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# A rare complication of a rare pediatric injury: Transient drop foot following a floating knee injury

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ABSTRACT

Floating Knee is a rare injury caused by high velocity, and has rarely been described in children. The purpose of this report is to present a case of a six-year-old female after a fall down three and a half flights of stairs, suffering from this rare injury and a rare complication, and her rehabilitation. She suffered fractures of the femur and tibia (Floating Knee type), and was operated on the day of the injury with closed reduction and internal fixation (CRIF). Following the operation, painful drop-foot was evident, related to the fractured bone pressure on the sciatic nerve and a very high level of anxiety. The patient was transferred to a rehabilitation hospital, where she received a total of about 350 physical therapy, hydrotherapy, psychology and occupational therapy treatments over a period of one year. Treatment also consisted of an ankle-foot orthosis (AFO) and transcutaneous electrical stimulation, and were assisted with examinations at the motion analysis laboratory using surface electromyography. The combined orthopedic and physical therapy treatment, and cooperation with psychology in the intervention and training for the care team, enabled achievement of all rehabilitation goals. The patient returned to a high functional level and full participation in daily life activities with her peers, without the need for the AFO or further treatment in the community. A re-examination after about six months showed continued functional improvement according to objective indicators. This case raises awareness of rare injuries and complications in pediatric orthopedic patients, that require multidisciplinary rehabilitation treatment and cooperation between the surgical and rehabilitation teams. Closed injury of the sciatic nerve can be followed for a long period without additional invasive studies or formal nerve exploration, and complete recovery can be achieved.

## Introduction

Isolated fractures of the femur or tibia of children are very common, ipsilateral fractures of tibia and femur are rare but severe injuries [1–6]. Blake and Macbride [7] were the first to describe that both fractures can appear together and coined the term "Floating Knee". The mechanism of floating knee relates to a high energy injury (i.e., high velocity), usually from motor vehicle accidents, and

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rarely from falls from high places [1–4,6,8–11].

Since the clinical implications of this phenomenon in children differ from those of adults, it is preferable to characterize them separately [6,9]. For example, the effect of fractures on growth and alignment of long bones can lead to complications that differ [3]. To date, results from children are sparse; only six articles were found in a systematic review [1,6].

Historically, pediatric floating knee was treated conservatively via traction and casting [1]. By the 1970s, Letts et al. [4] recommended surgical closed reduction with internal fixation (CRIF) of the femur. Bohn and Durbin [2] considered CRIF depending on the patient's age and severity of fracture. In the early 2000s, Yue et al. [10] and Arslan et al. [8] reinforced the importance of CRIF regardless of the child's age. In a multi-center, retrospective study, Schoenecker [6] examined data from 129 patients in 11 different centers. CRIF was performed on more than 90 % of the femurs and 70 % of the tibias. They recommended that both bones should be fixated for patients who are four years and older. Children who have been operated on usually require less hospitalization time [11].

Complications of a floating knee injury result from soft tissue injury which may affect the functional outcome [3,6,9]. Specific complications for children are similar to those that occur with any bony fractures (e.g., malunion, non-union, overgrowth, growth arrest, infections). Ligamentous injury (e.g., cruciate ligament) has been described more for adults than for children [4,9,10]. There is almost no mention of neurological complications with only 2 % (5/226) of the cases reported in both large samples [1,2,4,6]. The impact of complications associated with floating knee in the pediatric population has not been sufficiently discussed [9].

## Case history

The purpose of this case report is to present a six-year-old female patient after a fall down three and a half flights of stairs, with a rare injury, a rare complication and a long rehabilitation period. The patient sustained no loss of consciousness and had only mild facial injury including the loss of two teeth. She had a severe right lower limb injury of the thigh and leg with a hematoma and hyperesthesia. At presentation in the emergency room, the child was very agitated; it was not possible to evaluate the neurological status of the injured lower limb. Her Glasgow Coma Scale (GCS) was rated at 15 and Creatine PhosphoKinase (CPK) at 295.

As shown in Fig. 1 and b, x-rays demonstrated fractures of the Floating Knee type with prominent shortening of the femur and significant posterior displacement of the distal part of the femur. The patient was operated on the day of the injury and closed reduction with CRIF using Titanium Elastic Nail (TENS) was performed to the femur and tibia. During the operation, the fracture was reduced easily without over traction.

Following the operation, drop-foot was evident. Further assessment pointed to neuropraxia of the sciatic nerve. Additionally, she showed a very high level of anxiety. The patient was transferred to a rehabilitation hospital where she was hospitalized for two and a half months, and then treated as an out-patient for a further seven and a half months. During this time, there was a total of 350 treatment sessions including physical therapy ($n = 189$), hydrotherapy ($n = 73$) and psychology and occupational therapy ($n = 88$) treatments.

At the onset of rehabilitation, she was non-weight bearing, had swelling and pain in the foot. Her femur fracture healed as expected but healing of the tibia fracture was delayed (Fig. 2 and b). At seven months post-injury, an instrumented three-dimensional gait analysis was performed (GRAIL, Motek, the Netherlands). The analysis revealed an improvement in the drop foot during the swing phase (more active dorsiflexion), with respect to the initial clinical observations of her active range of motion and gait. With respect to the stance phase, she continued to walk with an increase in right ankle dorsiflexion, with large reductions in joint moments/power and

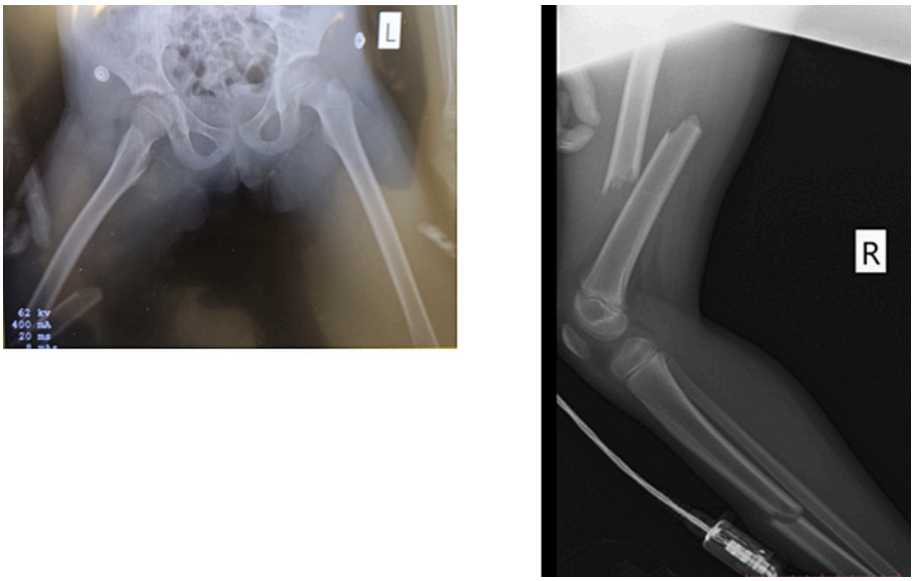


**Fig. 1.** (a) Anterior-posterior and (b) lateral x-rays of the Floating Knee type fracture on the day of injury.

medial gastrocnemius and soleus (plantar flexor) muscle activations. This was likely due to weakness/impaired ability to activate the plantar flexor muscles, as revealed during the physical examination and ultrasound assessment at the time of the gait analysis.

She was prescribed an articulating (hinged) ankle-foot orthosis (AFO) to optimize her ankle joint position to reduce secondary complications during weight bearing and improve gait function. In addition, she also underwent transcutaneous nerve electrical stimulation therapy in an attempt to improve her voluntary dorsal and plantar flexor muscle activity and reduce muscle atrophy. After three and a half weeks, due to noticeable improvements in gait function, she was re-assessed in the motion analysis laboratory. With respect to the first assessment, there was an improvement in plantar flexor muscle strength during the physical examination, as revealed by an increase in plantar flexor muscle activity during the stance phase (gastrocnemius>soleus), translating to an increase in plantar flexor moment ankle joint power during the pre-swing (Fig. 3). There was also an increase in spontaneous walking speed and gait symmetry. This clinical process is compatible with a sciatic neuropraxia caused by the femur fracture pattern.


**Fig. 2.** (a) Anterior-posterior and (b) lateral x-rays, 6-weeks post-op.

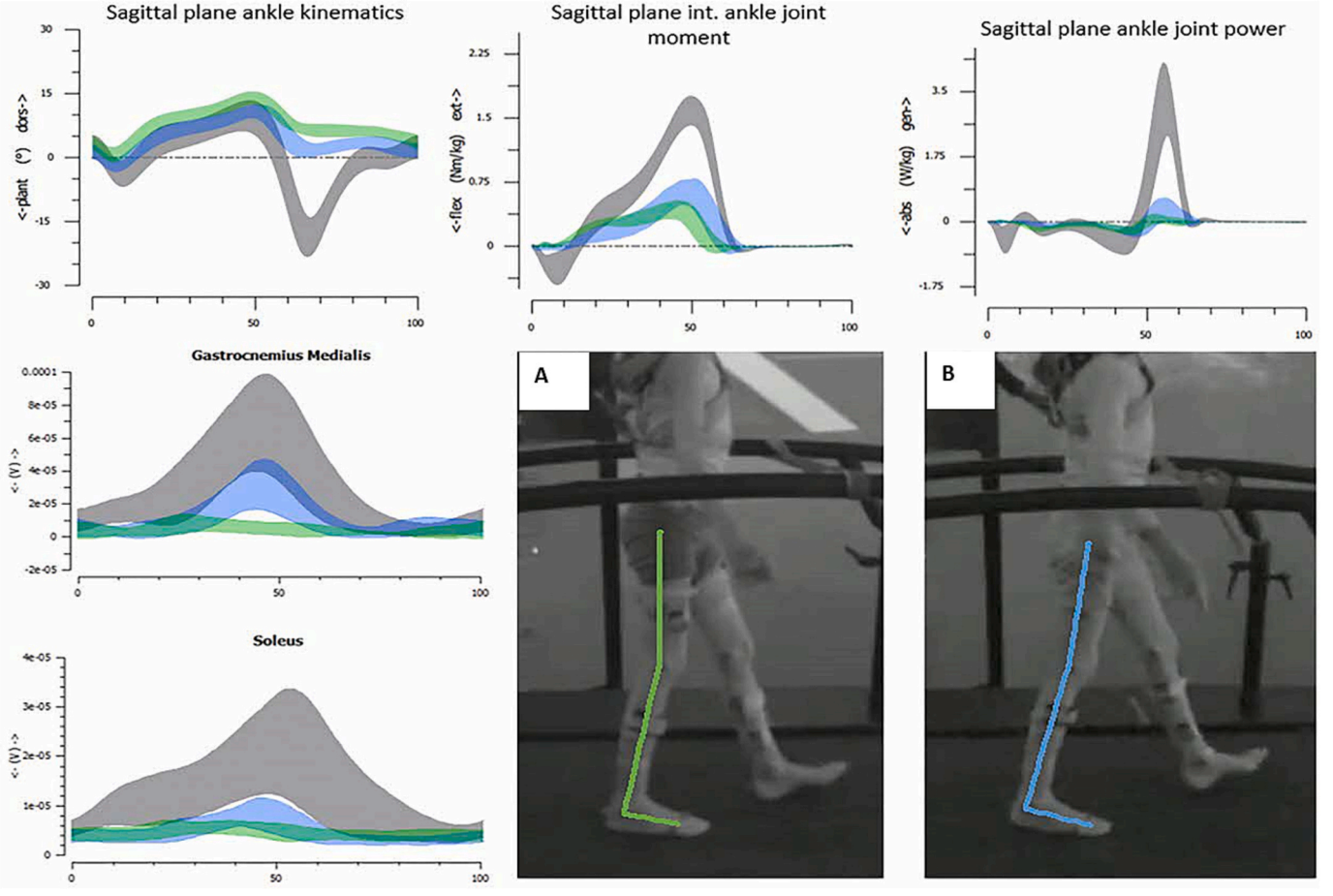


**Fig. 3.** Comparisons of gait function between the two analyses three and a half weeks apart, A = first assessment (green line), B = second assessment (blue line). Graphs show the sagittal plane ankle joint kinematics, moment and power and electromyograms for the gastrocnemius and soleus muscles. The first assessment is highlighted in green, whilst the second in blue. The graphs reveal a shift towards the normative reference data (grey bands), whilst the sagittal plane images of the child walking provide an example in the change at the terminal stance phase of the gait cycle (determined by the contralateral initial contact phase). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)


**Fig. 4.** One-year post-op x-rays - (a) anterior-posterior and (b) lateral of the femur; (c) anterior-posterior and (d) lateral of the tibia-fibula.

With combined orthopedic and physical therapy treatment, and cooperation with psychology in the intervention and training for the care team, all rehabilitation goals were achieved. The patient returned to a high functional level and full participation in daily life activities with her peers, without the need for an AFO or further treatment in the community. A re-examination after about six months showed continued functional improvement according to objective indicators. One-year post-op, x-rays demonstrated full healing of the fractures (Fig. 4a, b, c and d) and the patient was referred for removal of the TENS.

## Conclusions

This case raises awareness of this rare injury and rare complication in pediatric orthopedic patients, which require multidisciplinary rehabilitation treatment and cooperation between the surgical and rehabilitation teams. Closed injury of the sciatic nerve can be followed for a long period without additional invasive studies or formal nerve exploration, and complete recovery can be achieved.

## Declaration of competing interest

The authors report no conflicts of interest.

## Acknowledgements

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