devashish Kumar*

Department of Pharmaceutical Science, NSHM College of Pharmaceutical Science, NSHM Knowledge Campus Kolkata, India

INTRODUCTION

For decades, nanotechnology has transformed research and consumer goods. Drug delivery, medical diagnostics, and manufacturing have all enhanced as a result of its uses in medicine and biology. Recent study into the possibilities of this modern technology with novel types of disease detection and intervention, particularly in orthopaedics, has shown its potential. Recent advancements in bone tissue engineering, implantable materials, diagnosis and treatments, and surface adhesives have all contributed to the transformation of orthopaedics. Nanotechnology's potential in orthopaedics is tremendous, and most of it appears to be untapped, though not without challenges. Nanotechnology: Nanotechnology is the study and manipulation of matter on a molecular level. Nanotechnology, in particular, is concerned with "dimensions and tolerances of fewer than 100 nanometres," as well as the "manipulation of single atoms and molecules." Nanotechnology has been around for millennia, but with the arrival of the Information Age, it has exploded in popularity. Nanotechnology's earliest applications may be traced all the way back to pre-modern times, starting with the creation of glass for ceramic artefacts. Its use became ubiquitous in numerous sectors of science by the mid-twentieth century, providing as the foundation for tools like field ion and atomic microscopes. Throughout the twentieth century, the field expanded in scope and popularity. The vast capacity and potential of nanotechnology was highlighted by Richard Feynman's explanation of the field during a seminal 1959 address, prompting further investigation of its applications. By the early 2000s, a technology known as "nanotech" had made its way into the marketplace, allowing manufacturers to improve materials like sunscreens, tennis rackets, and electronic device display screens. Changing the girth of a guitar or tennis string, for example, can vary the sound and strength of the instrument. Nanotechnology is still used in a variety of aspects of daily life, and it is becoming increasingly essential in medical research and treatment. Nano medicine or the application of nanotechnology to medicine has been heralded as a game-changer [1]. Because the majority of biological molecules exist on the Nano scale, this type of technology has seen a lot of success and has a lot of room for expansion in the medical industry. Nanotechnology is being investigated for its potential to serve as a scaffold for nerve regeneration, among other applications, and has been utilized to change the methods by which medications are administered in its active form. Nanotechnology has so far been extremely successful in revolutionizing drug delivery, manufacturing, and medical diagnostic instruments. As scientists understand more about the mechanics and properties of medical nanoparticles, these molecules are being increasingly recognized for their pharmacologic potential in improving drug production and carriers, as well as optimizing materials and lowering toxicity. Permanent implantation of small devices, semi-automated diagnosis and treatment, rapid suspension of emerging diseases, cheaper surgical equipment, and the capacity to replace certain organs are just a few of the benefits of nanotechnology that have already become apparent in medicine. Nanotechnology has been utilized in cancer biology to administer medications like doxorubicin in a way that prevents cancer genes from allowing cells to escape the therapy [2]. To assess acetone levels in one's breath, 11 Nano-equipped breathalyzers for diabetics have been designed, offering an alternative to standard finger-prick glucose testing. Nano medicine has revolutionized eye surgery, for example, with the development of a magnetically guided robot that enables for more precise surgery and drug delivery dose. Nanotechnology has also been demonstrated to be useful in the diagnosis of cardiac arrest, and has been used to develop a sensor that detects heart attacks by examining blood cells. These examples are varied, but they barely scratch the surface of Nano medicine's capabilities, which have found applications in almost every field of medicine. In orthopaedic surgery, where bench and translational research have revealed various applications for manipulating nanoparticles, nanotechnology has invaded a particularly profitable niche. These advancements enable increased clinical skills through a variety of channels. Analytical and imaging tools, innovative treatments, and drug delivery systems are the three main dimensions through which nanotechnology can be used to make an effect in medicine and orthopaedic surgery [3]. Nanotechnology for bone implants and scaffolds: Current applications in orthopaedic surgery/ Nanotechnology: Implantable biomaterials have become key components of orthopaedic surgery, owing to their superior capacity to promote osteointegration and healthy bone processes when compared to traditional materials. These important

*Correspondence to: Devashish Kumar, Department of Pharmaceutical Science, NSHM College of Pharmaceutical Science, NSHM Knowledge Campus, Kolkata, India, E-mail: devashishkumar393@gmail.com

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advancements come at a critical moment, as the ageing population necessitates a greater number of orthopaedic implants. Joint implants, for example, are expected to be used by over 600,000 people in the United States each year, and this number is increasing [4]. Implants in orthopaedics are utilized in a number of ways in many different parts of the body, but adding nanomaterial's to implants improves their functionality and purpose across the board. Older methods of treating bone abnormalities, such as bone allografts and auto grafts, are still used in roughly 80% of bone defect procedures. These approaches, however, come with a slew of hazards, including infection, immune system rejection, and lengthy repair durations, particularly for tiny flaws. Many of these dangers have been reduced by employing nanomaterial in implants, but they are still there. Nanomaterial's-based implants are not yet capable of restoring complete capability, and they rarely last more than a decade or two at best. Complete implant failure is possible and can be very difficult, necessitating lengthy and costly re-operations. Nonetheless, nanotechnology has shown to be quite effective in the treatment of a variety of bone abnormalities and orthopaedic traumas when used in orthopaedic implants. Several materials have been studied and utilized, resulting in the employment of a diverse range of potential materials, each with its own set of qualities and advantages [5]. Gelatine, bioactive ceramics, biodegradable polymers, and polysaccharides such as agars are examples of materials. Because of their physical qualities and Nano scale features; this nanomaterial can work well within the human body, promoting cell proliferation and tissue regeneration. The capacity of this nanomaterial to imitate the cellular environment is critical for reproducing cell processes, which have Nano scale dimensions and combine together to form extracellular matrix. In addition, implants made of nanoparticles have a larger surface area, which aids in the development of a healthy environment for bone formation and lowers infection rates. A coating is frequently used to create scaffolding when nanoparticles are used for implants. Extracellular adhesion proteins have been demonstrated to interact more effectively with Nano phase implant scaffolds than with traditional implant surfaces. Increased protein absorption creates a favourable environment for osteoblast adhesion, bone growth, and implant-bone fusion. Furthermore, using nanotechnology for implants has been shown to have a number of good therapeutic outcomes, including a lower risk of infection and a better scar appearance. Nanomaterials have been proved to work in a variety of situations. For example, they've played a crucial role in total joint replacements (TJRs), where aseptic loosening is a common cause of failure. This danger has been found to be reduced by Nano textured material, which improves osteoblast adhesion and osteointegration. Similarly, implants and scaffolds composed of nanomaterial have been demonstrated to be helpful for treating bone abnormalities all over the body. The efficiency of Nano composite implants in the treatment of osteochondral knee deformities was proven in one study by Kon et al. Nanomaterial scaffolds have also been employed to help with the treatment of peripheral nerve damage. Silver-impregnated collagen scaffolds are used to boost the number of absorbed proteins that are useful for nerve mending, speeding up the rate of nerve regeneration. Nanotechnology boosted the thickness of myelin sheaths and improved nerve conduction in a research comparing silver (nanotechnology) scaffolds to normal collagen scaffolds. Nanomaterial's have a wide range of applications in orthopaedics, including implants and scaffolding, which can help patients recover faster, reduce surgery risks, and improve overall health. However, many prospective applications have yet to be researched and long-term safety and clinical benefits are yet unknown.

Diagnosis: The field of detection is another key application of nanotechnology in orthopaedics. Nanotechnology has been utilized to diagnose illnesses of the bones, including Paget's disease, renal osteodystrophy, and osteoporosis. Biosensors are commonly used for this. These sensors can be implanted and come in a variety of designs and forms. Carbon nanotubes (CNTs) are frequently used in biosensors because of their unique features, which make them robust and electrically conductive. A wide range of nanotechnology-based detecting tools are transforming orthopaedics. Techniques for diagnosis, for example, are critical in providing exact data detection in a fast, cost-effective, and non-invasive manner in the case of osteoporosis. There were few viable detection methods prior to the development of nanomaterial techniques.

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