AUCTORES
Globalize your Research

Journal of General Medicine and Clinical Practice
Adrian González Méndez *

Open Access

Review Article

Effectiveness of Biomechanical Software for Gait Analysis in Rehabilitation Services

Adrian González Méndez [1]*, Dayma Margarita Clove Basulto [2], Lázaro Rogelio Morell León [3], Deibis Buchaca Machado [4], Juan Carlos Mirabal Requena [5], Adolfo Cruz Carrera [6]

[1]Graduate in Health Technology, Physical Therapy and Rehabilitation profile. Assistant Professor. Associate Researcher. Sancti Spiritus University of Medical Sciences, Cuba.

[2]Industrial Engineer. MSc. in Address. Subdelegation of Science and Technology of Sancti Spiritus, Cuba.

[3]Doctor of Medicine. Specialist Second Grade Hygiene and Epidemiology. MSc. in Higher Medical Education. Sancti Spiritus University of Medical Sciences, Cuba.

[4]Bachelor of Science in Agriculture. Dr. C Pedagogical. MSc. in Educational Attention to Diversity. Jose Marti Perez University of Sancti Spiritus, Cuba. Email:

[5]Doctor of Medicine. Second Degree Specialist in Comprehensive General Medicine and First Degree in Physical Medicine and Rehabilitation. MSc. Bioenergetic Medicine. Assistant Professor. Assistant Researcher. Sancti Spiritus Provincial Health Directorate, Cuba.

***Corresponding Author:** Adrian González Méndez, Department of Postgraduate and Research, University of Medical Sciences of Sancti Spiritus, Cuba.

Received date: March 08, 2024; **Accepted date:** March 05, 2024; **Published date:** March 26, 2024

Citation: Adrian González Méndez, Dayma Margarita Clove Basulto, Lázaro Rogelio Morell León, Deibis Buchaca Machado, Juan Carlos Mirabal Requena, et all., (2024), Effectiveness of Biomechanical Software for Gait Analysis in Rehabilitation Services, *J. General Medicine and Clinical Practice*, 7(5); **DOI:**10.31579/2639-4162/159

Abstract

Introduction: Human body movement, made up of motor patterns and factors, is considered an essential element of health and well-being. The qualitative and quantitative analysis of the characteristics and parameters of gait has aroused great interest over time among researchers and clinicians, because alterations in the parameters that make it up have been associated with anthropometric factors.

Objective: To demonstrate the effectiveness of biomechanical software as a model for gait analysis in affected patients who attend Rehabilitation services.

Methods: A biomechanical analysis study was carried out at the Dr. Faustino Pérez Hernández Rehabilitation Hospital of Sancti Spiritus, structured in two stages, where in the first stage the functioning aspects of the biomechanical software (Kinovea) were assessed and in the second stage We proceeded to work with the study sample with the biomechanical software.

Result: In the gait analysis, the two patients who suffered from a sprain were the ones who came closest to the normal parameters in relation to the cycle and chain length of gait, in the biomechanical analysis of gait for each lower limb. In the patients, the angular amplitude of each joint could be accurately detected, where the angular deficit in the affected joint was demonstrated.

Conclusions: The use of the Kinovea software in the analysis of the spatiotemporal parameters of gait reflected excellent test- retest reliability and a good biomechanical analysis of the patients studied.

Kew Words: biomechanical software; kinovea; gait analysis

Introduction

Human body movement, made up of motor patterns and factors, is considered an essential element of health and well-being, the result of the interaction of different domains and body systems, which will allow man a high degree of functionality and independence for life. performing their activities of daily living and basic daily activities. As an essential component of movement, walking constitutes a fundamental pattern of great complexity, which will be related to the capacity for movement in space, and therefore with the capacity for interaction of man in the environment, its alteration being capable of generating a temporary or permanent disability.[1]

Walking is the result of correct coordination between muscles, tendons and joints of the lower extremities, to support the weight of the body and move it in a certain direction. It can be described by a cyclical pattern involving the central nervous system and sensory responses. A gait cycle, or stride, is defined as the time or space elapsed between the heel strike of one foot and the heel strike of the same foot in the next step. Each cycle is divided into two phases: the support phase (60 - 62% of the time in each cycle) and the balancing phase (38 - 40% of the time in each cycle).[2]

The analysis of human movement and more specifically of walking has interested many since ancient times, with references to it being made by Aristotle, Leonardo da Vinci, and Hippocrates, among others.[3]

Another pioneer was Eadweard Muybridge, an English photographer and researcher who made important contributions to the study of movement starting in 1860, through the use of serial photography, which he initially used to study the gallop of horses and determine if at any time they They kept their four legs off the ground. He later carried out studies in other animals and in humans. Marey also carried out movement studies based on photography and developed a simple system for the analysis of plantar pressures. Over time the systems were perfected, along with the introduction of computer systems and greater computer development, to obtain the modern and sophisticated systems available today. [3]

The exploration of gait within the process of evaluating human body movement is a fundamental tool that reveals the motor possibilities, the ability to carry out different daily activities and the level of social interaction within the framework of the contextual factors of each individual. [1]

The qualitative and quantitative analysis of the characteristics and parameters of gait has aroused great interest among researchers and clinicians over time, because alterations in the parameters that make it up have been associated with anthropometric factors, processes or normal changes related to it. with the aging process, or as a consequence of biomechanical alterations due to different pathologies, in addition to being related to alterations in other body structures, which can generate muscle imbalance and cause alterations in body disposition. [1]

The motion analysis laboratory allows the analysis of different types of human movements; However, the greatest development has focused on studying gait. [3]

Applications of the gait laboratory in the clinical field date back to the 1960s in North America, with the creation of the first movement analysis laboratory at the San Francisco Shriners Hospital, by Dr. David Sutherland, to study biomechanical alterations. of children with cerebral palsy. Dr. Sutherland, an orthopedic surgeon, observed how the epidemiological landscape had changed as a result of progressive advances in medicine starting in the 1940s. These changes determined the drastic decrease in infectious diseases and the eradication of poliomyelitis. the discovery of antibiotics and the creation of the anti-polio vaccine.[3]

Soares Leite defines Biomechanics as the study of different areas related to the movement of humans and animals, considering, among other things, the functioning of muscles, tendons, ligaments, cartilage and bones, in addition to the loads and overloads of specific structures. and other factors that influence performance. While for Ramón it can be defined in many ways, among which it stands out that it is the science that examines the internal and external forces that act on the human body and the effect they produce.[4]

A biokinematic analysis has specific elements that allow for detailed studies of a technical gesture in order to reach an appropriate execution. As it is a branch of biomechanics, biokinematic analysis allows us to describe movement in human beings, without taking into account the forces that act, depending on the angle or relative position of the joints.[5]

In the Rehabilitation services of the province of Sancti Spiritus, there are no technological systems that allow a deep and accurate analysis of the gait of patients with various pathologies. Currently, the difficulties that patients may experience when walking are observed with the vision of the service staff, without elements that give precision to the movements of the lower limbs, so it is unknown exactly what part of the lower limbs does not work properly or which muscle group needs differentiated work to resolve certain walking difficulties.

The above constitutes a health problem in Rehabilitation services, its concern lies in the high incidence of personnel who come to the service suffering from limitations when walking normally.

For all of the above, it was decided to carry out this technological development study with the objective of demonstrating the effectiveness of biomechanical software as a model for gait analysis in affected patients who attend Rehabilitation services.

Method

A biomechanical analysis study was carried out at the Dr. Faustino Pérez Hernández de Sancti Spiritus Rehabilitation Hospital by the University of Medical Sciences. Structured in two stages, where in the first stage the operating aspects of the biomechanical software (Kinovea) were assessed. In the second stage, work was carried out with the study sample. The universe was made up of 12 patients, depending on compliance with the required criteria. The sample was defined by 5 patients who met the inclusion criteria, were asked for informed consent to take part in the study, and approved by the Ethics Committee and Scientific Council of the University of Medical Sciences. The method used to perform the gait analysis was 2D and 3D systems analysis, which consisted of capturing the person's movement in the sagittal plane on video with a normal camera and then measuring the different gait parameters. They gave markers in the bone prominences to the people to be analyzed; as in the greater trochanter (hip), lateral epicondyle (femur), external malleolus (ankle) and the tip of the metatarsus of the little finger (distal metatarsus) (foot). These markers served as a guide to measure the angles that the legs formed during walking. In the free Kinovea software, each of the phases and subphases of gait were identified frame by frame; The software allowed the angles and any other lines to be drawn in a frame for the necessary measurements. Three reference angles were taken: one for the hip, one for the knee, and one for the heel. A reference distance and a coordinate origin were previously defined in the software so that the values displayed are as precise as possible. After analyzing the relevant frames, the program allowed us to export a spreadsheet that presented in table form all the measurements made in the corresponding frame. These results were organized to obtain a table of the additional parameters of each gait and three tables corresponding to each part analyzed (hip, knee, ankle). Subsequently, a graph was made where the angular displacement of these over time can be compared; This procedure is repeated for each walking test performed. Patients' acceptance to participate in the study was requested through informed consent. Authorization was also requested from the management of the Provincial Rehabilitation Hospital, approval from the Ethics Committee and the Scientific Council of the University of Medical Sciences for the execution of the study.

Results

The average age was 37.4, 60% were male and the sprain was the pathology that was present in two patients representing 40% (Table 1).

Variables	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age (years)	54	23	31	44	35
Sex	M	F	M	M	F
Weight (lbs)	192	165	167	181	162
Height (cm)	188	154	175	183	166
Pathology	Sprain (grade 1) MID	Chondromalacia MID	Hip fracture (non-dispnlacing) MII	Sprain (grade2) MID	MII gonoarthrosis

Table 1. Sociodemographic variables of the sample studied

Source: survey

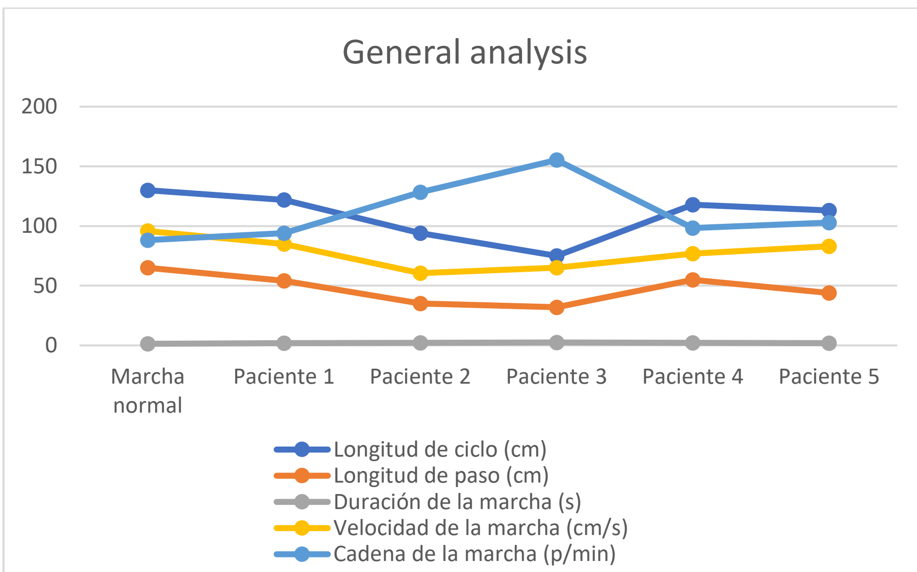
MID: Right lower limb MII: Left lower limb In the gait analysis, the two patients who suffered from a sprain were the ones who came closest to the normal parameters in relation to the cycle and chain length of gait (Table 2).

Spatial parameters	normal gait	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Cycle length (cm)	130	122	94	75	118	113
Step length (cm)	65	54	35	32	55	44
Walking duration (s)	1.36	1.89	2.21	2.45	2.03	1.83
Walking speed (cm/s)	95.8	85	60.5	65.1	77	83
Gear chain (p/min)	88.2	94.1	128.3	155.3	98.3	103

Table 2. Analysis of spatial parameters studied

Source: analysis with biomechanical software

Graph 1. Analysis of spatial parameters studied



Source: data analysis in Microsoft Excel

In the biomechanical analysis of gait for each lower limb of the patients, the amplitude in angle of each joint could be accurately detected, where the angular deficit was demonstrated in the affected joint of each lower limb and was compared with the normal angulations for each movement (Table 3).

Biomechanics of gait	Normal parameters	Patient 1		Patient 2		Patient 3		Patient 4		Patient 5	
		MID	MII	MID	MII	MID	MII	MID	MII	MID	MII
hip flexion	10th	10th	10th	6th	10th	10th	4th	10th	10th	9th	8th
Knee flexion during stance period	20°	20°	16th	15°	20°	19th	17th	20°	20°	17th	14th
Ankle plantarflexion	15°	15°	11th	13th	14th	15°	13th	14th	7th	14th	11th
Ankle dorsiflexion	8th	8th	5th	7th	8th	8th	7th	8th	3rd	7th	5th

Table 3. Biomechanical analysis of gait by limb in degrees of movement.

Source: analysis with biomechanical software

MID: Right lower limb MII: Left lower limb

Discussion of results

Biomechanics is the science that applies mechanics to explain the laws that govern the mechanical movement of living systems.[6] Through the use of the software, the biomechanical analysis was allowed as a starting point when the study subjects walked, which allowed us to verify the precision of the movements of each lower limb when walking, detailing the movement of each segment of their legs. joints, compare with normal movement parameters and allowed us to analyze which muscle or muscle group to work on for its best functioning. The use of the video analysis technique is today an appropriate technology for the scientific and academic environment. This technology allows the study of real phenomena to be developed and provides the unique opportunity to obtain, with low consumption of resources, a wide spectrum of information on the different magnitudes that allow us to better characterize the mechanical movement of bodies.[7]

In a study by Pons et al.,[7] with the aim of applying the kinovea software to pitching technique, where it can be seen that the coaches correct the technical elements on the basis of empiricism and go only to their observations to identify the behavior of the kinematic characteristics. With the use of biomechanical software, it was possible to determine the characteristics of the passing distance, the angle that the throwing arm forms with respect to the head, the height of the ball approaching the home plate , and the speed of the ball executed by the pitchers investigated.Fernández [8]

evaluated the inter-observer and intra-observer reliability of the Kinovea software for the kinematic study of the hip, knee and ankle during the initial contact and take-off phases, where with the use of the software it was possible to detail that Intra-observer reliability showed a good correlation for the joint range of the hip, knee and ankle. In relation to the data obtained from the recording of the spatiotemporal parameters of gait, the intra-observer and inter-observer reliability was excellent for all the parameters studied (ICC > 0.90), with the exception of speed, whose intra-observer reliability observer was good (ICC > 0.88). Velos [9] used the Kinovea software on 16 young, clinically healthy university men and women, that is, with no history of injuries or recent surgeries, in an age range of 18 to 25 years for the biomechanical analysis of each of the subjects. in which the angles formed between the markers in the static stance position were analyzed. Similarly, the angles formed in the hip, knee and ankle were analyzed both in flexion during the heel strike, as well as in flexion during oscillation. Of the sample, two patients have scoliosis, four have a descent in the right shoulder, while one in the left; one has hip descent on the right side, one has hip descent on the left side. One has varus in the right knee, one in the left, while three have valgus in the right knee and another three in the left. At the ankle level, three subjects have a varus on the right, one on the left, five have a valgus on the right and seven on the left. Of the total sample, eight people show a leg length discrepancy ranging from 3-8 mm with a predominance of 5 millimeters. Six people had flat feet, most of them normal, and no pes cavus was detected.

Chiliquinga [10] applied the biomechanical analysis of the different parameters to six athletes in the discipline of sports walking. The results obtained allowed us to compare the variability of these parameters, which showed that there are differences in relation to the increase in sports experience and anthropometric characteristics, a difference absent in the parameter of stride length and timing of support and stride.

Speziale[11] present, through a biomechanical analysis by Kinovea software, a clinical case of a child with cerebral palsy, after multilevel surgery, during the transition process, from walking assisted with a walker to achieving it independently. In the results, angles were observed that allowed us to discuss possible overloads on joints of the left lower limb. In the frontal plane, angles are graphed that offer a perspective on the inclination of the trunk to the right, at the initial moment of single-leg loading. trunk inclination was greater with the use of a walker.

Conclusions

The use of the Kinovea software in the analysis of the spatiotemporal parameters of gait reflected excellent test-retest reliability and a good biomechanical analysis of the patients studied in the recovery process. Therefore, the software as an accessible and properly managed tool fulfilled the clinical evaluation of gait with great precision and acceptance.

Conflict of interests

The autors declare that does not exist an interest conflict.

Financing

The authors have not received any financial support for the completion of this work.

References

1. Agudelo-Mendoza AI, Briñez-Santamaria TJ, Guarín-Urrego V, Ruiz-Restrepo JP, Zapata-García C. (2013). Marcha: description, methods, evaluation tools and normality parameters reported in the literature. *CES Movement and Health;* 1:29-43.
2. Haro DM. (2014). Gait and movement analysis laboratory. REV. MED. CLIN. Counts; 25(2): 237-247.
3. Cerda AL. (2014). Management of gait disorder in older adults. REV. MED. CLIN. Counts.; 25(2): 265-275.
4. Sangucho -Hidalgo NP, Rivadeneira-Arias KN, Aguilar-Morocho EK. (2022). Biomechanics applied to the long jump technique of Paralympic medalist Kiara Rodríguez. sport; 11:42.
5. Muñoz-Vivas OI, Gutiérrez-Galvis AR, Gutiérrez-Casa MV, Collazos-Morales CA. (2021). Biokinematic analysis of the flight phase of a simple extended forward roll with half a turn of the male gymnasts of the Colombian team with a German wheel. Impetus.; 13(2):48-54.
6. Pérez-Ruiz OA, Villegas-Sáez AF, Feito-Gácita A. (2021). Fundamentals of sports biomechanics (1st ed.). University Publishing.
7. Pons Gámez Y, Durañona Nápoles HA, Pérez Ruiz OA, Aguilera Vargas A. (2023). Use of the kinovea software for pitching technique in Baseball. *Convention Scientific International.*
8. Fernández-González P. (2022). Study of reliability and validity of a video analysis computer program for the evaluation of gait in healthy subjects [Doctoral Thesis] Universidad Rey Juan Carlos, Madrid-Spain.
9. Veles-Bustillos A. (2022). Effect of the use of plantar orthoses on the biomechanics of gait of clinically healthy young Mexicans. *Ibero Autumn Expo.*
10. Chiliquinga -Tarco OS. (2021). Comparative biomechanical study of the technique of athletic walking in athletes of different categories of the Tungurahua Sports Federation [Bachelor's Degree in Educational Sciences, Mention: Physical Culture] *Technical University of Ambato, Ambato-Ecuador.*
11. Speziale P. (2022). Towards independent walking: analysis of a case with spastic diplegia [Title of Specialist in Kinesiology and Neurological Physiatry] Universidad del Gran *Rosario, Santa Fe-Argentina.*

DOI:10.31579/2639-4162/159