

Bone Fractures in a Neonatal Intensive Care Unit



Fraturas Ósseas em uma Unidade de Cuidados Intensivos Neonatais

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ABSTRACT

Introduction: Fractures during the neonatal period are rare. Some fractures, especially long bones, may occur during birth. Moreover, neonates hospitalized in the Neonatal Intensive Care Unit have an increased risk of fractures for several reasons.

Objective: To evaluate the incidence and characterize fractures in newborns admitted in a tertiary Neonatal Intensive Care Unit.

Material and Methods: A retrospective analysis of the newborns admitted to the Neonatal Intensive Care Unit with a diagnosis at discharge of one or more bone fractures from January 1996 to June 2013.

Results: Eighty neonates had one or more fractures. In 76 (95%) infants the fractures were attributed to birth injury. The most common fracture was the clavicle fracture in 60 (79%) neonates, followed by skull fracture in 6 (8%). In two (2.5%) neonates, extremely low birth weight infants, fractures were interpreted as resulting from osteopenia of prematurity. Both had multiple fractures, and one of them with several ribs.

Conclusion: A change in obstetric practices allied to improvement premature neonate's care contributed to the decreased incidence of fractures in neonatal period. But in premature infants the diagnosis may be underestimated, given the high risk of fracture that these infants present.

Keywords: Fractures, Bone/epidemiology; Infant, Newborn; Intensive Care Units, Neonatal; Portugal.

RESUMO

Introdução: As fraturas ósseas são raras durante o período neonatal. Algumas das fraturas, sobretudo as de ossos longos, podem ocorrer durante o parto. Por outro lado, os recém-nascidos internados em Unidades de Cuidados Intensivos Neonatais têm um risco aumentado de fraturas ósseas por várias razões.

Objetivo: Avaliar a incidência e caracterizar as fraturas ósseas nos recém-nascidos internados numa Unidade de Cuidados Intensivos Neonatais nível III.

Material e Métodos: Análise retrospectiva dos recém-nascidos internados na Unidade de Cuidados Intensivos Neonatais com o diagnóstico na alta de uma ou mais fraturas ósseas, entre janeiro de 1996 a junho de 2013.

Resultados: Oitenta recém-nascidos apresentaram uma ou mais fraturas ósseas. Em 76 (95%) recém-nascidos, as fraturas foram atribuídas a traumatismo do parto. A fratura mais comum foi da clavícula em 60 (79%) recém-nascidos, seguida da fratura craniana em 6 (8%) recém-nascidos. Em dois (2,5%) recém-nascidos, prematuros de extremo baixo peso, as fraturas foram interpretadas como decorrentes de osteopenia da prematuridade. Ambos apresentaram fraturas múltiplas, um dos quais de várias costelas.

Conclusão: Uma mudança das práticas obstétricas, aliada à melhoria dos cuidados prestados ao recém-nascido prematuro contribuíram para a diminuição da incidência de fraturas ósseas no período neonatal. Contudo nos recém-nascidos prematuros o seu diagnóstico pode estar subestimado, dado o elevado risco de desenvolvimento de fratura que estes recém-nascidos apresentam.

Palavras-chave: Fraturas Ósseas/epidemiologia; Portugal; Recém-Nascido; Unidades de Cuidados Intensivos Neonatais.

INTRODUCTION

Bone fractures are a rare event in the neonatal period.¹ However, birth-related long-bone fractures namely of the clavicle, associated to shoulder dystocia and skull fractures mostly related to the use of forceps or ventouse have been known to occur.² In addition, newborns (NB) admitted to Neonatal Intensive Care Units (NICU) have an increased risk of bone fractures due to several reasons including prematurity, low-birth weight, malnutrition, as well as medical and drug-related trauma.¹⁻⁵ Fracture specific cause is generally difficult to determine in premature NB and is often attributed to osteopenia of prematurity.¹ Most cases

are incidentally diagnosed in X-rays performed for other reasons and therefore the exact incidence of fractures in premature NB is unknown.² According to the few published studies, the incidence of fractures is very variable, between 1.2 and 10.5%, being higher in very low birth weight (VLBW) infants.^{1,6}

Our study aimed to assess the incidence and characteristics of bone fractures in NB admitted to a single-centre level-III NICU, in order to optimize the best preventative and therapeutic approach.

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MATERIAL AND METHODS

This was a retrospective study based on clinical records of all NB admitted to our NICU and diagnosed at discharge with one or more bone fractures, from January 1996 to June 2013. The following variables were analysed: gestational age; birth weight; gender, delivery type; reason for admission; neonatal complications, including hyaline membrane disease (HMD), bronchopulmonary dysplasia (BPD), nosocomial sepsis, necrotizing enterocolitis (NEC), patent arterial duct (PAD), intraventricular haemorrhage (IVH), periventricular leukomalacia (PVL) and retinopathy of prematurity (ROP) and therapy, including postnatal steroids and surfactant replacement therapy, diuretics, invasive mechanical ventilation, phototherapy and sedation.

RESULTS

In total, 7,364 patients were admitted to our Department over the study period. From these, 80 NB were diagnosed with one of more bone fractures, corresponding to a 1.1% prevalence.

Fractures were related to birth trauma in 76 (95%) NB (Table 1). Clavicle fracture was the most frequent, found in 60 (79%) NB. Vaginal delivery was mostly used (97%) and ventouse was applied in 31%. An injury to the brachial plexus was found in 20% of NB, with a 100% full recovery. However, none of these newborns was admitted for a clavicle fracture. The reason for admission to the NICU was variable: birth defect (including cardiac) (n = 15), infectious pathology (n = 14), pulmonary pathology (n = 8), surgical

pathology (n = 6), perinatal asphyxia (n = 5), jaundice (n = 3) and others (n = 9).

The second most observed birth trauma-related fracture was a fracture to the skull, found in 6 (8%) NB. Most (n = 5) of these were born by ventouse; caesarean was required in one case, due to unsuccessful foetal extraction attempt. All of these five NB except the one who was born by caesarean presented with subdural or subarachnoid haemorrhage. One was admitted in hypotensive shock with metabolic acidosis quickly progressing to multi-organ failure and finally died. Another NB started with seizures on the first hours of life and progressed with brain paralysis. The remaining had a full recovery.

As regards NB with other birth trauma-related fractures there was one 34-week premature NB with hypoxic-ischaemic encephalopathy due to multi-organ failure who died and in whom a post-partum humeral fracture was found.

Two (2.5%) NB were admitted with brain fracture related to head injury after a fall at home (Table 2). One of these (patient 1, Table 2) presented with extensive subarachnoid haemorrhage quickly progressing to hypovolemic shock and died. The other patient (patient 2, Table 2) presented with subdural haemorrhage, started with seizures three days after the head injury with a subsequent diagnosis of cerebral palsy.

Fractures were interpreted as associated to osteopenia of prematurity in the remaining two (2.5%) NB – extremely low birth weight (ELBW) premature NB (Table 3). One of

Table 1 – Birth trauma-related fractures (n = 76)

Caraterística	Valor
Gender	
Female	34 (45%)
Male	42 (55%)
Gestational age (median)	39 semanas (23 – 42 semanas)
Birth weight (median)	3,345 g (806 – 5,250 g)
Macrosomia	13%
Type of delivery	
Eutocic	45 (59%)
Ventouse	24 (32%)
Caesarean	6 (8%)
Forceps	1 (1%)
Fracture	
Clavicle	60 (79%)
Parietal	5 (7%)
Occipital	1 (1%)
Humeral	4 (5%)
Femur	3 (4%)
Ribs	2 (3%)
Nasal septum	1 (1%)
Hospital stay	6 dias (1 – 82 dias)
Decease	2 (3%)

Table 2 – Head injury-related fractures (n = 2)

Characteristic	Values	
	Patient 1	Patient 2
Gender	Female	Male
Gestational age at birth	39 weeks	40 weeks
Birth weight	2,850 g	3,348 g
Days of life when diagnosed	19 days	7 days
Fracture	Parietal	Parietal
Hospital stay	1 day	13 days
Decease	Yes	No

these (patient 1, Table 3) was diagnosed on D103 of life with a femur fracture due to the presence of a swelling on the left thigh and subsequently several fractured ribs diagnosed on skeletal x-ray. The other patient (patient 2, Table 3) was diagnosed on D57 of life with bilateral femur, left humerus and radius fractures and, on D144 of life with right humerus fracture visible in an x-ray obtained due to an infectious complication. At the time when these fractures were diagnosed, both NB presented with elevated alkaline phosphatase (AP) (patient 1: 775 U/L; patient 2: 456 U/L) and a low phosphate (patient 1: 3.4 mg/dL; patient 2: 2.5 mg/dL). The calcium serum levels were normal. In patient 2, parathyroid hormone (PTH) level was also found to be elevated (320 pg/mL) with a normal vitamin D (21.6 ng/mL).

DISCUSSION

Most diagnosed fractures were related to birth trauma. The clavicle fracture was the most frequent, occurring spontaneously in approximately 0.4 – 10% of vaginal deliveries and rarely in caesarean deliveries, in line with previous studies.^{7,8} The most consistent risk factor was the presence of high birth weight, particularly when above 4,000 g.^{8,9} Other associated risk factors include more than 52 cm in length, long second stage of labour,⁷ instrumental deliveries^{7,8} and higher maternal age.⁸ This type of fracture is also associated to shoulder dystocia,^{4,7-9} which was found in just two (3%) of our NB.

The incidence of clavicle fracture was very high in our group of patients; nevertheless, these were NB admitted to the unit due to other reasons and this fracture is not usually observed in NICU. NB with this type of fracture rarely present with symptoms and usually progress to long-term full recovery. We found a simultaneous injury to the brachial plexus in 20% of the patients in our study, a figure higher than the expected 9% frequency that has been described.⁷

Humeral fractures are the second most frequent long-bone fractures in NB,¹⁰ as found in our study. This type of fracture, as well as femur fractures are often associated to caesarean deliveries during delivery of the limbs.¹⁰⁻¹³ In our series only one patient born by caesarean delivery with fracture to the humerus was found, while the remaining

three were born by eutocic delivery, the latter considered “as difficult”. The same occurred in NB with femur fractures; only one from three NB was born by caesarean section.

As regards fractures to the skull, a 7.5% incidence was found in our group of patients (n = 6) and this was the most frequent birth-related bone fracture after clavicle fracture. Instrumental delivery is a major risk factor to this type of injury, as well as increase in the incidence of intracranial haemorrhage,^{4,14,15} as found in our results. Ventouse was applied to five (83%) NB with fracture to the skull and four (67%) presented with subdural or subarachnoid haemorrhage. The incidence of this type of trauma has been reduced due to changes in obstetric procedures.¹⁶ A 5% prevalence of fractures to the skull was found in a retrospective study involving skull X-ray imaging in every ventouse application.¹⁷ However, all were linear fractures in asymptomatic NB. It is interesting to mention that four of our patients were diagnosed during the last semester of the study.

Neonatal skull fractures may arise from trauma with another aetiology, exemplified by the two (2.5%) NB admitted to our NICU upon a fall at home. Around 1 to 3% of small falls may produce a skull fracture and very rarely this fracture may be related to a subdural haemorrhage.¹⁸ In this type of fracture, progression and long-term outcome mainly depend on direct trauma-related brain damage, regardless of the aetiology.¹⁴

Rib fractures in NB, especially to the posterior ribs, are rare and very indicative of non-accidental injuries.^{1,2} These are even more rarely associated to birth trauma and found in the context of “difficult” deliveries of heavy NB.^{1,19} Two (2.5%) NB with birth trauma-related rib fractures were surprisingly found in our group of patients, one related to the use of ventouse and one to forceps. None of these was submitted to CPR (cardiopulmonary resuscitation) manoeuvres, which is another extremely rare cause for rib fractures in this age group, although frequent in the adult.^{1,19}

Neonatal fractures may be associated to other aetiologies, mainly in premature NB admitted to the NICU. Around 80% of bone mineralization occurs during the third trimester of pregnancy and therefore premature NB have

Tabela 3 – Fractures related to osteopenia of prematurity (n = 2)

Characteristic	Values	
	Patient 1	Patient 2
Gender	Male	Male
Gestational age	28 weeks	31 weeks
Birth weight	880 g	506 g
SGA	No	Yes
HMD	Severe	Mild
Surfactant	3 doses	1 dosis
BPD	Yes	Yes
Postnatal steroids (duration)	12 days	13 days
Diuretics (duration)	69 days	7 days
Invasive MV (duration)	185 days	147 days
Nosocomial sepsis (positive blood culture)	Yes	Yes
NEC \geq 2 nd week	No	No
Symptomatic PAD	Yes	No
IVH \geq III \pm infarction	No	Yes
PVL	No	No
ROP grade \geq 2	No	No
Phototherapy (duration)	6 days	7 days
Sedation (duration)	38 days	32 days
Hospital stay	184 days	147 days
Decease	Yes	Yes

SGA: small for gestational age; HMD: hyaline membrane disease; BPD: bronchopulmonary dysplasia; MV: mechanical ventilation; NEC: necrotizing enterocolitis; PAD: patent arterial duct; IVH: intraventricular haemorrhage; PVL: periventricular leukomalacia; ROP: retinopathy of prematurity.

an increased risk of osteopenia,³ particularly those born before the 28th week of gestation, with low birth weight and/or a complicated immediate neonatal period, with the need for extended parenteral nutrition, necrotizing enterocolitis, conjugated hyperbilirubinemia, bronchopulmonary dysplasia and the use of furosemide.^{2,3}

Metabolic bone disease (MBD) of prematurity occurs in around 23% of very-low birth weight (VLBW) and in 55-60% of extremely-low birth weight (ELBW) NB.^{4,6} There is no metabolite considered as a single marker to MBD.⁴ Calcium and phosphate levels may be normal despite low reserve levels, due to the effect of PTH.^{4,6} PA elevation is the most widely accepted marker of MBD; however, cut-off values vary widely between studies, from 300 IU/L (maximum level considered as normal in NB) to 900 IU/L.^{1,5} Less than 10% incidence of fractures in ELBW NB are expected to occur.⁶ Only two ELBW NB with MBD-related fractures were identified in our group. Multiple, mainly rib, fractures are more frequent in this group of patients,¹ as found in our group, in which two patients presented with multiple fractures, one of them with several rib fractures.

The reduction in the incidence of fractures in this group is mainly due to improved healthcare delivery to premature NB.² An adequate Ca and P supply in parenteral nutrition, as

well as minimizing its duration, stronger breast milk, the use of specific premature formulas, the reduction in the use of steroids and diuretics, early vitamin D supplementation and limb mobilization are increasingly implemented attitudes in NICU, aimed at promoting bone mass increase.

CONCLUSION

Despite the reduction in the incidence of birth-related trauma, due to improved obstetric procedures, bone fractures, mainly to the clavicle, are still a frequent cause of neonatal morbidity. However, long-bone, birth trauma-related fracture outcome is usually favourable.

Premature newborns, mainly ELBW, have an increased risk for multiple fractures with a usually multi-factorial aetiology. However, the incidence of fractures was reduced in this group due to improved healthcare delivery to these NB. The incidence may be underestimated, as most fractures are asymptomatic and incidentally diagnosed in premature NB. In our study, the low incidence of fractures in this group of NB may also be explained by its retrospective nature. We conclude that prevention and early detection of MBD is fundamental, in order to determine treatment and therefore fracture prevention.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

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