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Total Knee Arthroplasty in a Patient Diagnosed with Ochronosis: Case Report

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Abstract

Ochronosis is a rare autosomal recessive disorder caused by a deficiency in homogentisic acid oxidase, leading to significant orthopedic challenges, particularly in knee joints. This progressive pathology often necessitates arthroplasty, which can be complicated by the disease's severe joint degeneration. We report the case of a 72-year-old female who underwent successful total knee arthroplasty on both knees, with outcomes validated through three-dimensional kinematic assessments, medical records, and patient satisfaction surveys.

Keywords: Knee Arthroplasty, Biomechanics, Ochronosis, Rehabilitation

1. Introduction

Ochronosis is a rare metabolic disorder characterized by the accumulation of homogentisic acid and its derivatives in connective tissues, notably in cartilage and skin [1]. This condition poses a unique challenge in orthopedic surgery, particularly in the context of total knee arthroplasty (TKA) [2,1]. While TKA is a well-established procedure for alleviating pain and improving functionality in patients with advanced knee osteoarthritis[3], its efficacy and outcomes in individuals with ochronosis are not extensively studied [2].

The impact of ochronosis on joint health is substantial, necessitating distinctive considerations for surgical intervention [1, 4]. A thorough understanding of its pathophysiology and implications for TKA outcomes is essential [1, 4]. Despite the rarity of this condition, its prevalence has garnered increasing attention due to advancements in diagnostic techniques and the growing recognition of its musculoskeletal manifestations [1, 4].

Functionality in daily activities and locomotion are critical factors in assessing the success of TKA in patients with ochronosis [5, 6]. The extent to which surgical intervention can restore mobility, alleviate pain, and enhance overall quality of life in this population warrants in-depth investigation [5, 6].

This study aims to report a case of an elderly patient diagnosed with ochronosis who underwent total knee arthroplasty on both the right and left knees. After the surgical treatment and postoperative period, she was able to restore knee mobility and functional capacity for walking.

2. Case Report

This case report details the clinical journey of a 69-year-old female diagnosed with bilateral knee osteoarthritis, necessitating staged total knee arthroplasty (TKA). The peculiar discovery of ochronosis during the initial surgery and the comprehensive rehabilitation strategies that followed highlight the complexities and tailored approaches required in managing such orthopedic cases. This report aims to elucidate the surgical outcomes, rehabilitation processes, and gait analyses involved in her treatment.

Case Description

A 69-year-old female was diagnosed with bilateral knee osteoarthritis, prompting the recommendation for staged surgical interventions. The initial surgery on the left knee was followed by a planned procedure on the right knee to allow sufficient

recovery time for each joint. The first Total Knee Arthroplasty (TKA), performed when the patient was 69, unexpectedly revealed the presence of ochronosis, characterized by dark discoloration of the joint tissue, as illustrated in Fig 1. The postoperative rehabilitation was successful, achieving full range of motion in the operated knee without any reports of pain or movement impairments. Hydrogymnastics was integrated into the treatment plan to strengthen the knee.

Fig 1: Images of the left knee joint during total knee arthroplasty

Further examinations, including bone densitometry, X-rays, and magnetic resonance imaging of both knees, underscored the necessity for surgical intervention in the right knee, given the successful recovery of the left knee. The second surgery was conducted when the patient was 71 years old. Postoperative rehabilitation again proved successful, restoring the range of motion in the right knee joint, with no complaints of pain or movement difficulties. In this instance, weight training was prescribed as an additional muscle strengthening modality. At the conclusion of the treatment, bilateral recovery of the range of motion, ranging from 0 to 130 degrees, was observed.

Rehabilitation Treatment

Rehabilitation following total knee arthroplasty is a phased process, extending from the immediate postoperative period to long-term maintenance. Initially, pain control is prioritized through multimodal strategies, including preoperative medications and epidural analgesia, complemented by gentle mobility and muscle strengthening exercises [6]. During intermediate rehabilitation (weeks 2-6), the focus shifts to enhancing mobility and muscle strength, incorporating progressive weight-bearing activities and targeted exercises for the quadriceps and hamstrings[7]. Advanced rehabilitation (weeks 6-12) emphasizes functional activities, improving return to low-impact activities, gait quality, and endurance [8]. The long-term maintenance phase (beyond 12 weeks) focuses on integrating these activities into daily life, promoting regular physical activity to maintain joint health and enhance physical conditioning [9].

Gait Analysis

The patient's gait pattern was assessed using the Noraxon (USA) Research Pro Measurement Unit, an inertial sensor system, which evaluated the angular position (range of motion) of the ankle, knee, and hip joints, as well as gait speed, step length, and stride width. Two assessments were conducted post-TKA: the first one year after surgery, and the second three years post-procedure. Matlab software and artificial intelligence were utilized to compare cognitive behavior between the two assessments and with data from the literature. The results are presented in Table 1.

Table 1: Gait Assessment Results

Range of Motion		
	Assessment 1	Assessment 2
Right Hip Joint (Degrees)	13.31	19.08
Left Hip Joint (Degrees)	13.92	26.86
Right Knee Joint (Degrees)	11.72	26.08
Left Knee Joint (Degrees)	7.44	26.34
Right Ankle Joint (Degrees)	0.81	1.83
Left Ankle Joint (Degrees)	0.79	1.52
Space-Time Variables		
	Assessment 1	Assessment 2
Step Length (cm)	41.18	44.51
Stride Width (cm)	4.98	6.23
Gait Speed (steps/min)	121.61	135.48

Legend: The data are presented as mean values. The terms 'Left' and 'Right' are used to denote that a bilateral assessment was performed. Assessment 1: conducted 1 year after the total knee arthroplasty (TKA) procedure; Assessment 2: conducted 3 years after the total knee arthroplasty (TKA) procedure.

The data demonstrate substantial increases in the range of motion (ROM) for all measured joints between the first and second assessments. The right hip joint's ROM improved from 13.31 degrees to 19.08 degrees, while the left hip joint saw a more dramatic increase from 13.92 degrees to 26.86 degrees. Similarly, the ROM in the knee joints increased significantly, with the right knee joint improving from 11.72 degrees to 26.08 degrees and the left from 7.44 degrees to 26.34 degrees. These enhancements indicate successful surgical outcomes and effective postoperative rehabilitation, enhancing joint flexibility and potentially reducing the risk of post-surgical complications.

Changes in the ankle joints, although less pronounced than in the hip and knee joints, showed noticeable improvement. The right ankle's ROM increased from 0.81 degrees to 1.83 degrees, and the left ankle from 0.79 degrees to 1.52 degrees. These modest changes are crucial for maintaining balanced and stable gait patterns.

There were also recorded improvements in gait spatial-temporal variables, indicative of more confident and efficient walking patterns. The step length increased from 41.18 cm to 44.51 cm, and the stride width from 4.98 cm to 6.23 cm. Additionally, gait speed improved from 121.61 steps per minute to 135.48 steps per minute. These improvements suggest better overall muscle strength and coordination, which are vital for reducing fall risks and enhancing quality of life.

3. Discussion

In this case study of a patient diagnosed with ochronosis, significant improvements were observed in functional and gait recovery following total knee arthroplasty (TKA). The postoperative outcomes, particularly the enhancement in joint mobility and gait dynamics, underscore the efficacy of TKA in addressing the debilitating effects of ochronosis on the knee joints.

The data from Table 1 highlights notable advancements in the patient's joint range of motion and gait efficiency over the course of three years post-TKA. Specifically, the evolution in joint mobility, as demonstrated by the increase in the angular movements of the hip and knee joints, reflects significant functional recovery. The right hip joint's range of motion improved from 13.31 degrees initially to 19.08

degrees, while the left knee joint's range increased more substantially from 7.44 degrees to 26.34 degrees. These improvements are indicative of a successful surgical outcome, facilitating enhanced joint flexibility and contributing to the patient's overall mobility.

The improvements in gait parameters further validate the positive impact of TKA. The increase in step length and stride width, along with a faster gait speed from 121.61 steps per minute to 135.48 steps per minute, not only signify better physical capability but also a more stable and efficient walking pattern. These improvements align with the findings of recent studies, such as the 2022 research exploring the impact of weight changes on post-surgical recovery, which confirmed that effective weight management can significantly enhance joint function and gait post-TKA [12, 13, 14].

Moreover, these findings are consistent with existing literature, including a 2018 study that documented a 10-20% improvement in quadriceps strength and gait dynamics following TKA [12]. Such evidence underscores the role of TKA in enhancing musculoskeletal function, particularly in patients with rare conditions like ochronosis where joint degeneration can severely impair quality of life.

This case exemplifies the transformative potential of TKA in restoring function and mobility in patients with challenging conditions. It emphasizes the importance of targeted surgical interventions coupled with effective postoperative management to achieve optimal outcomes. The documented improvements not only provide a benchmark for assessing the success of TKA in similar clinical scenarios but also contribute to the growing body of evidence supporting the procedure's versatility and effectiveness in treating complex joint disorders.

4. Conclusion

The case of the patient diagnosed with ochronosis who underwent total knee arthroplasty (TKA) on both knees provides compelling evidence of the effectiveness of this surgical intervention in addressing the challenges associated with joint degeneration due to this rare condition. The follow-up assessments conducted at one and three years post-TKA illustrate substantial improvements in both joint range of motion and gait efficiency.

Significantly, the enhancements in the average angles of the right hip joint and the left knee joint, which increased considerably between the two assessments, indicate improved joint flexibility and mobility. These results are crucial, as they directly contribute to the patient's ability to perform daily activities with greater ease and less pain.

Additionally, the improvements in gait-related measurements—such as increases in average step length, average stride width, and gait speed—highlight a marked enhancement in the patient’s overall gait dynamics. These changes not only demonstrate the physical recovery facilitated by TKA but also suggest an increase in the patient’s confidence and independence in mobility.

Overall, this case reinforces the role of TKA as a transformative approach for patients suffering from ochronosis, by significantly improving functional outcomes and quality of life. The documented recovery trajectory in this patient provides valuable insights and benchmarks for the treatment of similar cases, supporting TKA as a robust option in the orthopedic management of ochronosis.

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