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A Review: Introduction to Bio – Mechanical Engineering

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ABSTRACT

Bio mechanical engineering seeks to unravel the mysteries of how living organisms move and function. It understands how forces, stresses, and strains impact biological tissues and structures. Bio-mechanical engineering has applications in healthcare and sports. Biomechanics contributes to the development of life-changing medical devices and technology. It is crucial for developing innovative solutions in healthcare, such as prosthetic limbs, artificial organs, and medical devices that interact with the human body. Biomechanical engineers also contribute to sports science by analyzing the biomechanics of athletes, using advanced tools like motion capture systems and force sensors. This study helps to understand the usage of biomechanical engineering Biomechanical advancements include the development of life-changing medical devices, improved sports performance, injury prevention, medical research, ergonomic design, efficient agricultural machinery and robotics, rehabilitation, product design and safety, and biomechanics research. In the daily life, biomechanical engineering is used in smart wearable, such as smart watches, biosensors, thermometers, connected inhalers, fitness trackers, ECG monitors, and blood - pressure monitors. These devices help individuals track their heartbeat, oxygen levels, diabetes statistics, and blood pressure, enhancing theiroverall health and well-being. We summarize the use of biomechanical engineering in humanlife in this study, along with the accessibility of biomechanical devices to people and some real-world witnesses.

KEYWORDS: *Biomaterials, Tissue engineering, biomechanics, Rehabilitation engineering and Medical imaging.*

1. Introduction

Bio mechanical engineering is a dynamic and interdisciplinary field that delves deep into the intricate relationship between biology and mechanics. It seeks to unravel the mysteries of how living organisms move, function, and adapt from a mechanical perspective. This encompasses a widerange of biological systems, from the human body's musculoskeletal structure to the movement of animals and the growth of plants [1, 2].
One of the core areas of focus in bio mechanical engineering understands how forces, stresses, andstrains impact biological tissues and structures as shown in the figure 1. This knowledge is vital for developing innovative solutions in healthcare, as itenables the design of prosthetic limbs, artificialorgans, and medical devices that interact

seamlessly with the human body. For instance, biomechanical engineers may design implants thatmimic the natural movement of joints or develop biomechanical models to simulate the behavior of tissues under various conditions.

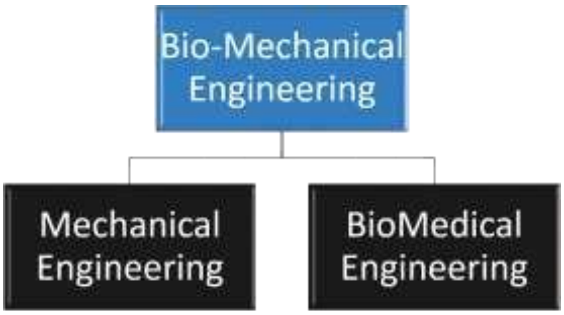


Figure 1: Illustrate the origin of bio mechanicalengineering

Moreover, bio mechanical engineers contribute significantly to sports science by analyzing the biomechanics of athletes. They use advanced toolslike motion capture systems and force sensors to study the mechanics of movements, which helps inoptimizing sports equipment, enhancing athletic performance, and preventing injuries.
Beyond healthcare and sports, bio mechanical engineering has applications in various fields, such as agriculture, where it can improve crop yield andplant growth through the study of plant biomechanics. It also plays a role in understandingthe mechanics of aquatic life for marine biology research and the design of underwater robotics. Inessence, bio mechanical engineering is a captivating field at the intersection of biology and engineering that empowers us to better understand, adapt, and improve the biological world around us, ultimately contributing to advancements in healthcare, technology, and our understanding of the natural world.

2. Impact of Bio-Mechanical Engineering on life

2.1 Healthcare Advancements:
It has led to the development of life-changing medical devices, such as artificial limbs, joint replacements, and assistive technologies, improving the quality of life for those with disabilities or health issues.

2.2 Sports Performance:
Athletes benefit from biomechanical analysis toenhance their techniques and reduce the risk of injuries. This has a direct impact on sports performance and safety.

2.3 Injury Prevention:

Biomechanical research contributes to safety advancements in industries like automotive,construction, and sports, reducing the occurrence and severity of injuries.

2.4 Medical Research:
Biomechanical studies aid in understanding themechanics of the human body, which is crucial for medical research, drug development, and treatment strategies.

2.5 Ergonomics:
Improved ergonomic designs in products and workplaces enhance comfort and reduce the risk of musculoskeletal disorders for workers and consumers.

2.6 Agriculture and Robotics:
Biomechanical engineering helps design efficient agricultural machinery and robotics, leading to increased productivity in farming and other industries.

Rehabilitation:
Biomechanical devices and techniques assist in the rehabilitation of individuals recovering from injuries or surgeries, facilitating faster and more effective recovery.

Product Design and Safety:
It ensures that products are designed with safety inmind, preventing accidents and hazards in various consumer and industrial goods.
2.9 Biomechanics Research:
Ongoing research in biomechanics contributes to our understanding of how the human body functions, leading to innovations in various scientific and medical fields.
Overall, biomechanical engineering's impact extends across numerous sectors, benefiting individuals' health, safety, and well-being while also advancing scientific knowledge and technology.

3. Bio-mechanical latest successors:

Prosthetics, from dentures to artificial limbsBionic contact lenses
Bionic exoskeleton
Robotic and laser instruments to assist insurgeries
Implantable medical and drug delivery devices Medical imaging, such as X-ray and MRI machines
Radiation therapy
Transcutaneous electrical nerve stimulation(TENS)
Genome editing An example for importance of Bio-mechanicalengineering in medical science is “Limb Surgery” A systematic review of the literature was conductedusing six electronic databases searched until April2017 for published peer-reviewed studies thatinvestigated lower limb biomechanics on the ACLRlimb compared with either the contra lateral limb
or those of control participants.[3-6] Meta-analysis with standardized mean differences (SMD) was performed for peak angles and moments (hip, kneeand ankle joints) in the sagittal plane during single-limb landing tasks as shown in the figure 2.

Figure 2: sagittal plane during single-limb landing

4. Application of Bio-Mechanical Engineering inlaboratory to improve human health:

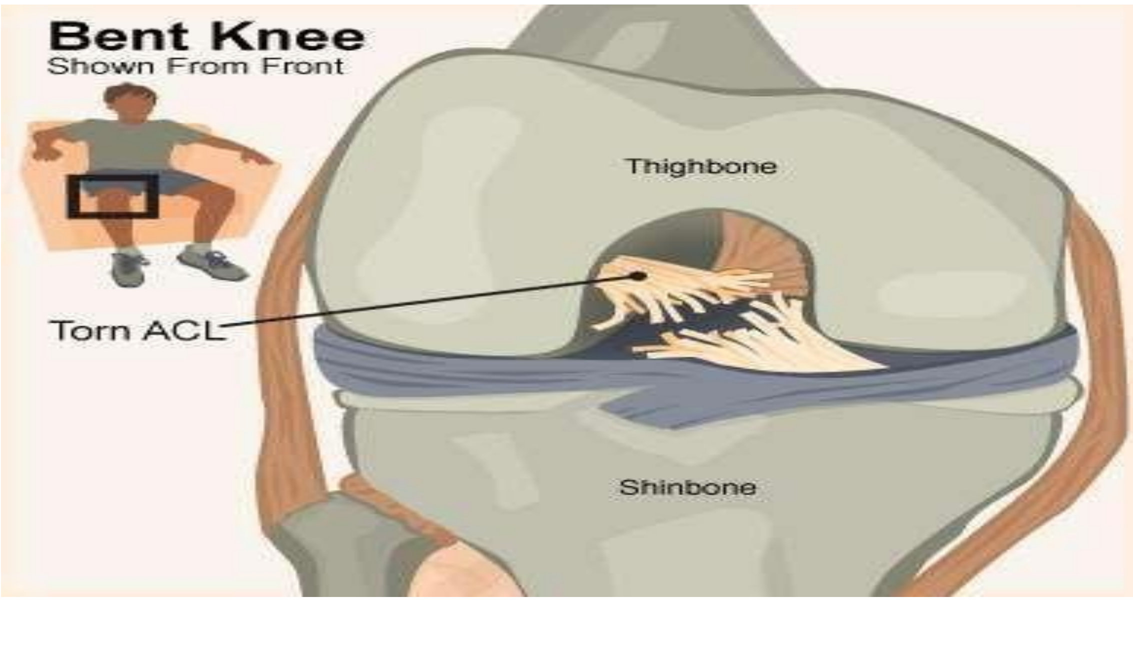
4.1 Abdominal Aortic Aneurysm (AAA):
Abdominal Aortic Aneurysm is an element of aortawhere the blood vessels deliver the blood to the body at the abdominal level.The Abdominal AorticAneurysmis the 10th leading cause of death for men at the age of 50s.The major cases conclude that it occurs in the men who smoke which cause the rupture of AAA and it can be life threatening asit records 90%of mortality rate.The surgery is suggested to be done on the analysis of the diameter of 5.5cms of theaneurysmexpansion.The modelling software is used to analyse and predict the AAA wall stresses. They are namely “Finite Element Analysis” (FEA) and “Fluid-Structure Interaction” (FSI) modelling the wall lumen surfaceexperiences transient.“Finite Element Analysis” (FEA) is used to mathematical calculation, model and stimulation to predict and understand how anobject might behave under various physical conditions [7,8].
This is followed by Computer Aided Engineering that is used in various applications like structural analysis, thermal analysis, automotive companies and other medical corporations too.
4.2 Magnetic Resonance Angiography (MRA): Magnetic Resonance Angiography is widely known as MRA scan which is evolved from MRI. The Magnetic Resonance Angiography is a technique used in late 1970sdeveloped by physicist Allan MacLeod Cormack and electrical engineer GodfreyHounsfield to identify the issues like AAA, Cancer etc.[9-11]
Successionof these techniques by the use of latest technology a development is mad which replace the MRA application. It was Computed Tomography Angiography (CTA).

4.3 Computed Tomography Angiography (CTA): The Computed Tomography Angiography is a scan technique that is evolved from MRA for theapplications of identifying Tumors, cancers etc.with ease, accurate and efficient [12].CTA has beenimproved in time management as it requires a fewminutes to identify where the MRA utilizes20-30mis of time.CTA upholds the effective working compared to MRA as it is very economicalthan MRA.CTA has an evolution that has beenwitnessed in 1999 was named as Multi SliceComputed Tomography(MSCT).[13,14,15]
4.4 Implementation of Biomechanics in InjuryRecoveries:
Anterior Cruciate Ligament (ACL) is a type of injury that occurs at the tissue connecting thigh bone to the shinbone at the knee as shown in the figure . This is the injury that is recorded mostly for the children of age 10 as they uphold the least control on the stability of the body and body weight and the injury is also said to be occurred in the sport players who perform in specific sports like cricket,football, basketball, skiing, baseball and tennis [16]. There come the cures for this issue

1. ACL
2. ARTHROSCOPY

The cure of ACL is considered to be replaced with new one if the ligament is torn. But the minor issues that occur at the ligament can be cured withArthroscopy. It requires less cut of body for surgery and promotes the individual to recover quicklywhile compared to the ACL.

Figure 3: Torn ACL tissue between thigh bone andshin bone (at Knee)



In the treatment of Ligament issue the bio absorbable materials are used. They are namely Poly Lactic Acid (PLA), Poly Lactic Co-glycolic Acid (PLCA) and Poly Caprolactone (PCL). Following the bio absorbable materials, some metallic elements like titanium and stainless-steel are used for support. In loading conditions 200Newtons is considered for the screw. And the maximum stressis designate to be 40 Mega Pascal as a concern to the graft tension at full extension during they walkas they displaces less than 0.06mm [17].They are designed to such stress conditions as they are stiff and offer lower vibrations.

4.5 Rehabilitation Using Bio-MechanicalEngineering:

Rehabilitation can be defined as the recovery of an individual from an injury or surgery shown in figure 4 (a). It is performed with the use of biomechanical devices.For a clear explanation we can consider Spinal Fusion [18]. The spinal fusionis an injury as it occurs at the spine. The support in the spine gets slowly out of control because of the weakening in the tissues and needs a mechanicalsupport as shown in figure 4 (b).

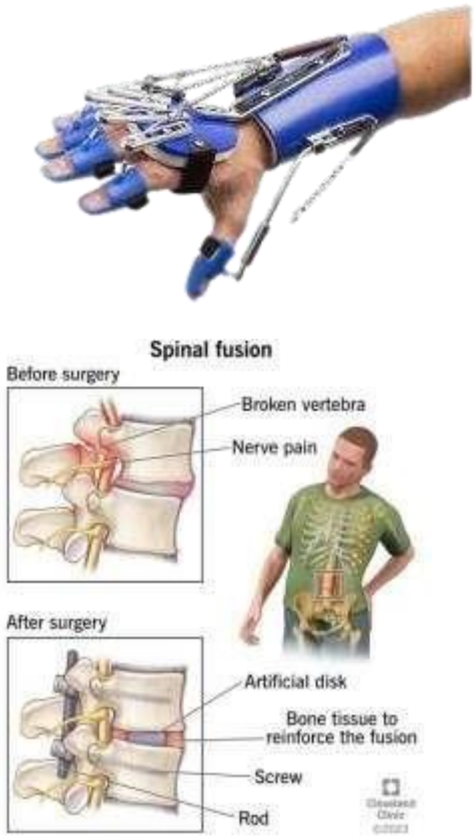


Figure 4: Rehabilitation (a) Bio-Mechanical devices
(b) Spinal Fusion

The treatment is done to the spine by implantingthe screws, rod and artificial discs. By the help of Bio-Mechanical procedures one can be cured fromthe massive injury that makes the life to be helpless.

4.6 Impact of bio-Mechanics in Sports:

The Bio-Mechanical engineering is also used in sports sector as to prevent injuries. This can be done by mathematical modeling, computer stimulation as shown in the figure.5 and measurements to enhance performance andprevent injuries at large scale by which the sport isno longer played with fear and boost up the playercourage enough.[19,20]

Figure 5: Illustrating the impact of bio-Mechanicsin Sports

5. Exploring the Role of Biomechanical Devicesin Our Everyday Lives:

In the human race of daily life, everyone wish to lead a healthier life. Smart wearable's as a sign of growing market one can accurately know about their body and health in day to day life.
An individual can track their heart beat, oxygen level, track their diabetes statistics, blood pleasureand more aspects respectively using designated devices that are handy and made by the principles of Biomechanics.

1. Smart Watches
2. Biosensors
3. Smart thermometers
4. Connected inhalers
5. Smart watches
6. Fitness trackers (Fit Bits)
7. ECG monitors
8. Blood pressure monitors

6. Incident that witnessed the role of smart biomechanics in real life.

A report by Local12 says Kimmie Watkins, at 29-year-old woman, was taking a nap when she was alerted of her extremely high heart rate by her Apple Watch. Her heart rate, while she was asleep,had spiked to 178 beats per minute. Before this, she had been feeling light-hearted and dizzy.

"I'm very lucky and that, if my nap hadn't ended, that my partner would have found me, maybe asleep on the couch, not actually sleeping instead of what did happen,"
she told the publication.She added,
"I was asleep for about an hour and a half before my watch woke me up with this alarm that said that my heart rate had been too high for too long.So for over 10 minutes, it was too high."
The report further states that when Watkins went to the doctors, she was told that she has saddle pulmonary embolism, a life-threatening blood clot. "A saddle pulmonary embolism is the most severe and life-threatening of all, because it's a blood clot that saddles both the blood vessel to the right lung and to the left lung," said Dr. Richard Becker, a cardiologist at the University of Cincinnati's College of Medicine.
Presently, Watkins is on blood thinners and is gaining her stamina back. [21]

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7. Incident that I personally witnessed which isnot published in media.

The incident has been taken place in Hyderabad. Aboy who was playing for a while and felt exhaustedand fallen back to rest. He had checked his watch which was notifying that his heart rate was falling down and his friends took initiative to take him to hospital and he is fine now.

8. Conclusion:

Biomechanical engineering is an interdisciplinaryfield that explores the relationship between biology and mechanics, focusing on understanding how living organisms move, function, andadapt. It is crucial for developinginnovative solutions in healthcare, such as prosthetic limbs, artificial organs, and medical devices that interact with thehumanbody.Biomechanicalengineers alsocontribute to sports science by analyzing the biomechanics of athletes, using advanced tools like motion capture systems and force sensors.

This study helps to understand the usage of biomechanical engineeringin medical appliances in improvement of human health. It explains about surgeries like **AAA, ACL, SPINAL FUISION** and **ARTHROSCOPY.**

Biomechanical progress spans life-changing medical devices, sports performance enhancement,injury prevention, medical research, ergonomic design, agricultural machinery, robotics, rehabilitation, safety, and ongoing biomechanicsresearch. In daily life, biomechanical engineeringdrives smart wearables like smartwatches, biosensors, thermometers, inhalers, fitness trackers, ECG monitors, and blood pressure monitors, aiding individuals in monitoring vital health metrics such as heart rate, oxygen levels, and diabetes statistics

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