Research article

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The treatment of femoral fractures in children with cerebral palsy

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Abstract

Objectives. The purpose of this study is to retrospectively evaluate a group of children affected by cerebral palsy with a recent femoral fracture, and to analyse the results and complications in relation to the treatment used.

Materials and methods. The analysis was performed on 36 children (21 M, 15 F, 8-14 years old) with cerebral palsy (7 diplegia, 28 tetraparesis, 1 hemiplegia) with a metaphyseal or a diaphyseal femoral fracture. The patients were subdivided into two groups according to their Gross Motor Function Classification System (GMFCS) level: level 2-3 (9 patients) and level 4-5 (27 patients), evaluating the presence of complications and malunions for each group at the end of each follow up.

Results. The fractures were displaced in 24 patients and non-displaced in 12 patients. In 26 cases the treatment involved a closed reduction and immobilisation in a long leg hip spica cast for 7 weeks, while in 10 cases the treatment involved an open reduction-internal fixation (ORIF) followed by a 3-week period in a plaster coated fracture bandage.

Conclusions. Taking into consideration the maximum possible recovery of function, an ORIF is preferable to prevent malunion, particularly in distal metaphysis and distal shaft fractures. In the GMFCS level 2-3 patients, surgery has allowed to recover, or at least maintain, the pre-fracture functional level, while in patients with GMFCS level 4-5, it has allowed to reduce the immobilisation times and prevent the development of decubitus lesions. ***Clin Ter 2018; 169(1):e18-22. doi: 10.7417/CT.2018.2049***

Key words: *cerebral palsy, children, femoral fracture, internal fixation, management, treatment*

Introduction

Infant cerebral palsy (ICP) is part of a group of disorders that cause a reduced motor function. This is due to central cerebral damage during the perinatal or postnatal period. The patient suffering from childhood cerebral palsy presents with motor deficiency, altered muscle control and an increased muscular tone. The central lesion remains unchanged, but the motor function progressively worsens with the years. In addition, patients suffering from childhood cerebral palsy also have visual, cognitive and communication deficits (1,2).

In these patients, there is a higher risk of fractures caused by low energy traumas due to the reduced mobility, hormonal factors and chronic intake of anticonvulsants, which cause a reduction in bone mineral density (3,4,5).

During the necessary immobilisation in case of fracture, the bone density decreases even further and this, in turn, can cause new fractures (6,7,8).

For this reason, the treatment of fractures in children with cerebral palsy should avoid any prolonged immobilisation and guarantee a speedy recovery, in order to prevent the loss of any pre-fracture functional and autonomy level. In patients with pre-fracture Gross Motor Function Classification System (GMFCS) levels 2 or 3, the treatment of choice should be one that prevents the deterioration of ability and motor function.

Conversely, a conservative treatment (9,10,11) is preferred in patients affected by ICP with severe motor disability and low recovery potential.

The spasticity and hypertonicity are often responsible, in up to 85% of cases, for secondary breaks of the immobilised fractures or malunion (12). Consequently, in non-surgically treated cases, the maintenance of the fracture reduction should be closely monitored. Post-operative monitoring is difficult in patients with more severe forms of CP, namely those with Gross Motor Function Classification System (GMFCS) levels 4 or 5, due to their poor verbal capacity and communication difficulties. In these cases, there is a high percentage of decubitus lesions or neurovascular complications secondary to plaster cast immobilisation (13). Scales such as the Non-Communicating Children's Pain Checklist (NCCPC) may be useful to assess the pain level in these patients, particularly in its "Post-operative Version" (NCCPC-PV) format (14).

The treatment of fractures in children affected by ICP must also take into account the difficult management of comorbidities, which can cause general complications such as infections or respiratory disorders (15).

Our retrospective study, conducted on a group of patients affected by ICP with meta-diaphyseal femoral fractures, examined the results of the surgical and non-surgical treatments, in relation to the functional level before the fracture,

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according to the GMFCS (16,17). The aim of our study is to describe and analyse the results of different treatments and the possible complications that can occur in children with cerebral palsy affected by meta-diaphyseal femoral fractures, trying to make them able to recover as faster as possible the best quality of life that they could have and prevent the possible orthopaedic and clinical complications that can occur in those frail patients when a femoral fracture occurs.

Materials and methods

A retrospective review was performed on a sample of 36 children (21 males and 15 females aged from 8 to 14 years old) with ICP (7 with diplegia, 28 with tetra-paresis and 1 with hemiplegia) with a metaphyseal or a diaphyseal femoral fracture, for which they were selected. They were treated between 2009 and 2014 at the Orthopaedics and Traumatology Department in the Sapienza University of Rome.

The patients were subdivided into two groups according to their Gross Motor Function Classification System (GMFCS) level: GMFCS level 2-3 (9 patients) and GMFCS 4-5 (27 patients), evaluating the presence of complications and malunions for each group at the end of each follow up (Tab. 1).

The full remodelling of the fracture was assessed through X-rays in two orthogonal projections, basing on the following patterns: the bone callus presence on at least three parts

Table 1. Table of the cases analyzed.

TREATMENT	GMFCS	FORM	SITE	DISPLACEMENT	MALUNION	COMPLICATIONS
CAST	2-3	DIPLEGIA	D	NO	-	-
CAST	2-3	HEMIPLEGIA	D	NO	-	-
K-WIRES	2-3	TETRA	DMe	YES	YES	-
CAST	2-3	DIPLEGIA	P	NO	-	-
CAST	2-3	TETRA	D	NO	-	-
CAST	2-3	DIPLEGIA	M	YES	-	LoR
PLATE	2-3	DIPLEGIA	D	YES	-	-
K-WIRES	2-3	DIPLEGIA	DMe	YES	-	-
EXFIX	2-3	TETRA	M	YES	-	PNEUMONIA
CAST	4-5	TETRA	D	NO	-	-
CAST	4-5	TETRA	D	YES	YES	-
CAST	4-5	TETRA	D	YES	YES	-
CAST	4-5	TETRA	D	NO	-	DECUBITUS (II S)
CAST	4-5	TETRA	D	YES	YES	DECUBITUS (II S)
CAST	4-5	TETRA	D	NO	-	PNEUMONIA
CAST	4-5	DIPLEGIA	DMe	NO	YES	-
CAST	4-5	TETRA	M	YES	YES	DECUBITUS (I S)
CAST	4-5	TETRA	M	YES	YES	-
CAST	4-5	TETRA	D	YES	YES	-
CAST	4-5	TETRA	P	NO	-	DECUBITUS (II S)
CAST	4-5	TETRA	D	YES	YES	-
CAST	4-5	TETRA	D	YES	-	DECUBITUS (I S)
CAST	4-5	TETRA	DMe	YES	YES	-
CAST	4-5	TETRA	P	YES	YES	DECUBITUS (I S)
CAST	4-5	TETRA	D	NO	-	-
CAST	4-5	TETRA	D	NO	-	-
CAST	4-5	TETRA	D	YES	-	DECUBITUS (I S)
CAST	4-5	TETRA	D	NO	-	-
CAST	4-5	TETRA	DMe	YES	YES	-
CAST	4-5	TETRA	P	YES	-	-
K-WIRES	4-5	DIPLEGIA	D	YES	-	-
K-WIRES	4-5	TETRA	D	YES	YES	-
EXFIX	4-5	TETRA	M	YES	-	INFECTION
K-WIRES	4-5	TETRA	D	YES	-	-
NAIL	4-5	TETRA	P	YES	-	-
NAIL	4-5	TETRA	P	YES	-	-

GMFCS: Gross Motor Function Classification System; D: Distal shaft;
P: Proximal shaft; M: Midshaft; DMe: Distal Metaphysis; EXFIX: External Fixator; LoR: Loss of reduction; I/II S: grades in decubitus lesions according to Shea Classification.

of the cortex, the bone gap bridging and the measurement of the axes.

The cases with a malunion were defined if they presented at least one of the following: a limb shortening higher than 2 cm, an angle higher than 30° on the sagittal plane and/or 10° on the front plane, a rotation higher than 10°.

Ethical approval: all procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical standards. Informed consent was obtained from all the individual participants included in the study.

Results

In all the cases except one (car accident), the fractures were caused by low energy trauma (mobilisation during nursing or therapy).

All the fractures were closed and no patient suffered bilateral fractures. The fractures were displaced in 24 patients (67%) and non-displaced in 12 patients (33%).

The fracture involved the distal shaft in 20 cases (56%), the distal metaphysis in 5 cases (14%), the proximal shaft in 6 cases (16%) and the midshaft in 5 cases (14%) (Tab. 1).

The fracture was transverse in 16 cases (44%), spiroid in 10 cases (28%) and oblique in the remaining 10 cases (28%).

In 26 cases (all 12 non-displaced fractures and 14 displaced fractures), the treatment involved a closed reduction and immobilisation in a long leg hip spica cast for 7 weeks (72%), while in 10 cases (all of them with displaced fractures), the treatment involved an open reduction-internal fixation (ORIF) (1 plate, 5 K-wires, 2 nails, 2 external fixators) followed by a 3-week period in a plaster coated fracture bandage (28%).

GMFCS Group level 2-3

In this group of 9 patients, 5 were treated with plaster cast immobilisation (55%). One patient suffered a loss of reduction after two weeks and had to undergo an ORIF with an intramedullary nail. However, to a statistical aim, this patient was considered as part of the cast group and the loss of reduction as a complication in the treatment (Tab. 1).

The other 4 patients (45%) were treated with an ORIF (2 cases with percutaneous K-wires, 1 case with Locking Compression Plate, 1 case with external fixator).

A malalignment occurred in 1 case (distal metaphysis fracture: osteosynthesis with percutaneous K-wires) and 1 patient suffered respiratory complications (pneumonia) (Tab. 2).

The total amount of complications in this group was 3 out of 9 cases (33%).

Table 2. Complications per group in relation to fracture site and treatment type.

	PROXIMAL SHAFT	MIDSHAFT	METAPHYSIS & DISTAL SHAFT
DISPLACED FRACTURE + ORIF (10 PATIENTS)			
GMFCS 2-3	0	1 PNEUMONIA	1 MALUNION
GMFCS 4-5	0	1 INFECTION	1 MALUNION
DISPLACED FRACTURE + CLOSED REDUCTION (14 PATIENTS)			
GMFCS 2-3	0	0	0
GMFCS 4-5	1 LESION 1 MALUNION	2 MALUNION	3 LESIONS 7 MALUNION
NON-DISPLACED FRACTURE + ORIF (0 PATIENTS)			
GMFCS 2-3	0	0	0
GMFCS 4-5	0	0	0
NON-DISPLACED FRACTURE + CLOSED REDUCTION (12 PATIENTS)			
GMFCS 2-3	0	0	0
GMFCS 4-5	1 LESION	0	1 MALUNION 1 LESION 1 PNEUMONIA

GMFCS: Gross Motor Function Classification System.

GMFCS Group level 4-5:

In this group of 27 patients, 21 were treated with a closed reduction and a hip-spica cast for 7 weeks (78%). Decubitus lesions (according to Shea Classification, 4 grade I and 3 grade II), which required subsequent dressing, developed in 7 of the cases (26%). In 11 cases (41%), the consolidation of the fracture resulted in a malalignment (3 distal metaphysis fractures, 5 distal shaft fractures, 1 proximal shaft fracture and 2 midshaft fractures). However, this latter complication did not affect the achievement of the seated position, the functional level and nursing.

In 6 patients (22%), the treatment was an ORIF (3 cases osteosynthesis with percutaneous K-wires, 1 case with external fixation, 2 cases with intramedullary nailing). In 1 case, the consolidation of the fracture resulted in a malalignment (a distal shaft fracture treated with K-wires). In 2 patients, respiratory (pneumonia) and infectious complications occurred (Table 2).

The total amount of complications in this group, considering also the decubitus lesions, was 9 out of 27 patients (33%).

Discussion

Low bone density is proportionally correlated with the GMFCS level, the severity of the neurological framework, the dietary difficulties and the intake of anticonvulsants (4,6,7,8,9,18,19). For these reasons, most fractures occur as a result of low energy traumas or the simple mobilisation of the patient.

The GMFCS is based on the concepts of abilities and limitations in gross motor function and is analogous to the staging and grading systems used in medicine to describe cancer. Palisano et al. believe that this approach to classification can enhance communication among professionals and families with respect to the utilization of rehabilitation services, the creation of databases and registries and the comparison and generalization of the results of program evaluations and clinical research (20). The GMFCS is designed for children with ICP and it has 5 levels that are based on differences in self-initiated movement, with particular emphasis on sitting and walking.

The literature agrees that in patients with post-traumatic spasticity and favourable functional prognosis, the treatment of the fracture requires an anatomic reduction and stable synthesis (4,9,13,21,22). Conversely, in patients with infantile cerebral palsy who suffered a femoral fracture, the treatment prescribed must take into account the uncertain rehabilitation outcomes and the pre-fracture functional level (10). In fact, if an unsuccessful result in a patient with a GMFCS level of 2-3 is able to worsen their functional level, often the same result does not affect nursing and the low functional level in a patient with a GMFCS level of 4-5.

In addition, post-treatment management should always take into consideration general complications (such as pneumonia and infections) and the high rate of decubitus lesions that developed in the plaster cast, especially in those patients with difficulty verbalising and communicating.

With regard to the type of treatment, the percentage of malunion was higher in patients treated with closed reduction (11 cases) compared to those treated with ORIF (2 cases with K-wires).

With regard to the fracture type, the percentage of malunion was found to be higher in distal shaft fractures and in distal metaphysis fractures. Malunion also lead to a deterioration of function in patients with GMFCS levels 2-3.

Local complications (decubitus lesions) were found most frequently in patients treated with closed reduction and, in particular, in the most severe ICP types, with higher communication difficulties. General complications (respiratory or infectious) were more frequent in patients treated with an ORIF.

The exiguous GMFCS level 2-3 patient sample did not permit a significant statistical comparison analysis between the two groups. In subsequent assessments, a larger number of subjects treated with ORIF should also be included, in order to obtain a comparison between numerically homogeneous samples and achieve statistical significance.

However, this data confirms the fact that, in patients with a GMFCS level 2-3, the bone density values are higher and the fracture rate can be therefore lower than that of the patients with the more severe GMFCS levels 4 or 5.

An ORIF is preferable in order to prevent malunion, particularly in distal metaphysis and distal shaft fractures (23). In the GMFCS level 2-3 patients, surgery has allowed to recover, or at least maintain, the pre-fracture functional level, while in patients with GMFCS level 4-5, it has allowed to reduce the immobilisation times and prevent the development of decubitus lesions.

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