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(CASE REPORT)

# Utility of 3D-Gait Analysis for planning Rehabilitation Program for an 8-Year-Old Child Diagnosed with KBG Syndrome: A Case Report

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## Abstract

KBG syndrome (ICD-10: Q87.8) is a rare genetic condition resulting from mutations in the ANKRD11 gene, characterized by distinctive facial features, macrodontia, skeletal anomalies, and developmental delays. An 8-year-old male child with KBG syndrome presented with an abnormal gait pattern. The child was enrolled for gait analysis using the Qualysis motion capture system for detailed objective gait evaluation, like spatiotemporal and kinematic parameters . This report demonstrates the utility of detailed preoperative gait analysis for informed clinical decision-making, coordinated rehabilitation planning, and the development of structured prehabilitation strategies.

**Keywords:** KBG syndrome; Gait analysis; Physiotherapy; Pediatric neurorehabilitation

## 1. Introduction

KBG syndrome (ICD-10: Q87.8) is a rare genetic condition resulting from mutations in the ANKRD11 gene, characterized by distinctive facial features, macrodontia, skeletal anomalies, and developmental delays [(1)]. Motor impairments, including delayed milestones and coordination deficits, are prevalent but under-documented quantitatively. Also, quantitative assessments of gait in these individuals are limited. One way to characterize the gait pattern of individuals with pathological conditions is through a three-dimensional (3D) biomechanical analysis, where a motion capture system composed of high-speed video cameras and force platforms is typically employed [(2)]. Three-dimensional (3D) motion capture systems provide accurate and detailed measurements of gait abnormalities, crucial for planning comprehensive care with multidisciplinary rehabilitation teams involving orthopedic surgeons, physiotherapists, etc.[(3)]. This report demonstrates the utility of detailed preoperative gait analysis for informed clinical decision-making, coordinated rehabilitation planning, and structured prehabilitation strategies. This case report presents a quantitative gait analysis of an 8-year-old male with a confirmed diagnosis of KBG syndrome.

## 2. Case Presentation

The child is an 8-year-old male diagnosed with KBG syndrome. He was born at 8 months of pregnancy through Lower Segment Cesarean Section, with a birth weight of 1.5kg. He cried immediately after birth, suggesting an uncomplicated

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neonatal transition. No history of stay in the Neonatal Intensive Care Unit. History of delayed milestones, started walking independently at 7 years of age with therapeutic intervention.

The primary concerns parents included an abnormal way of walking with frequent falls leading to fractures and malunions.

### 2.1. Clinical findings

A thorough clinical examination of posture and range of motion was performed. On observational gait analysis, the child walks with, out-toe toeing gait pattern. His foot progression angle on the right side is 41° and on the left side is 35.5°[4]. He has difficulty climbing stairs and needs one hand support to perform the same. An objective gait assessment using the Qualysis motion capture system was planned.

## 3. Methodology

An 8-year-old boy diagnosed with KBG syndrome underwent clinical evaluation and preoperative 3D gait analysis using the Qualisys motion capture system. The marker set used was Istituto Ortopedico Rizzoli (IOR) lower body (fig 1a and fig 1b)[5]. Walking barefoot at a comfortable pace along a 4.2-meter walkway, the child completed six consistent trials, which were averaged to determine spatiotemporal and kinematic parameters.

## 4. Results

Gait analysis revealed significant deviations from age-matched norms (Table 1). Notable pelvic asymmetry in the transverse plane involved differences in external and internal rotations. Marked reductions in hip extension and ankle plantarflexion, particularly on the left, significantly impaired propulsion. Persistent bilateral knee abduction and transverse tibial rotation were observed, along with compensatory foot biomechanics such as increased pitch and pronounced out-toeing (Graph 1). Temporospatial data highlighted shorter step lengths, slower walking speeds, higher cadence, and prolonged stance phases, indicative of compromised motor control. A high Gait Profile Score (GPS > 20°) on the right side confirmed clinically significant gait deviations (Table 2) [6].

## 5. Discussion

This case underscores the critical role of preoperative 3D gait analysis in identifying specific motor abnormalities characteristic of KBG syndrome [7]. The precise identification of compensatory movements, driven by femoral malalignment and resultant pelvic asymmetry, knee valgus, and altered foot biomechanics, informs targeted surgical interventions [8][9]. Furthermore, detailed gait data aids physiotherapists in developing individualised therapeutic approaches focused on correcting biomechanical dysfunctions and improving functional mobility [10]. Prehabilitation strategies, guided by gait analysis findings, include targeted strengthening of hip extensors, plantar flexors, and core musculature; balance and coordination training; gait retraining; and neuromuscular re-education to enhance movement patterns and functional performance preoperatively. Integration of gait analysis results into the broader multidisciplinary rehabilitation strategy ensures cohesive and tailored patient care, facilitating more effective treatment outcomes and providing a baseline for postoperative rehabilitation progress monitoring.

## 6. Conclusion

Preoperative 3D gait analysis identified key gait abnormalities in a child with KBG syndrome, guiding precise surgical planning and targeted physiotherapy. It enabled a focused prehabilitation strategy and informed coordinated multidisciplinary care. Integrating gait analysis into routine assessment can significantly improve functional outcomes in complex pediatric cases.

## Compliance with ethical standards

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*Disclosure of conflict of interest*

The authors have no conflicts of interest.

*Statement of ethical approval*

The present result work is ethically approved.

*Statement of informed consent*

Written informed consent was obtained from parents.

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