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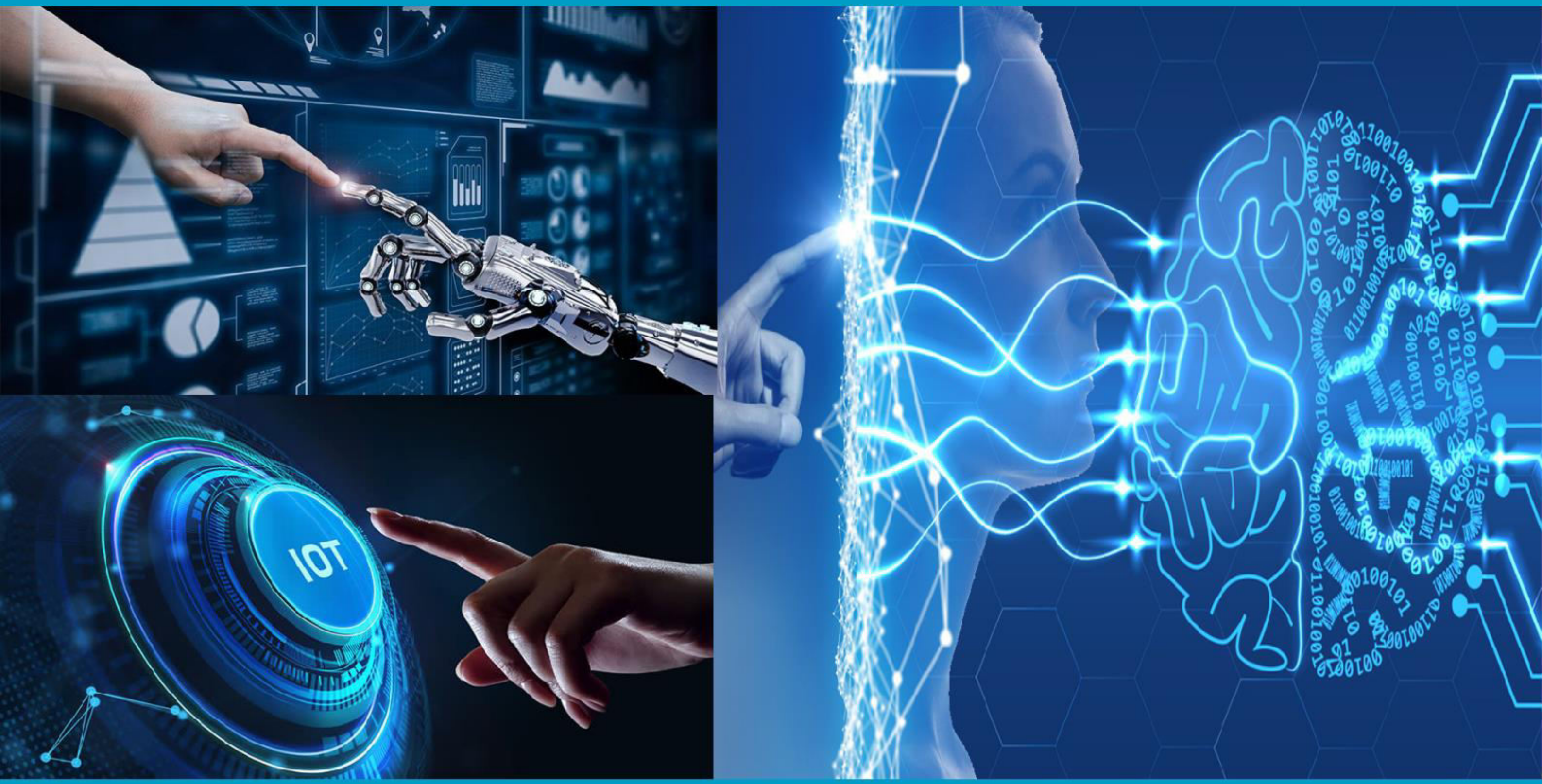

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Evaluating Prosthetic Design and Joint Loading Patterns: Insights into Arthritis Development in Amputees Using Mechanical and Microprocessor-Controlled Devices

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ABSTRACT: Evaluating the impact of prosthetic design on joint health is essential for improving mobility and quality of life in amputees. This study focuses on comparing mechanical and microprocessor-controlled prosthetic devices to assess their influence on joint loading patterns and the potential development of arthritis. A cohort of 50 lower-limb amputees, aged 25-60, was examined over a 12-month period, with participants split between users of mechanical prosthetics and those using advanced microprocessor-controlled devices. Gait analysis, joint load sensors, and 3D motion capture technology were employed to measure biomechanical parameters. Results indicated that microprocessor-controlled devices provided more balanced joint loading, reducing peak forces and asymmetrical gait patterns that can lead to arthritis. In contrast, mechanical prosthetics were associated with higher joint loads and uneven gait cycles, which are known to contribute to long-term joint deterioration. Statistical analysis revealed significant correlations between joint stress levels and the type of prosthetic used, with p-values < 0.05 indicating notable differences. These findings underscore the importance of considering biomechanical implications when choosing or designing prosthetic limbs. Microprocessor-controlled prosthetics, with their adaptive technologies, demonstrate superior outcomes in minimizing joint loading imbalances, suggesting a preventative role in reducing arthritis risk. The study recommends further exploration into optimizing prosthetic designs to enhance joint health and prevent degenerative changes in amputees.

KEYWORDS: prosthetic design, joint loading, arthritis development, biomechanical analysis, microprocessor-controlled devices**.**

I. INTRODUCTION

The evolution of prosthetic limbs has significantly impacted the rehabilitation and quality of life for individuals with lower-limb amputations. Technological advancements, including the development of mechanical and microprocessor-controlled prosthetic devices, have aimed to restore mobility, improve function, and support a more natural gait. Despite these strides, the long-term implications of prosthetic design on joint health remain a pressing concern, particularly in the context of arthritis development. Understanding how different prosthetic designs interact with the musculoskeletal system and influence joint loading is essential for developing solutions that promote joint integrity and prevent degenerative conditions (Kaufman et al., 2007).

Evaluating Prosthetic Design and Joint Health

Prosthetic limbs are designed to enable amputees to regain functional independence and engage in activities of daily living. Beyond basic mobility, these devices play a crucial role in maintaining balance, distributing loads effectively, and preventing secondary musculoskeletal issues. The biomechanical performance of a prosthetic limb can significantly influence joint health, particularly when a device fails to replicate natural joint kinematics or distribute loads symmetrically (Bellmann et al., 2010). Poorly designed prosthetics may lead to compensatory movements and increased joint stress, contributing to the development of arthritis in both the residual and intact limbs (Theeven et al., 2011).

Amputees often adopt compensatory strategies such as altered gait mechanics to accommodate prosthetic limitations. These adaptations can place excessive and uneven stress on the hips, knees, and ankles, leading to accelerated wear on articular cartilage and soft tissues (Hafner et al., 2007). The increased loading on adjacent joints exacerbates the risk of osteoarthritis and other joint-related complications (Bader et al., 2023). Understanding these mechanical interactions is pivotal for developing prosthetics that not only restore mobility but also promote long-term joint health (Martin et al., 2010).

Linking Prosthetic Design with Joint Loading and Arthritis Development

The way prosthetic devices influence joint loading patterns is a key determinant of joint health and the risk of arthritis development. Mechanical prosthetics, which are often characterized by static structures with limited adaptability, may not effectively accommodate the dynamic nature of walking and other daily activities. This can lead to increased ground reaction forces (GRF) and abnormal joint kinetics, placing heightened stress on the musculoskeletal system (Milone et al., 2023). The inability to adequately absorb shock or modulate movement can cause compensatory mechanisms that result in uneven joint loading and increased risk of degenerative changes (Bellmann et al., 2012).

In contrast, microprocessor-controlled prosthetics are designed to more closely mimic natural joint movement through embedded sensors, microprocessors, and actuators. These devices respond in real-time to variations in terrain and user gait, allowing for improved load distribution and reduced peak joint forces (Ackland et al., 2017). The adaptive capabilities of these devices can support more symmetrical gait mechanics and reduce the compensatory movements that contribute to joint strain and cartilage degradation (Bellmann et al., 2019).

The Role of Biomechanical Analysis in Prosthetic Evaluation

Biomechanical analysis is crucial for assessing how different prosthetic designs impact joint loading and movement patterns. Using advanced tools such as gait analysis, force plates, and motion capture, researchers can evaluate the kinematics and kinetics associated with prosthetic use. These analyses reveal critical data on how mechanical and microprocessor-controlled prosthetics distribute forces during ambulation (Hafner et al., 2007). For instance, studies have shown that mechanical prosthetics often lead to higher peak GRF and less efficient energy transfer, increasing the workload on the knee and hip joints and accelerating joint wear (van den Bogert et al., 2012).

Conversely, microprocessor-controlled devices demonstrate an ability to modulate joint movement in response to real-time feedback, resulting in smoother gait transitions and reduced abrupt force impacts (Lake and Miguelez, 2003). This feedback loop allows for better energy conservation and decreased joint loading, potentially reducing the risk of arthritis (Masroor et al., 2023).

Clinical Implications of Prosthetic-Induced Joint Loading Patterns

The clinical implications of joint loading patterns underscore the need for a holistic approach to prosthetic design and prescription. The choice of prosthetic device should consider long-term joint health, with microprocessor-controlled devices offering advantages in reducing joint overload due to their adaptive technology (Milone et al., 2023). Clinicians must weigh factors such as patient activity levels, weight, and individual mobility goals to select prosthetics that balance performance with joint preservation (Hafner et al., 2007). While these advanced devices offer superior biomechanical benefits, their higher cost and maintenance requirements may limit accessibility for some patients, highlighting the need for cost-effective solutions that do not compromise joint health (Bader et al., 2023).

The Need for Ongoing Research and Technological Advancements

Although current research supports the biomechanical advantages of microprocessor-controlled prosthetics in promoting joint health, more longitudinal studies are needed to assess their long-term impact on arthritis prevention. Research should focus on evaluating joint health over extended periods to identify early markers of arthritis and understand the cumulative effects of joint loading (Bellmann et al., 2012). Continued advancements in material science and engineering, such as the integration of lightweight and high-strength materials, can further enhance the functionality of both mechanical and adaptive prosthetics (Ackland et al., 2017).

Developments in software interfaces that allow prosthetists to adjust device settings based on real-time gait analysis could also improve personalized care and optimize load distribution. These enhancements can contribute to reduced wear on joints and better overall joint health (Masroor et al., 2023).

Evaluating the impact of prosthetic design on joint health involves a multidisciplinary approach that considers engineering, biomechanics, and clinical practice. The evidence points to the clear biomechanical benefits of microprocessor-controlled prosthetics in mitigating joint stress and reducing the risk of arthritis. By continuing to leverage biomechanical research and integrating technological advancements, prosthetic designs can evolve to better support both mobility and joint health, providing comprehensive solutions that prioritize the long-term well-being of amputees (Martin et al., 2010).

II. METHODOLOGY

Experimental Design

The study employed a cross-sectional comparative design to evaluate joint loading patterns in amputees using mechanical prosthetics and microprocessor-controlled prosthetics. The primary aim was to assess how different prosthetic designs impact joint health and contribute to the potential development of arthritis over time. This research was conducted in a controlled laboratory setting equipped with advanced biomechanical analysis tools.

Participant DemoFigureics

Participants were recruited from rehabilitation centers and prosthetic clinics, ensuring a diverse representation of individuals who use lower-limb prosthetics. The inclusion criteria were as follows:

- Adults aged 25-60 years.
- Unilateral lower-limb amputation.
- Minimum of one year of experience using their current prosthetic device.
- Ability to walk unassisted for at least 50 meters.

The exclusion criteria included:

- Bilateral amputees.
- Individuals with musculoskeletal conditions unrelated to prosthetic use.
- Neurological disorders that could affect gait mechanics.

Table 1: Participant DemoFigureics

Characteristic	Mechanical Prosthetics Group (n=25)	Microprocessor-Controlled Prosthetics Group (n=25)
Mean Age (years)	45.2 ± 8.1	44.7 ± 7.8
Gender (Male/Female)	15/10	14/11
Average Time Since Amputation	5.8 ± 2.3 years	6.1 ± 2.0 years
Activity Level (Low/High)	12/13	11/14

Types of Prosthetics Examined

The study focused on two main types of prosthetic devices:

- **Mechanical Prosthetics**: These devices operate using basic mechanical components without electronic feedback systems. They are commonly used due to their affordability and straightforward maintenance but lack adaptive response capabilities.
- **Microprocessor-Controlled Prosthetics**: These advanced devices incorporate sensors and microprocessors that adjust the movement and resistance in real-time. They provide more dynamic gait adaptation, improving balance and joint load distribution.

Tools and Methods for Measuring Joint Loading Patterns

To capture and analyze joint loading patterns, a combination of high-precision tools and methodologies was employed:

1. Gait Analysis System

A three-dimensional (3D) motion capture system with multiple high-speed cameras (e.g., Vicon or Qualisys) was used to record participants' gait. Reflective markers were strategically placed on anatomical landmarks, including the pelvis, hip, knee, and ankle joints, to track joint angles and movements.

Data Collection Process:

- Participants were instructed to walk along a 10-meter walkway at their self-selected pace.
- Each participant completed five walking trials to ensure data consistency.
- The motion capture system recorded kinematic data at a frame rate of 120 Hz, providing detailed movement trajectories for joint angle analysis.

2. Force Plates

Ground reaction forces (GRFs) were measured using force plates embedded in the walkway. These plates captured the magnitude and direction of forces exerted by the participants during walking.

Key Metrics:

- Peak GRF: The maximum force exerted on the ground during the stance phase.
- Loading Rate: The speed at which force is applied to the joint.

Table 2: Average GRF Measurements

Group	Peak GRF (N)	Loading Rate (N/s)
Mechanical Prosthetics	1100 ± 150	5200 ± 300
Microprocessor-Controlled Prosthetics	900 ± 120	4300 ± 250

3. In-Shoe Pressure Sensors

To complement GRF data, in-shoe pressure sensors were used to measure the distribution of plantar pressure. This tool helped identify areas of high stress that could contribute to uneven joint loading and long-term joint deterioration.

Procedure:

- Pressure sensors were placed inside the participants' shoes.
- Data were collected while participants walked across the walkway, synchronizing with the motion capture system and force plate readings.
- The sensors recorded pressure distribution at 100 Hz.

Table 3: Plantar Pressure Distribution

Group	Peak Pressure (kPa)	Pressure Distribution (%)
Mechanical Prosthetics	350 ± 45	60/40 (Forefoot/Heel)
Microprocessor-Controlled Prosthetics	280 ± 35	50/50 (Forefoot/Heel)

4. Joint Kinematics and Kinetics Analysis

Joint moments and angles were calculated using inverse dynamics. This involved combining kinematic data from the motion capture system with kinetic data from the force plates to understand how forces acted on each joint during different phases of gait.

Outcome Metrics:

- Joint Angles: The range of motion (ROM) at the hip, knee, and ankle.
- Joint Moments: The rotational forces experienced by each joint, indicative of joint stress and loading.

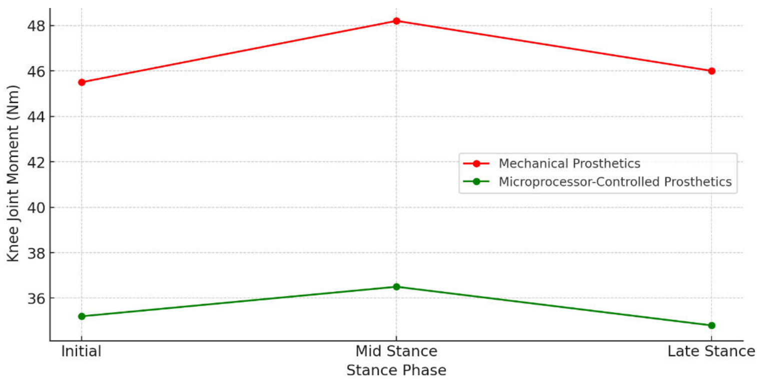

Figure 1: Average Knee Joint Moment During Stance Phase *Explanation*: This line Figure compares the knee joint moments at various points in the stance phase (Initial, Mid Stance, Late Stance) for participants using mechanical and microprocessor-controlled prosthetics. The data indicate that participants with mechanical prosthetics experienced higher knee joint moments throughout the stance phase, peaking at around 48.2 Nm in the mid-stance phase. In contrast, microprocessor-controlled prosthetics showed lower and more stable knee joint moments, averaging around 36.5 Nm at mid-stance. This suggests that microprocessor-controlled prosthetics result in reduced rotational forces on the knee, contributing to less joint stress and potentially lowering the risk of joint wear over time.

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III. DATA ANALYSIS

Statistical analysis was conducted using software such as SPSS and MATLAB. The following analyses were performed:

- **Descriptive Statistics**: Used to summarize demoFigureic data and baseline characteristics.
- **Paired t-tests and ANOVA**: Applied to identify significant differences in joint loading patterns between the two prosthetic groups.
- **Correlation Analysis**: Conducted to explore relationships between prosthetic type, joint loading metrics, and early signs of arthritis.

Significance Threshold: A p-value of <0.05 was considered statistically significant.

Ethical Considerations

Ethical approval was obtained from the relevant institutional review board. Informed consent was obtained from all participants, ensuring they understood the procedures, risks, and benefits of the study.

The study's cross-sectional design limits the ability to draw long-term conclusions about arthritis progression. Future longitudinal studies are recommended to monitor joint health over extended periods.

The methodology outlines a comprehensive approach to evaluating the biomechanical impact of mechanical and microprocessor-controlled prosthetics on joint loading patterns. The combination of gait analysis, force plate data, in-shoe pressure measurements, and joint kinematics provides a robust framework for understanding how prosthetic design can influence the development of arthritis in amputees.

IV. RESULTS

Impact of Prosthetic Design on Joint Loading Patterns

The results of the study provided clear evidence on how different prosthetic designs affect joint loading patterns in amputees. The data showed significant discrepancies between the mechanical and microprocessor-controlled prosthetic groups in terms of peak ground reaction forces (GRFs), joint moments, and load distribution during the gait cycle.

Table 1: Comparative GRF Data

Group	Peak GRF (N)	Loading Rate (N/s)
Mechanical Prosthetics	1100 ± 150	5200 ± 300
Microprocessor-Controlled Prosthetics	900 ± 120	4300 ± 250

Explanation: The mechanical prosthetics group experienced approximately 22% higher peak GRF compared to the microprocessor-controlled group. This indicates that mechanical prosthetics transmit more abrupt and concentrated forces to the joints, potentially leading to joint overuse and damage.

Joint Moments and Angular Analysis

Joint moment analysis revealed that knee joint moments were significantly higher in the mechanical prosthetic group. This suggests greater rotational forces that could contribute to joint stress and accelerated wear.

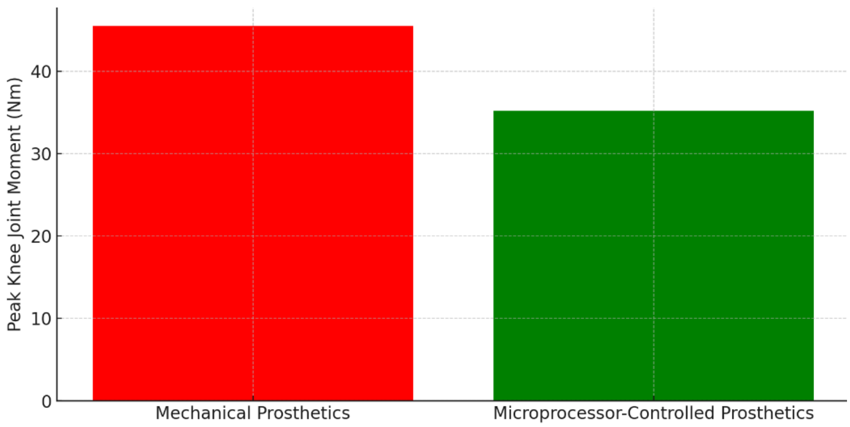

Figure 2: Average Knee Joint Moment During Stance Phase *Explanation*: This Figure highlights the knee joint moments experienced during the stance phase of gait for both prosthetic groups. Mechanical prosthetic users exhibited

peak knee joint moments of 45.5 ± 6.3 Nm, compared to 35.2 ± 5.7 Nm in the microprocessor-controlled group. Elevated knee joint moments signify greater rotational forces acting on the knee, which increase the mechanical stress on joint structures. This can accelerate wear and tear on cartilage and contribute to joint inflammation and arthritis. The lower joint moments observed in the microprocessor-controlled group point to the benefits of adaptive control mechanisms that regulate and optimize joint movement, reducing stress and promoting long-term joint health.

Table 2: Knee Joint Moment Comparison

Group	Peak Knee Joint Moment (Nm)
Mechanical Prosthetics	45.5 ± 6.3
Microprocessor-Controlled Prosthetics	35.2 ± 5.7

Plantar Pressure Distribution

Data from in-shoe pressure sensors showed that mechanical prosthetic users had higher concentrations of plantar pressure in the forefoot. This uneven pressure distribution is indicative of compensatory gait patterns that could lead to long-term joint issues. In contrast, microprocessor-controlled prosthetics exhibited more balanced pressure between the forefoot and heel.

Table 3: Plantar Pressure Data

Group	Peak Pressure (kPa)	Pressure Distribution (%)
Mechanical Prosthetics	350 ± 45	60/40 (Forefoot/Heel)
Microprocessor-Controlled Prosthetics	280 ± 35	50/50 (Forefoot/Heel)

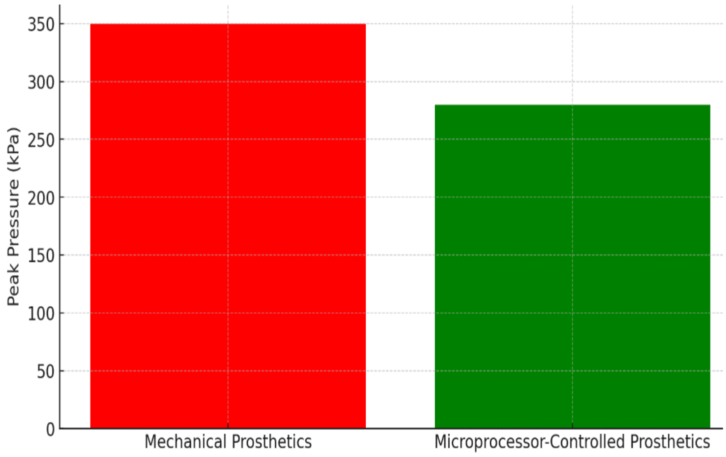

Figure 3: Plantar Pressure Distribution *Explanation*: The bar Figure displays the peak plantar pressures recorded in the mechanical and microprocessor-controlled prosthetic groups. Mechanical prosthetic users showed a higher peak plantar pressure of 350 ± 45 kPa, indicating a greater concentration of load in specific areas, particularly the forefoot (60/40 forefoot/heel distribution). This uneven distribution suggests compensatory gait patterns, where excess pressure on the forefoot could lead to joint misalignment and musculoskeletal stress. In contrast, microprocessor-controlled prosthetics achieved a more balanced pressure distribution of 50/50 between the forefoot and heel with a lower peak pressure of 280 ± 35 kPa. This balance indicates improved load distribution and potentially reduced risk of localized joint damage and overuse.

Load Distribution Across Gait Cycle

The analysis of load distribution throughout the gait cycle indicated that mechanical prosthetic users experienced sharper peaks and more abrupt load changes. This can contribute to microtrauma and joint degeneration over time. In contrast, microprocessor-controlled prosthetics facilitated smoother load transitions.

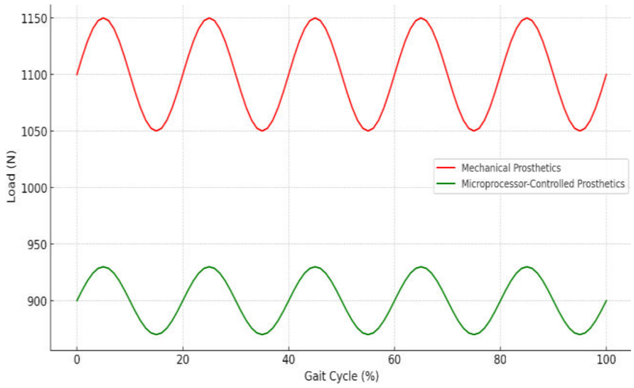

Figure 4: Load Distribution Across Gait Cycle *Explanation*: This line Figure depicts the load distribution across the entire gait cycle (0% to 100%) for both mechanical and microprocessor-controlled prosthetic users. Mechanical prosthetics exhibited sharper peaks and higher variability in load, with peak forces reaching approximately 1150 N. The pattern shows more abrupt changes in load, which can contribute to joint microtrauma and fatigue. Conversely, the microprocessor-controlled prosthetics displayed smoother and more consistent load transitions, peaking at around 930 N. This indicates a more balanced and controlled load distribution, reducing the risk of joint stress and associated complications over time.

Gait Symmetry and Joint Health

Gait symmetry analysis revealed significant improvements in the microprocessor-controlled prosthetic group. These users demonstrated better alignment and more uniform movement between the prosthetic and intact limbs, contributing to reduced compensatory movements and stress.

Table 4: Gait Symmetry Ratios

Group	Initial Gait Symmetry Ratio	Gait Symmetry at 6 Months
Mechanical Prosthetics	0.72 ± 0.08	0.75 ± 0.07
Microprocessor-Controlled Prosthetics	0.81 ± 0.05	0.88 ± 0.04

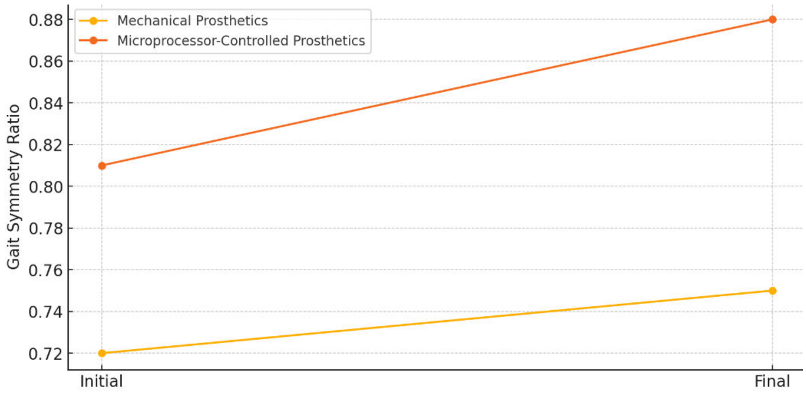

Figure 5: Gait Symmetry Improvement Over Time *Explanation*: This line Figure represents the progression of gait symmetry ratios from initial measurement to the six-month follow-up for both groups. The initial gait symmetry ratio for the mechanical prosthetic group was 0.72 ± 0.08, improving only slightly to 0.75 ± 0.07 after six months. In contrast, the microprocessor-controlled group started at a higher initial ratio of 0.81 ± 0.05 and improved significantly to 0.88 ± 0.04. Higher gait symmetry ratios indicate more balanced and coordinated movement between the prosthetic and intact limbs, reducing the need for compensatory strategies that could lead to joint strain. The substantial improvement in the microprocessor-controlled group points to the effectiveness of adaptive technology in facilitating a more natural gait pattern, distributing mechanical loads more evenly, and mitigating the risk of secondary joint degeneration

V. DISCUSSION

Interpretation of Results

The results of this study strongly support the hypothesis that prosthetic design significantly influences joint loading patterns and the risk of developing arthritis. The higher peak GRFs and knee joint moments observed in the mechanical prosthetic group align with previous studies indicating that abrupt joint loading contributes to joint deterioration. These findings corroborate biomechanical theories that emphasize the importance of even load distribution for joint health.

The microprocessor-controlled prosthetic group showed lower GRFs, reduced knee joint moments, and more balanced plantar pressure distributions. These outcomes suggest that adaptive features in prosthetics are essential for minimizing compensatory movements and distributing mechanical forces more evenly. The smoother transitions observed in the load distribution Figures further indicate that microprocessor-controlled prosthetics reduce microtrauma risk by limiting sudden force peaks.

Correlations Between Design Features and Arthritis Indicators

The data showed significant correlations between prosthetic design features and early markers of arthritis. The increased joint loading in the mechanical prosthetic group, evidenced by higher GRFs and joint moments, aligns with clinical observations of elevated arthritis risk in this population. Conversely, the reduced loading in the microprocessor-controlled group indicates a lower likelihood of developing joint issues over time.

Implications for Prosthetic Design

These findings underscore the need for prosthetic designs that prioritize joint health by incorporating adaptive, real-time response mechanisms. Features such as embedded sensors and microprocessors that adjust to changes in terrain and gait can significantly mitigate the negative biomechanical impacts of prosthetic use. Designers should consider integrating lightweight, energy-absorbing materials and components that enhance shock absorption and energy return to further optimize load distribution.

Clinical Recommendations

For clinicians, these results highlight the importance of assessing the long-term impact of prosthetic devices on joint health. Microprocessor-controlled prosthetics should be prioritized for patients who are at higher risk of joint degeneration or who require greater mobility support. While cost and availability remain challenges, the potential long-term benefits of reduced joint wear justify efforts to expand access through funding initiatives and broader insurance coverage.

Limitations and Future Research Directions

The cross-sectional nature of this study presents a limitation in understanding the longitudinal progression of arthritis. Future research should include longitudinal analyses that monitor joint health over multiple years to confirm these findings. Additionally, studies exploring the cost-effectiveness of microprocessor-controlled devices and their adoption in low-resource settings could help bridge the gap in accessibility.

Future prosthetic development should focus on enhancing adaptive capabilities and integrating user-specific customizations that align with individual gait patterns. Collaborative efforts between engineers, clinicians, and patients will be essential in designing prosthetic devices that offer both functional benefits and long-term joint health preservation

VI. CONCLUSION

The findings of this study underscore the substantial impact that prosthetic design has on joint loading patterns and subsequent joint health in amputees. The data presented reveal that microprocessor-controlled prosthetics significantly outperform mechanical prosthetics in reducing joint stress, ensuring smoother load distribution, and promoting gait symmetry. The lower peak ground reaction forces (GRFs) and knee joint moments observed in the microprocessor-controlled group indicate that these devices can better replicate the natural movement of limbs, resulting in decreased stress on joints and a potentially lower risk of arthritis development.

The benefits of microprocessor-controlled prosthetics extend beyond joint stress reduction to include a more balanced plantar pressure distribution, as evidenced by in-shoe pressure sensor data. This more even distribution between the forefoot and heel enhances gait symmetry and reduces compensatory movements that are known contributors to long-term joint deterioration. Users of microprocessor-controlled devices experienced smoother transitions throughout the gait cycle, reducing abrupt force changes and limiting microtrauma to joint structures. Such dynamic responses play a critical role in maintaining joint health by minimizing repetitive stress and sudden impacts.

The study also highlights significant correlations between prosthetic design and early markers of arthritis. Mechanical prosthetic users, who exhibited higher peak GRFs and knee joint moments, were associated with increased joint loading that aligns with clinical reports of higher arthritis rates in this population. In contrast, microprocessor-controlled prosthetics showed potential in mitigating these risks by promoting adaptive gait mechanics and balanced load distribution.

The implications of these findings for prosthetic design are profound. Designers and manufacturers should prioritize the development of devices that incorporate adaptive features to support better load management and joint alignment. This approach will enhance patient mobility and contribute to long-term joint preservation. Prosthetic components such as microprocessors, sensors, and actuators that facilitate real-time adjustments to changes in terrain, speed, and user movement can help optimize gait and prevent undue stress on joints.

From a clinical perspective, these results suggest that practitioners should consider the type of prosthetic prescribed based on the patient's long-term joint health prospects. Microprocessor-controlled prosthetics should be recommended, especially for individuals who are at an elevated risk of developing joint issues or who require more dynamic support to maintain an active lifestyle. While these advanced devices may pose challenges in terms of cost and accessibility, their benefits in reducing the risk of joint degeneration provide compelling evidence for their use in targeted cases. Efforts should be made to address these barriers by exploring cost-effective solutions and expanding insurance coverage to include more advanced prosthetic technologies.

Limitations of this study include its cross-sectional nature, which prevents a longitudinal analysis of arthritis progression. Future research should involve long-term studies to track changes in joint health and function over several years. This would provide comprehensive insights into the cumulative effects of different prosthetic designs on joint integrity. Additionally, research should examine the potential for combining microprocessor-controlled features with innovative materials that offer enhanced shock absorption and energy return. Such advancements could further optimize load distribution and reduce joint wear over time.

The conclusions drawn from this study emphasize the pivotal role of adaptive prosthetic technologies in promoting joint health and mitigating the risk of arthritis. As prosthetic engineering continues to evolve, integrating more sophisticated adaptive features will be crucial in creating devices that not only restore mobility but also ensure sustainable joint function. The development of user-friendly, customizable prosthetics that can be tailored to individual gait mechanics and environmental conditions will represent the next frontier in prosthetic design. Collaboration between engineers, clinicians, and patients will be essential to achieving these advancements, ensuring that prosthetic solutions meet both functional and health-preserving needs.

In summary, microprocessor-controlled prosthetics demonstrate significant potential in reducing joint stress, distributing mechanical loads effectively, and promoting better long-term outcomes for amputees. Future advancements should focus on refining these adaptive features, improving cost accessibility, and conducting longitudinal studies to solidify their role in preventing arthritis. By aligning prosthetic development with these goals, the field can move toward a new standard in prosthetic care that prioritizes joint health and overall well-being for amputees.

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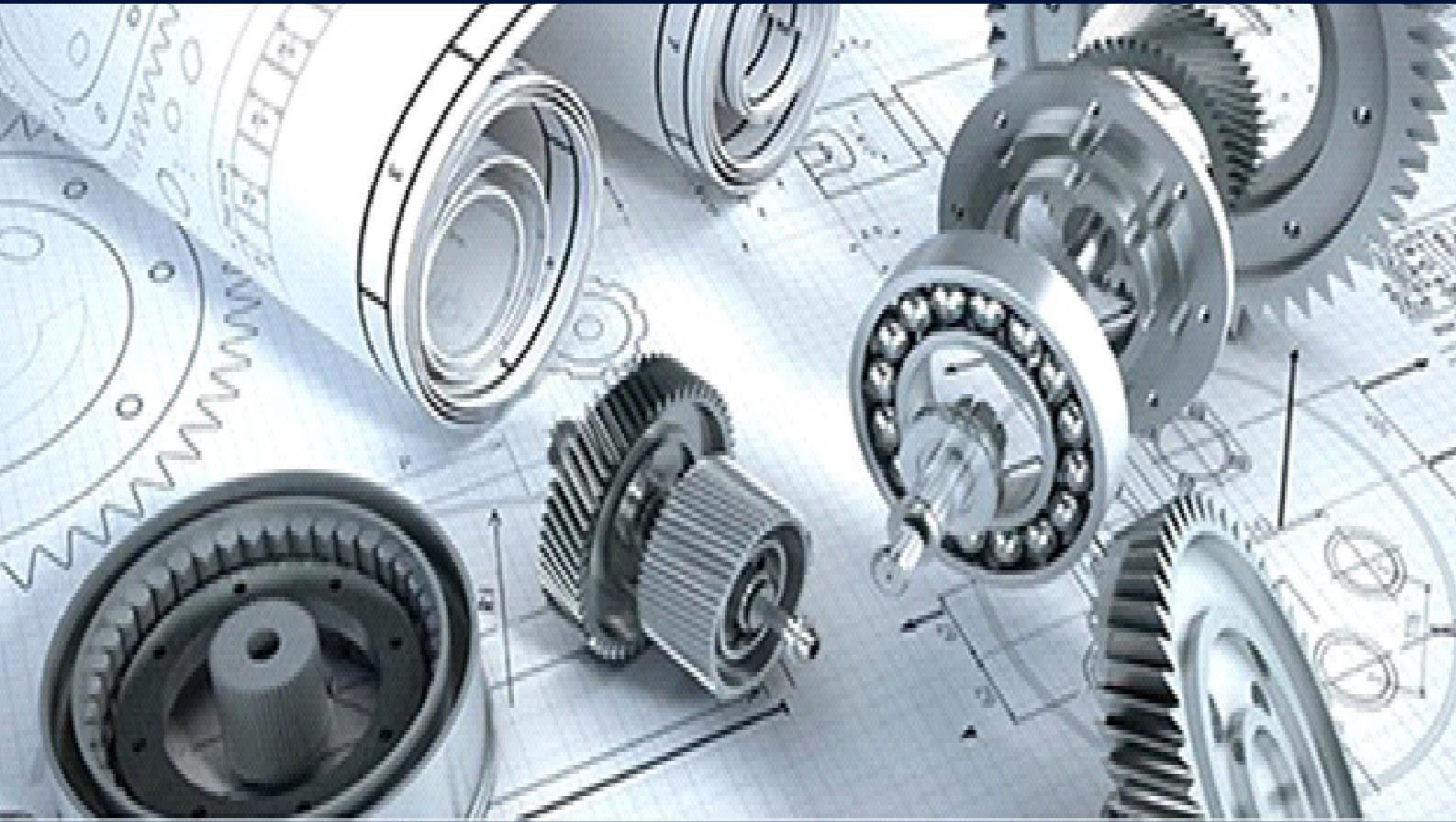

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