



## FRACTURES OF LONG TUBULAR BONES IN NEWBORNS: MECHANISMS OF INJURIES, METHODS OF DIAGNOSIS, AND TREATMENT

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**Background.** Medical information on the provision of emergency trauma care to newborns with fractures of tubular bones is scarce.

**Aim.** This scientific review aimed to inform children's orthopedic traumatologists regarding the main mechanisms of injury, methods of diagnosis, and treatment of fractures of long tubular bones in newborns.

**Material and methods.** The article presents a systematic analysis of 60 scientific works of domestic and foreign authors on topical aspects of fractures of long tubular bones in newborns from 1986 to 2018. For writing the literature review, we used modern electronic databases of medical information: PubMed, MEDLINE, Ulrich's Periodicals Directory, DOAJ, Cyberleninka, and eLibrary.

**Results and discussion.** Similarly from the analysis of scientific publications, the main mechanism of fractures of limb segments in newborns is intranatal trauma, in which the child can receive both during birth through the birth canal and during cesarean section. The predisposing factors for obtaining bone fractures are intrauterine osteopenia, congenital diseases of the digestive system, and prematurity. Fractures are diagnosed on the basis of clinical examination and results of ultrasound and X-ray studies of the injured limb. In the treatment of limb bone fractures, both conservative and surgical methods are used. In recent years, a tendency has been clearly observed in scientific publications, highlighting the ever-widening introduction into clinical practice of operational methods for stabilizing fractures of long tubular bones in newborns, including using the techniques of transosseous osteosynthesis.

**Conclusion.** The presented article fills the existing gap of summarizing scientific publications on the treatment of fractures of limbs in newborns.

**Keywords:** newborns; fractures of long tubular bones; injury mechanisms; diagnosis; treatment.

## ПЕРЕЛОМЫ ДЛИННЫХ ТРУБЧАТЫХ КОСТЕЙ У НОВОРОЖДЕННЫХ: МЕХАНИЗМЫ ТРАВМЫ, МЕТОДЫ ДИАГНОСТИКИ И ЛЕЧЕНИЯ

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**Введение.** В настоящее время опубликовано незначительное количество научных статей, посвященных вопросам оказания экстренной травматологической помощи новорожденным с переломами трубчатых костей. **Цель** данного научного обзора заключалась в информировании широкой аудитории детских травматологов-ортопедов об основных механизмах травмы, о методах диагностики и лечения переломов длинных трубчатых костей у новорожденных.

**Материал и методы.** В статье представлен систематизированный анализ 60 научных работ отечественных и зарубежных авторов по актуальным аспектам переломов длинных трубчатых костей у новорожденных, опубликованных в период с 1986 по 2018 г. Для написания литературного обзора были использованы современные

электронные базы данных медицинской информации: PubMed, MEDLINE, Ulrich's Periodicals Directory, DOAJ, Cyberleninka, eLibrary.

**Результаты и обсуждение.** Как следует из анализа научных публикаций, основной механизм переломов сегментов конечностей у новорожденных состоит в интранатальной травме, которую ребенок может получить как в ходе родов через естественные родовые пути, так и при операции кесарева сечения. Предрасполагающими факторами получения костных фрактур являются внутриутробная остеопения, врожденные заболевания органов системы пищеварения, недоношенность родившихся детей. Диагноз переломов устанавливается на основании клинического осмотра, результатов ультразвукового и рентгенологического исследований травмированной конечности. В лечении переломов костей конечностей используются как консервативные, так и оперативные методы. В последние годы в научных публикациях отчетливо прослеживается тенденция все более широкого внедрения в клиническую практику оперативных методов стабилизации переломов длинных трубчатых костей у новорожденных, в том числе с использованием методик чрескостного остеосинтеза.

**Заключение.** Представленная статья восполняет существующий пробел обобщающих научных публикаций, посвященных лечению переломов костей конечностей у новорожденных.

**Ключевые слова:** новорожденные; переломы длинных трубчатых костей; механизмы травмы; диагностика; лечение.

## Introduction

Presently, few scientific articles devoted to the issues of emergency trauma care for newborns with tubular bone fractures have been published. We report modern scientific information about the mechanisms of injury, methods of diagnostics, and treatment of long tubular bone fractures in newborns.

## Material and methods

Modern electronic medical information databases (PubMed, MEDLINE, Ulrich's Periodicals Directory, Directory of Open Access Journals [DOAJ], Cyberleninka, and eLibrary) were used to review the literature on long tubular bone fractures in newborns. Because of the rarity of reports on this subject, the depth of the literature search (60 sources) was 30 years.

## Results and discussion

Birth trauma is the main cause of skeletal bone fractures in newborns, including long tubular bones [1–3]. Intrauterine bone fractures due to prenatally caused neuromuscular diseases [4, 5], osteopetrosis [6], or osteogenesis imperfecta [7, 8] are extremely rare. The literature describes cases of spontaneous long tubular bone fractures in newborns, without even minimal external exposure, who received treatment immediately after birth in intensive care units [9, 10].

Birth injuries to the skeletal bones in newborns are caused most often by the aids used by obstetrician-gynecologists and delivery nurses

during labor through the natural birth canal [11, 12] and during operative delivery [13–17]. There is no single viewpoint on which obstetric aid method (natural or operational) is most dangerous in causing a birth injury. Some researchers consider that birth through the birth canal is the most traumatic [18–21], whereas others are convinced that cesarean section bears the risk of fracture, especially when performed under emergency indications [22–25]. In addition to obstetric manipulations, the high risk factors for birth injury of the skeletal bones include a large fetus, clinically contracted pelvis, large uterine myoma, numerous previous pregnancies in a parturient woman, and rapid or, on the contrary, prolonged labor [19, 26].

Osteopenia contributes to skeletal bone fractures in children during the first weeks and months of life, and its frequency in premature babies reportedly is 20% to 60% of cases (depending on the gestational age and weight of the newborn) [27–29]. Bone fractures are diagnosed in approximately 10% of premature babies, and they occur on average at 2–3 months of life [30]. Congenital diseases of digestive system organs, diuretic therapy, and parenteral nutrition with a deficiency of trace elements, especially calcium and phosphorus, exacerbate the course of osteopenia [27, 29–33]. Even the most careful and sensitive care for such children by medical personnel or parents is fraught with risk of bone fractures [34]. That is why in the structure of bone fractures, rib fractures are most frequent, since the rib cage is always under external influence [30], followed by fractures of the humeral and femoral bones [3, 20, 23].

Thus, an analysis of published literary sources shows that the average incidence of humeral fractures in newborns amounts to 1 (0.1%) per 1000 live newborns [35]. The primary cause of fractures during labor is shoulder dystocia, which is the condition when, after birth of the fetal head, release of the front shoulder is delayed by 60 h and it is impossible to extract without obstetric manipulations [36, 37]. The frequency of humeral fractures occurring during shoulder dystocia is increased compared with that of the general population and is already 3% of clinical cases [38, 39]. The average time to diagnose a humeral fracture in newborns is approximately 40 h after delivery [40], and ultrasound examination of the injured limb, besides radiography, is of great diagnostic value [34, 41–43]. Differential diagnostic studies of a humerus fracture should be performed primarily in cases of brachial plexitis, osteomyelitis, dislocation of the forearm bones, and congenital abnormalities of development [35, 44].

As a rule, treatment of fractures is conservative with the help of a plaster cast and retentive bandages [41, 42], but in some cases, surgical hardware may be used [40, 43]. Thus, Ratti et al. [23] reported that conservative techniques were used in 29 (88.0%) of 33 newborns with intrauterine lower third humeral fractures, whereas surgical methods were applied in four (12.0%). The study of long-term results, regardless of the applied methods of treatment, demonstrated the correct axis of the shoulder in 88% of cases and full amplitude of movements in the elbow joint of the injured limb in 80%.

Femur fractures are diagnosed in newborns much less frequently than humerus fractures [21], and the average frequency of occurrence is 0.13 cases per 1000 newborns [45]. As a rule, children suffer fractures at this location during delivery through the birth canal, when various obstetric aid techniques are used [11, 12]. Femoral fractures also are possible during cesarean section and often not of one bone but both at the same time (left and right) [14, 15, 25, 46]. Thus, Toker et al. [24] analyzed complications of delivery during 221,939 births and found an incidence of femur fractures during natural delivery of 0.077 cases per 1000 newborns; during cesarean section, this incidence was four times higher (0.308 cases per 1000 newborns). An effective measure to prevent severe intrapartum injury of long tubular bones in newborns can be

avoidance of longitudinal incisions in the lower uterine segment during cesarean section [47], as well as careful attitude of the obstetrician-gynecologist regarding the fetus extracted with complete relaxation of the uterus, which is achieved with adequate anesthetic management [11].

To diagnose femur fractures objectively, X-ray examination of the injured limb is performed [48, 49]. Often, the final diagnosis is not established immediately after birth but after some time, sometimes up to 4 days after delivery [16].

Treatment of femur fractures in newborns usually is conservative [40, 42], using well-proven methods as mentioned above [49–51]. The literature also includes reports on surgical treatments in newborns. Thus, Neizvestnykh et al. [52] reported that transosseous osteosynthesis was performed to treat three (21.42%) of 14 newborns with femur fractures that occurred during delivery. The indications for surgery included an open fracture of the femoral limb segment (one case) and significant angular deformity of the hip (two cases). According to the investigators, in these cases, use of an external fixation device enabled satisfactory achievement of bone fragment position, facilitated care for an injured child, and reduced the period of fracture consolidation.

Use of the Mini Penning Orthex external fixation device in newborns with femur fractures can be indicated in cases where traditional treatment methods cannot be applied for any reason [53]. These cases can include during clinical observations, when a child who suffered a femur fracture is scheduled for medical manipulations, such as surgery, where the abdominal organs and functioning traction or a coxofemoral plaster bandage will significantly impede abdominal intervention [31]. When performing transosseous osteosynthesis in newborns, inflammatory complications inherent in this method of treatment should be considered first, as they occur in up to 40% of cases in pediatric practice [54].

When determining the therapeutic approach to femur fractures in young children, one should focus on the study conducted by Strohm et al. [55], who analyzed the therapeutic approach for 756 femur fractures in children younger than 3 years at clinics in Germany. The frequency of use of conservative and surgical methods of treatment in injured children was approximately the same, namely, 49%

and 51% of clinical cases, respectively. Thus, the dynamics clearly can be traced to increasingly active surgical tactics in providing traumatologic care to young patients with femur fractures.

The terms of consolidation of femur fractures in newborns ranged from 3 [14, 16] to 6 [50] weeks. As a rule, the treatment results satisfied the attending physicians. Valgus up to 3° and recurvation up to 5° were considered tolerable deviations of the femoral segment axis [50]. However, for deformities exceeding these values, then the specialists followed the expectant management with follow up of the patient and relied on the compensatory capabilities of the body [11, 51].

Regarding surgical interventions in children during the neonatal period, information in the literature concerning the consequences of these surgical interventions should be cited. Golomidov et al. [56] indicated that delayed neuropsychic development and impairments in implementation of the genetic growth program, manifested by backwardness in physical development, are typical consequences for the operated neonates. In addition, infants who have undergone surgery may experience abnormalities in the functioning of vital body systems; however, they are tolerated well by young children [57].

According to Shastin [58], current trends toward an increase in the frequency of surgical interventions in treatment of bone fractures in young children require further analysis and understanding. On one hand, the emergence of new technologies of metallic osteosynthesis under the control of an electron and optical converter, according to the author, simplified the technique of repositioning and stabilization of fractures, which ultimately had a positive effect on the quality of life of the operated children. On the other hand, surgeries often are performed in cases where conservative treatment methods can be sufficient, but for various reasons, surgical methods are preferred.

## Conclusion

Analysis of modern medical literature shows that, despite the development and improvement of various areas of perinatal medicine, many issues remain unresolved [59, 60]. With regard to pediatric traumatology, the problem of providing specialized care to newborns who suffer long

tubular bone fractures is of current importance, with elaboration of the generally accepted diagnostic and treatment tactics of actions of pediatric orthopedic traumatologists.

The literature review presented replenishes the existing gap in generalizing scientific publications on the treatment of limb fractures in newborns.

## Additional information

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**Conflict of interest.** The authors declare no evident and potential conflicts of interest related to the publication of this article.

### Contribution of the authors

*E.G. Scriabin* was involved in search for scientific articles in the electronic medical information databases MEDLINE, Ulrich's Periodicals Directory, DOAJ, Cyberleninka, and eLibrary; analysis of literary sources; and writing the text of the manuscript.

*M.A. Akselrov* performed search for scientific articles in the electronic medical information database PabMed and conducted analysis of literary sources.

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