

# Evaluating gross motor function of cerebral palsy patients using the GMFM pre and post lower extremity orthopedic surgery

## Avaliação da função motora grossa pela GMFM pré e pós cirurgia ortopédica de membros inferiores em pacientes com paralisia cerebral

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### ABSTRACT

Orthopedic surgery is often used to improve the gait of ambulatory patients with cerebral palsy. The objectives may change, given the motor severity-however, an improvement in the patient's mobility can be achieved through surgical procedures of the lower extremity. The Gross Motor Function Measure (GMFM) is a measure of gross motor function, used to evaluate therapeutic choices, rehabilitation progress and, in our institution, to evaluate orthopedic surgeries. **Objective:** The main goal of this study was to evaluate orthopedic surgeries performed on children with cerebral palsy through the comparison of the GMFM score pre and post procedure. **Method:** We included patients in this study that were greatly limited in functional mobility, but who had the potential to improve (Levels III and IV of the Gross Motor Function Classification System), and who had undergone surgical procedures between January 2010 and December 2012, achieving a total of 36 subjects. **Results:** There was no statistically significant change between the measures, except for the C domain (crawling and kneeling), which presented a lower post-surgical procedure score. Age, time of follow up, the nature of the surgery, and, most of all the instrument used, which in our case was the GMFM, were all indicated as possible difficulties in objectively measuring the results of lower extremity surgery in children with cerebral palsy. **Conclusion:** A larger sample of subjects evaluated with a more suitable instrument is still necessary to reveal the real effects of orthopedic surgery on lower extremities of patients with cerebral palsy.

**Keywords:** Cerebral Palsy, Lower Extremity, Evaluation, Scales

### RESUMO

Em pacientes com paralisia cerebral (PC) deambuladores, a cirurgia ortopédica é bastante utilizada para melhora do padrão de marcha. Conforme aumenta o acometimento motor, os objetivos podem mudar, contudo, uma melhora na mobilidade é importante e pode ser conseguida através de procedimentos cirúrgicos. A *Gross Motor Function Measure* (GMFM) é uma escala quantitativa da função motora grossa, utilizada para diversos fins, como controle da evolução terapêutica, progressos na reabilitação e, em nosso serviço, avaliação de cirurgias ortopédicas. **Objetivo:** A avaliação padronizada e sistematizada dessas cirurgias, comparando a GMFM pré e pós procedimento. **Método:** Incluímos no estudo aqueles pacientes que apresentam uma maior limitação da mobilidade e com potencial para melhorar sua movimentação (níveis III e IV da *Gross Motor Function Classification System*), operados entre janeiro de 2010 e dezembro de 2012 obtendo 36 pacientes. **Resultados:** Notamos que não houve diferença estatisticamente significativa entre os momentos da GMFM, a não ser, no domínio C (engatinhar e ajoelhar), no qual notamos uma queda da pontuação. A idade dos pacientes, o tempo de aferição entre as medidas, a natureza da cirurgia e, principalmente, o método de avaliação, que em nosso caso, foi a GMFM, foram citados na literatura como dificuldades em se quantificar objetivamente o resultado obtido pelas cirurgias ortopédicas de membros inferiores em pacientes com PC. **Conclusão:** Uma avaliação de um número maior de pacientes, talvez com um instrumento diferente do utilizado em nosso trabalho, se faz necessária para uma melhor percepção do real efeito da cirurgia ortopédica de membros inferiores em pacientes com PC.

**Palavras-chave:** Paralisia Cerebral, Extremidade Inferior, Avaliação, Escalas

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## INTRODUCTION

The concept of cerebral palsy (CP) encompasses a group of developmental, movement, and postural disorders engendering limitations in the performance of tasks; they are attributed to non-progressive disturbances that take place during brain development in fetuses and children. These motor disorders are commonly accompanied by convulsions, and disturbances in behavior, cognition, communication, vision, and hearing.<sup>1,2</sup> CP is a static motor disorder with no evidence of a progressive disease or loss of motor acquisitions already previously acquired.<sup>3</sup>

Despite the efforts of professionals dedicated to rehabilitation, there are still many aspects of the clinical evolution of CP patients that remain obscure. However, classifications based on clinical evaluation such as the Gross Motor Function Classification System (GMFCS) and the Gross Motor Function Measure (GMFM) were developed to help define the prognosis and quantify the motor function of children with CP.<sup>4</sup>

The GMFCS evaluates movements initiated by the patient and his need for assistive technology, thereby evaluating the quality of his performance. It is divided into five functional levels depending on limitations such as trunk control and gait, the need for adaptations, and the means to aid movements. Level III includes children who walk with assistance and who are limited in walking in public, while level IV includes children with limited mobility who need to use a wheelchair to get around outside the house and in the community.<sup>1,5</sup>

The GMFM is a quantitative instrument developed to evaluate alterations in gross motor functions in children with CP; initially it had 88 items divided into five dimensions: lie down and roll over; sit up; crawl and kneel; stand up; and walk, run, and jump.<sup>1,6</sup>

An updated version of the GMFM with 66 items is also quite popular and validated for the evaluation of children with CP. It is numerical evaluation scale, in which, a greater score implies a better gross motor function. In addition to longitudinal changes, the GMFM also helps define therapeutic objectives and provides information on the rehabilitation progress.<sup>1</sup>

For the CP patients who can walk, orthopedic surgery is greatly used and it is considered the gold standard to improve gait. However, the effectiveness of surgeries to improve and maintain the mobility of patients with worse functional levels has not yet been established. Patients classified as GMFCS IV have

their mobility very limited, but may be able to transfer and walk small distances with external support.<sup>7</sup>

The most common objective of surgeries in patients with more severely affected motor levels is the treatment and prevention of spastic hip and scoliosis.<sup>7</sup> However, patients with CP may be submitted to other surgeries to improve the alignment, to eliminate contractures, and to reduce the effects of spasticity helping thus their mobility and deambulation.<sup>8</sup> Surgeries like these can be extensive and carry the risk of complications.

To evaluate the effectiveness of these surgeries to obtain functional improvements (even if small) in this population in which mobility is limited (GMFCS III and IV), continues to be a challenge and was what motivated this work.

## OBJECTIVE

The objective of this study is to evaluate in a systematic and standardized manner the result of orthopedic surgeries performed in patients with CP and levels III and IV by the GMFCS, using one of the instruments employed in our institution, the GMFM scale before and after the procedure.

There is also the interest in verifying the profile of the patients submitted to these surgeries including data such as type of procedure done, age, gender, and distribution among the levels. Finally, there is the objective to quantify objectively the results of the procedures mentioned, helping in the decision-making by the medical team responsible for future cases.

## METHOD

This is a retrospective study that evaluates medical records. A survey of patients submitted to orthopedic surgeries in the CP outpatient clinic was taken between January of 2010 and December of 2012.

In the study were included patients in the clinic referred who presented levels III and IV, according to the GMFCS and who had been measured by the pre and post surgery GMFM. Those patients from any other level of GMFCS and/or who had not received the GMFM either before or after the procedure were excluded from this study. A total of 953 medical records of patients submitted to orthopedic surgeries were analyzed in the period between January of 2010 and December of 2012. From those patients, 192

were level III and 29 received GMFM before and after the procedure, and 203 were level IV within which, seven received GMFM before and after their surgeries. Thus, a total number of 36 patients was obtained. The patients who did not have all the domains of the GMFM pre and post surgery were compared only on the domains in which there was such correspondence, with the other non-paired scores being dismissed, which did not affect the total average and neither the average of the other domains.

The statistical tests used considered the variables as parametric for they were quantitative and continuous data, therefore paired the *Student t* test was used and the  $p < 0.05$  was adopted as a statistically significant value for all the data.

## RESULTS

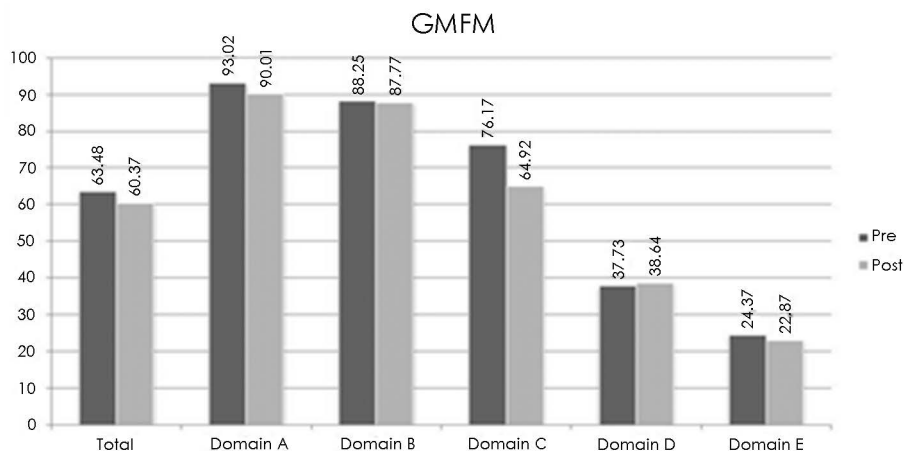
The average age of the patients on the date of their surgeries was  $12.1 \pm 1.3$  years (min = 5, max = 22), the gender distribution was 27.8% females (10 patients) and 72.2% males (26 patients); as for the GMFCS, 80.6% were classified as level III (29 patients) and 19.4% as level IV (seven patients). The characterization of the patients' pathology was spastic diparesis for 34 patients, choreoathetoid with spastic component for one patient and quadriplegia for one patient. The average number of surgeries to which these patients had been submitted to the date of the analysis was 2.2 (min = 1, max = 6), with the type of surgery varying from tendon release to more complex ones involving bone components (osteotomies).

When comparing the GMFM pre and post orthopedic surgery, the average time between measurements was of 2.88 years (min = 0.34, max = 12.08). The average time between the pre surgery measuring and the procedure was 1.98 years, while the average time between the surgery and the post measuring was of less than one year (0.89) (Table 1).

There was no statistical difference between the total GMFM moments pre and post surgery ( $p = 0.212$ ) (Figure 1). However, in the analysis of the GMFM domains per individual the following results were found: Domain A (lie down and roll over) - without statistical relevance between the moments ( $p = 0.125$ ); Domain B (sit up) - without statistical relevance between the moments ( $p = 0.854$ ); Domain C (crawl and kneel) - statistically significant difference with a drop of average post surgery (pre = 76.17, post = 64.92;  $p = 0.009$ ); Domain

**Table 1.** Complete description for Age, Surgeries, and Time

| Description           | Average | Median | Standard Deviation | CV   | Q1   | Q3   | Min  | Max   | N  | IC   |
|-----------------------|---------|--------|--------------------|------|------|------|------|-------|----|------|
| Age                   | 12.1    | 12     | 4.1                | 34%  | 5    | 14.3 | 5    | 22    | 36 | 1.3  |
| Surgeries             | 2.2     | 2      | 1.1                | 52%  | 1    | 3    | 1    | 6     | 36 | 0.4  |
| Time pre/post (years) | 2.88    | 1.55   | 2.78               | 97%  | 0.34 | 3.19 | 0.34 | 12.08 | 36 | 0.91 |
| Time pre/Cx (years)   | 1.98    | 0.62   | 2.79               | 140% | 0.0  | 2.54 | 0.0  | 11.5  | 36 | 0.91 |
| Time Cx/post (years)  | 0.89    | 0.88   | 0.42               | 47%  | 0.08 | 1.17 | 0.08 | 2.0   | 36 | 0.14 |



Domain A: Lie down and roll over; Domain B: Sit up; Domain C: Crawl and kneel; Domain D: Stand up; Domain E: Walk, run, and jump

**Figure 1.** Comparison between the pre and post moments of the GMFM domains

D (stand up) - without statistical relevance between the moments ( $p = 0.819$ ); Domain E (walk, run, and jump) - without statistical relevance between the moments ( $p = 0.621$ ) (Table 2).

## DISCUSSION

Despite its great use and good results observed in daily clinical practice, the orthopedic surgery in cerebral palsy patients finds difficulty in having its effectiveness and long-term effects evaluated scientifically, through well-designed studies. Some surgical procedures such as lengthening and muscle transferences or even, derotational osteotomies are routinely performed in patients with CP who can walk,<sup>8</sup> however, the cost-benefit of these surgeries, especially for the patients with greater motor impairment has been questioned in the literature.<sup>7</sup>

In a recent systematic review,<sup>9</sup> the authors pointed out that despite the tendency to favorable results in the gait, orthopedic surgeries (in particular, the multiple procedures performed

in one only surgical event) still need evidence, especially of randomized clinical trials, already existing in other interventions.

One of the greatest difficulties, when evaluating the impact of orthopedic surgeries (or even other interventions) is the little information available on the natural history of the walking capacity of people with cerebral palsy. It is observed a decline in the gait quality at the beginning of adolescence and, even more important, the variations provided by interventions may be masked by the evolution of changes that are characteristic to this pathology.<sup>10</sup> This would explain the need for multiple orthopedic surgeries, already reported in the literature<sup>11</sup> and confirmed in this study. Also, as there was a relatively long period of time (2.88 years) between the measures, the results of the intervention evaluated may be mixed with the changes recurrent in CP. It is noteworthy that the age of the patients evaluated (on average 12 years) may have confused the results, since the period of time between the measures could have included, for some of them, the decline that was expected with aging.

The manner of evaluating (GMFM) has also shown to be quite controversial in the world literature. Despite very well known and validated, its use in measuring the results of orthopedic surgeries has not been promising. Because it is a long test that covers many areas of the gross motor function, a score change in some items, such as the one provided by these surgeries may not be capable of generating a tangible alteration in its final result. It is possible that, despite increasing the score of certain domains, orthopedic surgeries reduce the score in others, leaving the final score similar to the initial one, as observed in this study. Knee lengthening surgeries are a good example of this: although very useful to improve the gait of patients with CP, they make it difficult to squat and kneel, leading to the loss of points in this domain.

It is necessary to point out that the patients who had multiple GMFM measures in our service, may be those cases in which there were doubts on the gross motor function, and are potentially more complex cases under the functional point of view, which may have contributed to the little evolution in its scoring.

Some studies allege also that the GMFM may not be as sensitive to the changes provided by the orthopedic surgeries as other measures available, arguing that the changes seen in the gait parameters seem to be substantially greater than those shown in the evolution of the GMFM, suggesting, thus, that the type of ability changed is possibly more complex than those represented in this test.<sup>12</sup> It is important to remember that the GMFM is measured always in ideal conditions, instead of during the day to day performance, which could generate another confusion factor.<sup>13</sup>

This tendency from the GMFM in not reflecting the improvement noted in the clinical evaluation and in other means of evaluation has already been noticed many times in different studies, and was even referred to in the results of the systematic review by Mcginley et al.<sup>9</sup> who characterized the GMFM changes as small, variable, and inconclusive. In another study, there was a GMFM drop six months after surgery with consequent return to the pre surgery value after one year.<sup>14</sup>

The randomized clinical trial made by Thomason et al.<sup>15</sup> showed an improvement of the group that went through surgical intervention in the GMFM as much as in the other parameters, when compared to the control group. However, by the design of the study itself, the GMFM results were compared with patients in the control group instead of its previous

**Table 2.** Comparison of moments for GMFM domains

| GMFM     |      | Average | Median | Standard Deviation | CV  | Min   | Max   | N  | IC    | p - value |
|----------|------|---------|--------|--------------------|-----|-------|-------|----|-------|-----------|
| Total    | Pre  | 63.48   | 65.40  | 17.14              | 27% | 12.24 | 93.39 | 33 | 5.85  | 0.212     |
|          | Post | 60.37   | 61.92  | 16.80              | 28% | 21.90 | 92.06 | 33 | 5.73  |           |
| Domain A | Pre  | 93.02   | 94.12  | 10.70              | 11% | 41.18 | 100   | 33 | 3.65  | 0.125     |
|          | Post | 90.01   | 94.12  | 11.46              | 13% | 49.00 | 100   | 33 | 3.91  |           |
| Domain B | Pre  | 88.25   | 95.00  | 19.36              | 22% | 20.00 | 100   | 33 | 6.61  | 0.854     |
|          | Post | 87.77   | 93.33  | 15.93              | 18% | 46.67 | 100   | 33 | 5.43  |           |
| Domain C | Pre  | 76.17   | 85.71  | 29.65              | 39% | 0     | 100   | 33 | 10.12 | 0.009     |
|          | Post | 64.92   | 69.05  | 28.80              | 44% | 0     | 100   | 33 | 9.83  |           |
| Domain D | Pre  | 37.73   | 37.18  | 24.11              | 64% | 0     | 79.49 | 36 | 7.88  | 0.819     |
|          | Post | 38.64   | 35.90  | 24.43              | 63% | 0     | 87.17 | 36 | 7.98  |           |
| Domain E | Pre  | 24.37   | 19.44  | 20.80              | 85% | 0     | 93.06 | 36 | 6.79  | 0.621     |
|          | Post | 22.87   | 19.44  | 20.53              | 90% | 0     | 84.72 | 36 | 6.71  |           |

result, keeping in this way, the doubt as for the use of the GMFM in the evaluation of orthopedic surgeries.

There is also the question of follow-up time between the evaluations with the GMFM, which averaged 2.88 years in the present study. In a study to evaluate CP patients five years after orthopedic surgery,<sup>16</sup> something interesting was found. The improvement was considered as significant between the first and second years after the procedure, leading to the belief that the best time for the reapplication of the GMFM be this period.

To summarize, the physician needs objective criteria to evaluate the mobility problems of CP patients to be able to make the appropriate decision in relation to orthopedic surgeries as much as to other interventions such as orthoses, medication, and physical therapy treatment. Another example of this type of evaluation, the tridimensional gait analysis (gait laboratory) that many clarifies the mobility difficulty and explains also the deformities that interfere with its pattern.<sup>17</sup> Other measures that show the evolution and confirm the improvement in gait after surgical procedures include the Gillete Gait Index (GGI),<sup>10,15,16,18</sup> the Functional Mobility Scale (FMS),<sup>9,15,16</sup> the Gait Profile Score (GPS),<sup>15,16</sup> and the Gillete Functional Assessment Questionnaire (FAQ).<sup>9</sup>

The GGI and the GPS are measures made after the tridimensional gait analysis and, although reliable, is not available everywhere and represents a considerable additional cost which makes them not ideal to be standardized in the evaluation of all patients, and may be reserved for the most complex cases in order to help the decision of the surgical team.

The FAQ is a functional scale that evaluates the gait through a questionnaire answered by the parents of the patient or by the responsible persons. The FMS was developed to measure the functional mobility of the CP patients in three different environments (home, school, and long distances), taking into consideration the use of gait assistance devices, providing thus more information on the patient. Its advantage is the fact of measuring what the patient actually does and not what he or she could do,<sup>13</sup> even if it also does not evaluate the gait quality, which would be interesting for the surgical planning of these patients.

## CONCLUSION

In the present study, there was no statistically significant difference between the GMFM pre and post orthopedic surgery, which was also observed in other studies that used this scale as an evaluation means. The drop observed in the C domain of the GMFM (crawl and kneel) may be explained by the nature and objective of some of the surgeries performed (knee extension). Despite being a greatly used treatment and with positive results seen in daily clinical practice, the objective evaluation of the orthopedic surgeries is still a challenge. The number or variables involved, the evaluation method, and the follow-up time are important factors that make it even more difficult to obtain solid data.

Other studies with a larger number of patients, more appropriate evaluation methods, and follow-up time of one year, as suggested by the literature, would be necessary for an

objective perception of the results from orthopedic surgeries in the lower limbs of patients with CP and limited mobility.

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