IMPACT OF SURGICAL TREATMENT ON THE GAIT OF PATIENTS WITH CERVICAL MYELOPATHY

IMPACTO DO TRATAMENTO CIRURGICO NA MARCHA DE PACIENTES PORTADORES DE MIELOPATIA CERVICAL

IMPACTO DEL TRATAMIENTO QUIRÚRGICO EN LA MARCHA DE PACIENTES CON MIELOPATÍA CERVICAL

Dhara Siqueira Lages[1] (iD), Thabata Pasquini Soeira[1] (iD), Mariana Demétrio de Sousa Pontes[1] (iD), Carlos Fernando Pereira da Silva Herrero[1] (iD)

1. Universidade de São Paulo, Ribeirão Preto Medical School, Ribeirão Preto, SP, Brazil.

ABSTRACT

Objective: To analyze the impact of surgery on gait characteristics of individuals with Cervical Spondylotic Myelopathy (CSM) after one month of the procedure. Methods: Observational, cohort type study, with a quantitative analysis approach. Two assessments were performed, the first one week before surgery and the second 30 days after the decompression procedure. The following space-time variables were analyzed: steps per minute, step length, cycle time, speed, steps per minute, support time, swing time, step time. The kinematic variables obtained were analyzed by Gait Profile Score (GPS) and Movement Analysis Profile (MAP). Results: comparing pre and postoperative values, there was a decrease in the number of steps per minute (p=0.006), an increase in support time (p=0.011) and an increase in cycle time (p=0.004). Other variables did not present statistically significant differences. The patients' total GPS average in the pre-surgery assessment was 10.41 and 1 month after the procedure, an average of 10.56 was obtained, which does not characterize a statistical difference between the assessments. When establishing a comparison between the two assessments specifically on each joint movement of the lower limbs using the MAP, it was observed that the obliquity and rotation of the pelvis showed some improvement immediately after the surgical procedure. Knee flexion and extension were significantly (p=0.018) more compromised after the procedure when compared to the value of the same population before surgery. Conclusion: the preliminary analysis of the gait of these patients after one month of intervention did not show immediate benefits of the procedure. ***Level of Evidence II; Therapeutic studies - Investigation of treatment outcomes.***

Keywords: Myelopathy; Decompression; Gait Analysis; Surgery.

RESUMO

*Objetivo: Analisar o impacto da cirurgia na marcha de indivíduos portadores de Mielopatia Cervical Espondilótica (MCE) após um mês do procedimento. Métodos: Estudo observacional, longitudinal, com abordagem de análise quantitativa. Foram realizadas duas avaliações, a primeira uma semana antes da cirurgia e a segunda 30 dias após o procedimento. Foram analisadas as variáveis de espaço-tempo: avanços por minuto, comprimento do passo, tempo de ciclo, velocidade, passos por minuto, tempo de apoio, tempo de balanço, tempo do passo. As variáveis cinemáticas obtidas foram analisadas pelo Gait Profile Score (GPS) e Movement Analysis Profile (MAP). Resultados: comparando os valores pré e pós-operatórios, houve diminuição do número de passos por minuto (p=0,006), aumento no tempo de apoio (p=0,011) e aumento no tempo de ciclo (p=0,004), outras variáveis não apresentaram diferenças estatisticamente significativas. A média do GPS total dos pacientes na avaliação pré-cirurgia foi de 10,41 e após 1 mês do procedimento obteve-se a pontuação média de 10,56 o que não caracteriza diferença estatística entre as avaliações. Ao estabelecer uma comparação entre as duas avaliações em cada movimento articular dos membros inferiores utilizando o MAP, observa-se que a obliquidade e a rotação da pelve apresentaram alguma melhoria imediatamente após o procedimento cirúrgico. Já a flexão e extensão do joelho mostrou-se significativamente (p=0,018) mais comprometida após o procedimento quando comparada com o valor da mesma população pré cirurgia. Conclusão: a análise preliminar da marcha dos pacientes com MCE após um mês de intervenção não evidenciou benefícios imediatos do procedimento. **Nível de Evidência II; Estudos terapêuticos - Investigação dos resultados do tratamento.***

Descritores: Mielopatia; Descompressão; Análise da Marcha; Cirurgia.

RESUMEN

Objetivo: Analizar el impacto del tratamiento quirúrgico en las características de la marcha de personas con Mielopatía Cervical Espondi- lótica (MCE) después de un mes del procedimiento. Métodos: Estudio observacional, longitudinal, con enfoque de análisis cuantitativo. Se realizaron dos evaluaciones, la primera una semana antes de la cirugía y la segunda 30 días después del procedimiento de descompresión. Se analizaron las siguientes variables espacio-temporales: pasos por minuto, longitud de paso, tiempo de ciclo, velocidad, pasos por minuto, tiempo de apoyo, tiempo de balanceo, tiempo de paso. Las variables cinemáticas obtenidas fueron analizadas mediante Gait Profile Score (GPS) y Movement Analysis Profile (MAP). Resultados: Al comparar los valores pre y postoperatorios, hubo una disminución en el número

de pasos por minuto (p=0,006), un aumento en el tiempo de soporte (p=0,011) y un aumento en el tiempo de ciclo (p=0,004), otras variables no presentaron diferencias estadísticamente significativas. La media del GPS total de los pacientes en la evaluación prequirúrgica fue de 10,41 y 1 mes después del procedimiento se obtuvo una puntuación promedio de 10,56, lo que no caracteriza diferencia estadística entre las evaluaciones. Al establecer una comparación entre las dos evaluaciones específicamente sobre cada movimiento articular de los miembros inferiores mediante el MAP, se observó que la oblicuidad y rotación de la pelvis mostraron cierta mejoría inmediatamente después del procedimiento quirúrgico. La flexión y extensión de la rodilla estuvieron significativamente (p=0,018) más comprometidas después del procedimiento en comparación con el valor de la misma población antes de la cirugía. Conclusión: Los pacientes con MCE presentan deterioro de la marcha en comparación con la población típica, el análisis preliminar de la marcha de estos pacientes después de un mes de intervención no mostró beneficios inmediatos del procedimiento. **Nivel de Evidencia II; Estudios terapéuticos - Investigación de resultados del tratamiento.**

Descriptores: Mielopatía; Descompresión; Análisis de la Marcha; Cirugía.

INTRODUCTION

Cervical spondylotic myelopathy (CSM) is the most frequent cause of spinal cord dysfunction in the adult population, especially in individuals over 55.[1-2] The degenerative process of the cervical spine can lead to a progressive and chronic reduction in the diameter of the spinal canal and consequent compression of the cervical spinal cord.[1,2] Surgical spinal canal decompression is the treatment indicated in the majority of cases, and an early approach can prevent the progression of the disease and be associated with a significant improvement in neurological symptoms, functional activities, and the patient's quality of life.[3]

Patients with CSM may progressively lose strength in their lower limb muscles, develop a significantly slower gait speed, find it difficult to take proper steps, and spend less time in unipodal support, which implies a lack of stability.[4-7]

Thus, as gait is characteristically affected in CSM, its detailed analysis can be important for establishing improvement parameters in the post-operative period and quantifying functionality.[8-10] Physical and imaging exams alone cannot accurately predict the results of surgery.[8-10] Nor should they be used in isolation to assess the patient's functional recovery, as they generate more subjective results that depend on the patient's perception and can be affected by expectations about the surgery.[11]

Previous studies that analyzed the gait of individuals diagnosed with CSM have been carried out in heterogeneous populations without detailed three-dimensional gait analysis.[12,13] Therefore, this study aims to analyze the impact of spinal decompression surgery on the gait characteristics of individuals with CSM one month after the procedure.

METHODS

The research project was approved by the Research Ethics Committee, protocol number 1.153.692, complying with the prerogatives of Resolution 466/20125 of the National Health Council regarding research parameters with human beings.

This is an observational, longitudinal, and prospective cohort study with a quantitative analysis approach. The patients underwent two pre-operative assessments and one 30 days after the surgical procedure at the hospital's Movement Analysis Laboratory (MAL).

Inclusion criteria included patients of both sexes, over 18 years of age, with a clinical and radiological diagnosis of CSM, carried out using magnetic resonance imaging, and agreeing to participate in the study by signing an informed consent form. Patients were excluded if they had severe respiratory or heart disease, co-existing neurological disorders, or a history of neurological disease with a persistent deficit and/or symptomatic musculoskeletal problems if any of these affected walking.

The following patient data was collected: gender, age, height, and BMI. The following space-time variables were analyzed: strides per minute, stride length (m), cycle time (s), speed (m/s), steps per minute, support time (s), swing time (s), and step time (s). The kinematic variables obtained were analyzed using the *Gait Profile Score* (GPS) and *Movement Analysis Profile* (MAP).

For the three-dimensional gait analysis, 17 reflective markers (Figure 1), both anatomical and tracking, were placed on the patient's lower limbs, capable of being detected by the system of eight Qualisys Oqus 300 infrared emission cameras positioned and fixed approximately 2.6 m from the laboratory floor. Initially, the reference position of each patient was captured. Then the patients walked barefoot, at a comfortable speed, along the rubberized walkway at least five times along the entire length of the walkway, taking between eight and twelve steps on each lap, depending on their stride size. Evaluations were conducted one week before the surgical procedure and 30 days after spinal decompression.

In the descriptive analysis, continuous variables were expressed in summary measures (mean, median, standard deviation, and quartiles), while categorical variables were expressed in frequencies and percentages. The non-parametric Mann-Whitney paired test was used to compare the different periods in the continuous variables because they did not follow a normal distribution (Anderson-Darling test) and were homogeneous (Bartlett's test). The Wald test was used for categorical variables. The significance level adopted for the tests was 0.05. Two-tailed hypotheses were considered. In addition, the confidence intervals constructed are 95%. R software version 4.0.2 was used to carry out all the analyses.

RESULTS

The data collected from the 9 individuals included in the study is summarized in Table 1. Most of the individuals were male (88%) with average values for height of 1.66 meters, age of 58.67 years, BMI of 27.39, and weight of 76.33 kilograms.

Figure 1. Tracker location.

Table 1. Characteristics of the study patients.

Variable	Average	Standard Deviation
Length of lower limbs (cm)	87.22	3.52
Height (m)	1.66	0.08
Age (years)	58.67	14.67
BMI (kg/m^2)	27.39	3.11
Weight (kg)	76.33	12.81

Concerning the space-time variables, when we compared the values between the preoperative period and 30 days after surgery, there was a decrease in the number of steps per minute (p=0.006), an increase in support time (p=0.011) and an increase in cycle time (p=0.004); other variables did not show statistically significant differences. Compared to values for healthy individuals aged between 50 and 64,[12] gait speed and stride length are the variables with the greatest discrepancy. (Table 2)

The average total GPS of the patients in the pre-surgery evaluation was 10.41, and 1 month after the procedure, the average score was 10.56, which does not characterize a statistical difference between the evaluations. However, compared to the GPS score of the healthy population used as a reference,[4,12] these patients' gait dysfunction was statistically evident in both assessments. (Figure 2)

When comparing the two evaluations, specifically on each joint movement of the lower limbs using the MAP, it can be seen that the obliquity and rotation of the pelvis showed some improvement immediately after the surgical procedure. Knee flexion and extension, on the other hand, knee flexion and extension were significantly (p=0.018) more compromised after the procedure compared to the same population pre-surgery.

DISCUSSION

The GPS analysis showed no changes in the three-dimensional characteristics of gait in the 30-day follow-up assessment of patients with CSM who underwent surgical treatment for decompression of the spinal canal. The score obtained by the patients in the study in the preoperative assessment shows a discrepant pattern with the gait data of healthy individuals, i.e. individuals with CSM do indeed have a characteristic deviation from the typical gait, already established in the literature by other studies.[4,9,11,13] The maintenance of this high score in the assessment one month after the procedure therefore indicates that the three-dimensional assessment of the gait of these patients in the immediate postoperative period could not show any changes.

A study that analyzed the gait of 10 patients after one year of decompression surgery also found no improvement in the kinematic parameters of the gait of this same population.[14] However, due to the disease's progressive nature, the possibility of stabilizing the clinical picture through surgery can be interpreted positively as maintaining patients' quality of life.

Maezawa Y. et al.[9] correlated in their study that the increase in gait speed after surgical decompression was in response to better simple support time resulting from an improvement in hip and knee range of motion in the swing phase and plantar flexion in the support phase.[9] This may explain the lack of changes in the kinematic gait variables of our patients, as there was no improvement in their
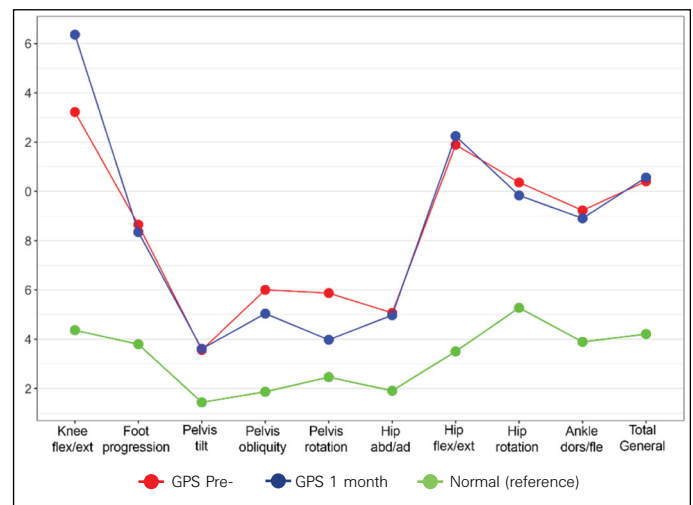

Figure 2. Gait Profile Score (GPS): Comparison of the study patients' scores with those of typical individuals.

MAP scores, especially the worsening of knee flexion-extension movement, which corroborates against gait improvement.

In the study by Singh A. et al.[15] only the gait speed of patients undergoing surgical decompression was assessed using the 30-meter walk test, in which they found better values for gait speed 6 months after the intervention, which was maintained until the 3-year follow-up.[15] Therefore, assessing patients one month after the procedure seems premature, perhaps due to the influence of factors such as pain and using the cervical collar, which can interfere with balance and gait performance. The evaluation 30 days after the surgical procedure may not identify any improvement in the muscle strength of these patients since the gain in strength is more related to the rehabilitation that these patients undergo in the postoperative period than to the surgical procedure itself, which is interesting to evaluate in future research. Our findings regarding space-time measurements showed a worsening in the preliminary assessment (30 days after surgery), which can be explained by the fact that our post-operative rehabilitation began 30 days after surgery. We therefore hope that the study of late results will show favorable changes in these variables.

Among the limitations of this study are the small sample size, the lack of a pain scale, and the lack of a quality-of-life questionnaire such as the SF-36 or Neck Disability Index to analyze whether or not there was improvement perceived by the patients beyond the numerical data, which would complement the quantitative nature of this study. However, we were able to design an appropriate three-dimensional gait assessment protocol in a specialized laboratory, presenting the main alterations found in a sample of patients with cervical spondylotic myelopathy (CSM).

CONCLUSION

The CSM patients differed from the typical gait indicated by the GPS and MAP values in this study. However, the preliminary evaluation of the gait of these patients only one month after spinal decompression surgery did not indicate significant improvements in the gait pattern. It is therefore necessary to carry out a three-dimensional gait analysis over the long term, also considering the patient's rehabilitation factors.

All authors declare no potential conflict of interest related to this article.

Table 2. Space-time variables of healthy individuals and patients with cervical myelopathy (pre- and post-operative) during walking.

| | Reference[12] | Patients | |
		Preoperative	1 month after surgery
Advances per minute		43.31 (13.01)	41.61 (13.53)
Step length	0.76 (0.22)[3]	0.46 (0.1)	0.46 (0.16)
Cycle time	1.2 (0.36)	1.35 (0.25)	1.81 (1.21)[2]
Speed	1.32 (0.5)[3]	0.74 (0.31)	0.72 (0.37)
Steps per minute	104 (31)	92.07 (15)	83.99 (26.37)[1]
Support time		0.88 (0.23)	1.31 (0.1)[2]
Swing time		0.47 (0.04)	0.50 (0.13)
Step time		0.67 (0.13)	0.82 (0.67)

[1] - significant decrease from pre- to post-operative time, p < 0.05. [2] - significant increase from pre- to post-operative time, p < 0.05. [3] - greater differences between the patients in the study and reference data from healthy individuals.

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