

Impact of Total Knee Arthroplasty on Energy Expenditure Using Physiological Cost Index a Prospective Observational Study

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Abstract—Knee osteoarthritis is a progressive degenerative joint disorder that causes pain, stiffness, reduced mobility, and impaired functional performance. These changes alter gait patterns and increase the energy expenditure required for walking. Total Knee Arthroplasty (TKA) is considered the gold standard treatment for end-stage knee osteoarthritis and aims to restore joint function and improve mobility. This prospective observational study evaluated the impact of TKA on energy expenditure using the Physiological Cost Index (PCI) and assessed functional outcomes using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Thirty participants aged 50–80 years diagnosed with knee osteoarthritis were assessed before surgery and six weeks after surgery. The results showed a significant reduction in PCI and WOMAC scores postoperatively ($p < 0.05$), indicating improved walking efficiency and functional performance. The findings suggest that Total Knee Arthroplasty significantly enhances mobility and reduces the physiological effort required for walking. The Physiological Cost Index can be used as a simple, reliable, and clinically feasible tool for evaluating rehabilitation outcomes in patients undergoing Total Knee Arthroplasty.

Index Terms—Energy Expenditure, Gait Analysis, Knee Osteoarthritis, Physiological Cost Index, Total Knee Arthroplasty, WOMAC Index.

I. INTRODUCTION

Knee osteoarthritis (KOA) is a chronic degenerative joint disease that primarily affects older adults and is one of the leading causes of disability worldwide. The condition is characterized by progressive deterioration

of articular cartilage, osteophyte formation, joint space narrowing, and inflammation of the synovial membrane. These pathological changes result in pain, stiffness, reduced range of motion, and impaired physical function.

As the disease progresses, patients often develop altered gait patterns such as reduced walking speed, shorter stride length, and increased double-support time. These compensatory mechanisms increase the energy required for walking and reduce overall mobility and quality of life. Increased energy expenditure during ambulation can lead to fatigue and decreased participation in daily activities.

Total Knee Arthroplasty (TKA) is considered the gold standard surgical intervention for end-stage knee osteoarthritis. The procedure aims to relieve pain, correct joint deformities, restore alignment, and improve functional mobility. Although improvements in pain and function following TKA are well documented, assessment of energy expenditure provides additional information regarding walking efficiency and rehabilitation outcomes.

The Physiological Cost Index (PCI) is a simple, non-invasive, and clinically practical method used to evaluate the energy cost of walking. It is calculated using heart rate response during walking and walking speed. Therefore, this study was conducted to evaluate the impact of Total Knee Arthroplasty on energy expenditure using PCI and to assess functional improvement using the WOMAC Index.

II. OBJECTIVES OF THE STUDY

A. Primary Objective

- To evaluate the effect of Total Knee Arthroplasty on energy expenditure using the Physiological Cost Index.

B. Secondary Objectives

- To assess functional improvement using the WOMAC Index.
- To compare preoperative and postoperative walking efficiency.
- To determine the clinical usefulness of PCI in rehabilitation assessment.

III. METHODOLOGY

A. Study Design

A prospective observational study was conducted to evaluate changes in energy expenditure and functional outcomes following Total Knee Arthroplasty.

B. Study Population

Thirty participants diagnosed with knee osteoarthritis and scheduled for unilateral Total Knee Arthroplasty were included in the study.

C. Inclusion Criteria

- Age between 50 and 80 years.
- Diagnosed with knee osteoarthritis.
- Scheduled for unilateral Total Knee Arthroplasty.
- Willing to participate in the study.

D. Exclusion Criteria

- Neurological disorders affecting gait.
- Cardiopulmonary instability.
- Previous lower limb surgeries.
- Severe cognitive impairment.

E. Data Collection Procedure

Baseline assessment was performed before surgery. Follow-up assessment was conducted six weeks after surgery. Resting heart rate and walking heart rate were measured to calculate the Physiological Cost Index. Functional ability was assessed using the WOMAC Index.

F. Statistical Analysis

The collected data were analysed using paired t-test. Statistical significance was considered at $p < 0.05$.

IV. RESULTS

The results demonstrated a significant reduction in Physiological Cost Index following Total Knee Arthroplasty, indicating improved walking efficiency. WOMAC scores also showed substantial improvement, reflecting enhanced functional performance and reduced disability.

V. DISCUSSION

The findings of this study suggest that Total Knee Arthroplasty significantly improves energy expenditure and functional outcomes in individuals with knee osteoarthritis. The reduction in PCI indicates improved cardiovascular efficiency during walking. Pain relief, restoration of joint alignment, and normalization of gait patterns are likely responsible for these improvements.

VI. CONCLUSION

Total Knee Arthroplasty significantly reduces energy expenditure and improves functional performance in patients with knee osteoarthritis. The Physiological Cost Index is a reliable and clinically useful tool for assessing walking efficiency and monitoring rehabilitation outcomes following surgery.