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ORIGINAL PAPER

Functional outcome after lengthening with and without deformity correction in polio patients

Khaled M. Emara · Ahmed Khames

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Abstract Poliomyelitis is one of the causes of limb length discrepancy. The aim of lengthening and deformity correction in such patients is to improve the functional mobility of the patient. This study aims to find out whether or not improvement of limb length inequality with or without deformity correction affects or improves ambulation. This prospective study included 32 skeletally mature patients managed using the Ilizarov technique and external fixation for limb lengthening with or without deformity correction. Functional Mobility Scale scoring was used for assessment of ambulation before lengthening and at the final follow-up. The average duration of follow-up was 2 years and 9 months. Lengthening alone did not change the Functional Mobility Scale score. While lengthening associated with deformity correction improved the mobility scale at 5 m only (in the house), it had no effect on the 50 and 500 m score.

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K. M. Emara
Department of Orthopaedic Surgery, Ain Shams University,
Cairo, Egypt

A. Khames
Orthopaedic Surgery Department, El Mabara Hospital,
Cairo, Egypt

K. M. Emara (✉)
13 B Kornesh EL Nile, Agha Khan,
Cairo, Egypt
e-mail: kmemara@hotmail.com

Résumé La poliomyélite est une des causes de l'inégalité de longueur des membres. Le but du traitement est de corriger l'inégalité et la déformation axiale, chez ces patients, afin d'améliorer le résultat fonctionnel et la mobilité. Cette étude a pour but de déterminer si l'amélioration est suffisante avec le traitement isolé de l'inégalité ou si elle nécessite de corriger également la déformation de façon à optimiser l'autonomie de marche. Une étude prospective incluant 32 patients en fin de croissance a été conduite dans ce sens. Le traitement de l'inégalité de longueur a été réalisé selon la méthode d'Ilizarov avec ou sans correction de la déformation axiale. Le résultat fonctionnel a été évalué selon une échelle d'autonomie avant l'allongement et au dernier suivi. Le suivi moyen a été de deux ans et neuf mois. L'allongement isolé ne change pas le score fonctionnel alors que l'allongement associé à la correction de la déformation axiale améliore celui-ci mais seulement sur 5 mètres en déambulation intérieure, en effet entre 50 et 500 mètres, le score reste inchangé.

Introduction

Poliomyelitis is still a common condition in developing countries. Immunisation has decreased the number of new patients, but still there are many patients who qualify for the sobriquet "old polio patient" [6].

Poliomyelitis is a viral infection that affects the anterior horn cell. During the acute phase the patient experiences fever and progressive weakness; then, this acute phase resolves leaving the patient with residual permanent damage involving some anterior horn cells. The final form of weakness, the type of muscle involved and the functional outcome result depend on the number of anterior horn cells damaged.

This condition, which is associated with flaccid paralysis, commonly affects muscles of the lower limb. The paralysed muscles are affected in variable degrees with some muscles affected more than others. If this condition occurs during childhood, the resulting muscle imbalance and associated muscle contractures can result in abnormal development of the limb and limb length discrepancy with or without limb deformity. The patients with residual weakness, with or without deformity, are diagnosed as old polio patients [4].

Limb lengthening with or without deformity correction in skeletally mature patients with old polio is associated with more complications than other types of lengthening. Studies have shown slow bone consolidation [10], the development of contractures during lengthening, and recurrence or progression of the existing deformities even after the lengthening phase has finished [5]. To decrease this high complication rate, many modifications have been described, including bone grafting [7, 11], lengthening over a nail [2], early removal of external fixation and replacement by internal fixation [12], aggressive physical therapy, and stabilisation of joints above and below the lengthened bone [1]. Some authors recommend adding bony fusion following correction of the soft tissue deformity in the foot to avoid recurrence [4].

Both patient and surgeon in polio cases are looking for better functional outcome after treatment. The treatment includes redistribution of muscle power by tendon transfer to improve the muscle balance, joint stability by osteotomy or fusion, followed by deformity correction, and limb length equalisation. So far, there has been no medication or surgery that can be applied to regain the paralysed muscle power. Thus, the aim of surgery in polio is to improve the function, not to make a normal limb.

The objective of this study is to find out the effect of limb lengthening on function in skeletally mature old polio patients, and whether or not limb lengthening in this group of patients improves their ambulation level.

Materials and methods

This study included 32 patients (13 male and 19 female) with old polio. All had a history of poliomyelitis during their childhood, with unilateral lower limb residual weakness and limb length discrepancy. The mean age at the time of presentation was 18 years and 9 months (range 16 years and 2 months to 20 years and 4 months).

Inclusion criteria included skeletally mature patients with old poliomyelitis presenting with limb length discrepancy (with or without deformity) due to this paralytic condition. Patients managed using Ilizarov external fixation were included. The excluded patients included those managed by lengthening over a nail or those managed by internal fixation during or after external fixation. Also excluded were patients who needed multiple surgery for bone graft or bone marrow injection at the lengthening site, or patients with fractures of the distraction callus that needed casting or surgical intervention. Patients with associated femoral lengthening were also excluded. All these patients were excluded to avoid the effect of the other variables other than tibial lengthening and deformity correction on the outcome.

All patients presented with a chief complaint of limb length discrepancy with or without associated deformity. All patients stated at the time of presentation that they would like to improve their gait and function, how they look and their walking distance.

At the time of presentation the Functional Mobility Scale (FMS) [2] was used to assess their functional level. The patients involved in the study were treated by tibial lengthening with correction of the associated deformity—if present—using the Ilizarov technique and external fixation system. Associated foot deformity was managed using the Ilizarov technique and selective fusion of the involved joints. In cases of knee flexion deformity distal femoral extension osteotomy was performed with internal fixation.

The follow-up after removal of the external fixation and full fusion and consolidation of the distraction callus ranged between 4 years and 9 months to 1 year and 10 months (average 2 years and 9 months). The Functional Mobility Scale (FMS) was used at the final follow-up. We compared the preoperative FMS score with the final follow-up FMS score to find out whether or not the ambulation level changed after the lengthening procedures, and whether the deformity correction with limb lengthening improved the outcome.

The FMS rates the walking ability at three specific distances: 5, 50 and 500 m. This represents mobility at home, at school and in the community setting. The observer is asked to rate the walking ability of the patient at each of the three distances according to the need for assistive devices such as crutches, walkers or wheelchairs [3].

Data were collected, revised, verified, and then edited on PC. Data were then analysed statistically using SPSS statistical package version 13. The following non parametric tests were used: Median and Standard error of the Mean, Mann-Whitney test, and Wilcoxon Signed Ranks test.

Results

Out of the 32 patients, 21 presented with limb length discrepancy without associated deformity. The remaining 11 patients presented with limb length discrepancy associated with deformity involving the ipsilateral foot and/or knee. Twenty-eight patients out of the 32 had had previous surgical treatment (before presentation for limb lengthen-

ing) for management of muscle imbalance by tendon transfer, or deformity correction by soft tissue release with or without bony osteotomy, and bone stabilising operations in the form of selective joint fusion in the foot, or pelvic osteotomy for hip stability.

There was no statistically significant difference between the two groups of patients (with and without deformity) regarding age, sex and the limb length discrepancy.

The average limb length discrepancy at initial evaluation was 7.0 cm (range 4.2 to 8.4 cm). Diagnosis was based on clinical evaluation, plain radiographs and CT scans. The average lengthening was 5.2 cm (range 3.5 to 7 cm). All frames were maintained in situ until full consolidation of the distraction callus and healing of the foot joint fusion if used.

The average duration of external fixation was 11.3 months (range 8–15 months). The deformity correction in 11 patients was in the form of correction of residual tibial valgus deformity in 5 patients, foot deformity in 10 patients and supracondylar extension osteotomy with internal fixation in 1 patient for residual knee flexion deformity. In cases of tibial valgus deformity correction was achieved during the gradual distraction at the corticotomy site by Ilizarov frame adjustment. Patients with foot deformity were treated by triple fusion with correction and external fixation using extension of the Ilizarov frame to the foot.

The corticotomy site for lengthening was at the junction of the proximal and middle thirds of the tibia in all patients.

The external fixation was removed after full consolidation and healing of the distraction callus, and the mean healing index (also the external fixation index) was 2 months per cm (range 1.8–2.3 months per cm).

The FMS scores were compared in the two groups of patients (shortening with deformity and shortening without associated deformity), for the 5, 50 and 500 m ambulation scores, both before and after surgery. There was a statistically significant difference between the two groups in the preoperative 5 and 50 m ambulation score for the group of patients with shortening plus deformity who had a lower score than those with shortening without deformity. However, regarding the preoperative 500 m ambulation score, there was no statistically significant difference between the groups. Regarding the postoperative final FMS score, there was no statistically significant difference between the groups according to the 5, 50 and 500 m ambulation scores (Table 1).

Comparison between the preoperative and final FMS scores showed no statistically significant difference in the group of patients who underwent lengthening, but did not have deformity. In the other group with lengthening and deformity correction, there was a statistically significant difference between the preoperative and the final FMS scores in the 5 m function, with improvement in the final follow-up score. The 50 and 500 FMS scores showed no statistically significant improvement (Table 2).

Table 1 Comparison of the group of patients who underwent lengthening only with the group of patients who underwent lengthening plus deformity correction

	Before lengthening FMS 5 m	Before lengthening FMS 50 m	Before lengthening FMS 500 m	After lengthening FMS 5 m	After lengthening FMS 50 m	After lengthening FMS 500 m
Lengthening only group (n=21)						
Mean	4.4286	3.7619	2.8571	4.4762	3.9048	2.8571
Standard deviation	0.8106	0.9952	1.3522	0.7496	1.2611	1.3887
Median	5	4	3	5	4	3
Standard error of the mean	0.1769	0.2172	0.2951	0.1636	0.2752	0.3030
Lengthening and deformity correction group (n=11)						
Mean	3.3636	3.0909	2.000	4.000	3.2727	2.000
Standard deviation	0.5045	0.5394	0.6325	0.6325	0.6467	0.6325
Median	3	3	2	4	3	2
Standard error of the mean	0.1521	0.1626	0.1907	0.1907	0.1950	0.1907
Mann–Whitney U test	36.500	61.000	71.500	74.000	72.000	72.500
Z	−3.305	−2.327	−1.798	−1.793	−1.791	−1.758
Significance	0.001 (highly significant)	0.020 (significant)	0.072 (not significant)	0.073 (not significant)	0.073 (not significant)	0.079 (not significant)

The statistical analysis shows a significant difference between the two groups with regard to the FMS score before treatment in the 5 and 50 m scores, which improved in the deformity correction group. After treatment there was no statistically significant difference between the groups.
FMS Functional Mobility Scale

Table 2 Comparison of FMS score before and after lengthening in the two groups of patients, showing statistically significant improvement in 5 m ambulation in patients treated by lengthening and deformity correction

	FMS score for 5 m before vs. after lengthening	FMS score for 50 m before vs. after lengthening	FMS score for 500 m before vs. after lengthening
Lengthening only group (n=21)			
Z	−0.577	−0.749	0.000
Significance	0.564 (not significant)	0.454 (not significant)	Not significant
Lengthening and deformity correction group (n=11)			
Z	−2.070	−0.816	0.000
Significance	0.038 (significant)	0.414 (not significant)	1.000 (not significant)

There was no statistically significant difference in the lengthening only group and with regard to the 50 and 500 m ambulation scores in the lengthening and deformity correction group.

Discussion

The aim of surgery in poliomyelitis patients can include improvement of the limb function and/or the cosmetic appearance of the limb. The types of surgery used to achieve these goals are muscle balance, deformity correction, joint stability and limb length equalisation [8]. Tibial lengthening procedures in poliomyelitis patients are associated with frequent complications. The most common complications recorded in such cases are delayed consolidation and recurrent equinus contracture of the ankle requiring additional lengthening of the Achilles tendon [10]. In our patients, we held the ankle in the proper position during lengthening using the Ilizarov frame (by a foot plate attached to the tibial frame) to avoid development of equinus deformity. Aggressive physical therapy was also required on the ipsilateral knee to avoid development of knee flexion contracture. Another common complication is pin site infection and discomfort. This discomfort is very common with external fixation and the longer the duration of the external fixation the higher the risk of pin site infection [9]. Other less frequent complications include peroneal nerve palsy and compartment syndrome.

Despite all these complications, patients with poliomyelitis are willing to undergo this lengthy procedure with the hope of better function and ambulation.

For assessment of ambulatory function we looked at many scoring systems, trying to find a score that focuses on the ambulation function and is least affected by other variables. We found that the Functional Mobility Scale (FMS) [3] is the most appropriate. This scale is used and has been validated for cerebral palsy patients between the age of 6 and 18 years, and can also be used for spina bifida patients. In our opinion, this scale is the most appropriate for our group of patients because it focuses on mobility without the distractions of other variables such as residual bone or joint deformity, brain intellectual function or type of neurological involvement, or other variables that can affect the score without giving a clear, idea of the ambulatory function, which is the focus of this study.

The objective of the study was to find out whether or not tibial lengthening for limb length equalisation improves the functional mobility of these patients. In all patients the lengthening was achieved, maintaining a residual 1–2 cm limb length inequality. This was part of the treatment plan to make it easier for the patient to clear his weak limb from the ground as recommended by many authors [5, 10].

The paralysed muscle cannot be transformed into a normal muscle by surgery or medication in old polio patients. The aim of treatment is to improve the limb function, not to make it normal, and this must be made very clear to the patient. Some patients have high expectations of what doctors can achieve at present. The use of this study is to help the doctor and the patient to set clearer, more realistic goals in the treatment plan, and to make it easier for the treating surgeon to answer some of the patients' questions.

From the data in this study preoperative ambulation level in patients with deformity was statistically significantly less than in patients without deformity at 5 and 50 m (in house and school), but there was no statistically significant difference between the two groups of patients at 500 m ambulation.

As can be seen from the statistical analysis of our data, lengthening alone does not improve the ambulatory function, while patients with deformity correction and lengthening achieve improvement of function (statistically significant) at short distance ambulation only (5 m or inside the house). However, there is no statistically significant change regarding 50 and 500 m ambulation.

Conclusion

Deformity correction in old polio patients can help to improve the ambulatory function at 5 m and 50 m, but not at 500 m. Lengthening alone can improve the appearance of

the limb, but not the ambulatory function. Lengthening and deformity correction combined can be helpful to improve function in short distance ambulation. This information needs to be communicated and shared with the patient to give a better idea about what to expect after lengthening.

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