Femoral shaft fracture fixed with intramedullary nailing in a child resulting in femoral neck narrowing deformity and fracture

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Treatment of fractures in children is different from that of adults because improper internal fixation, including selection of internal fixation device and epiphysis approaching, may cause epiphysis injury, which may result in a series of secondary lesions in bone development, such as growth arrest, limb length discrepancy, osteonecrosis, and other deformities. Under some circumstances, an internal fixation device near the epiphysis but not crossing the epiphysis or growth plate can still cause developmental deformity of the bones nearby. In this study, we reported a case of femoral neck fracture with slight trauma secondary to the femoral neck narrowing deformity induced by a femoral shaft fracture, which was fixed with an intramedullary nail through the piriformis fossa (neither passing through the epiphysis of greater trochanter nor invading the epiphysis of the femoral head) six years ago.

CASE REPORT

Medical history review
A 14 year-old boy suffered from a femoral shaft fracture induced by a heavy object when he was 8 years old (Fig.1). A doctor in a county hospital fixed the fracture with a long intramedullary nail (percussopunctator nail, made in China) through the piriformis fossa after an open reduction with a lateral thigh incision just over the region of the fracture, but the nail seemed too long to insert in the medullary cavity properly from the X-ray picture at that time (Fig.2). The nail was taken out one year later because of fracture union. After then, the boy was in a normal motion and his leg showed no abnormal signs for 5 years. In July 2005 (approximately 6 years since the femur broken and when he was 14 years old), the boy broke the femoral neck in the ipsilateral leg with a slight trauma (falling down to the ground). Physical examination showed no evidence of systematically developmental abnormality, no significant rotational deformity or leg length discrepancy (in the distance from the great trochanter to the medial malleolus). X-ray picture (Fig.3) and CT film (Fig.4) showed that the basocervical fracture, the bone density of the fracture area including intertrochanter and femoral basocervical region was heterogenous, osseous sclerosis occurred in the terminations of fracture, and the femoral neck was narrowed in the basocervical region, which made the whole neck look like a tipped pencil. Radiological pictures did not show avascular necrosis or malformation of the femoral head as well as the coxa varus or valgus deformity. Although all of his laboratory test values were normal, including serum alkaline phosphatase, calcium, and so on, the signs in the radiological image seemed to imply that it was a pathological fracture or old fracture. Therefore, we planed an operational scheme to treat it as follows.

Operation and general manifestation after operation
The boy was anesthetized by general ketamine anesthesia combined with peridural anesthesia. Gibson incision was applied with a lateral operational position. During the course of exposure, we did not find any abnormality in the soft tissues around the hip joint. When exposing the objective region, we found that the basocervical fracture and the proximal femoral neck were in a medial rotational position with both ends of the fracture impacting each other. After reduction, we found that the posterior region of the femoral neck near the basocervical region lost its oval shape in transverse view, became flat in the upper-posterior area of neck, and seemed nearly a hemisphere shape in transverse view. That’s why the femoral neck seems narrow when it is in a medial rotational position. When in a correct
position, the femoral neck was not narrowed in coronal section view. The color and luster of the cortical bone of both ends of the fracture were normal. The medullary cavity of both ends were impacted by some rigid osseous tissues as well as some natural cancellous bone tissues. The abnormal tissues under gross view in the medullary cavity of both ends were scrapped out with a curet, and some of them were kept as specimens for pathological examination. After performing the fracture reduction again, we took the pedicle bone flap of the quadratus femoris according to the method of the literature, implanted it into the area of flattened posterior femoral neck and bridged the ends of the fracture. The residual space between the terminations of the fracture was impacted by the iliac cancellous bone, which were taken from the ipsilateral ilium. The fracture was then fixed by a half spiral dynamic screw, which was inserted through the lateral femoris under the great trochanter according to the natural direction of neck-shaft angle. The inserting depth of the screw (50 cm in length and 55 mm in diameter) was controlled according to the length of the contralateral femoral neck evaluated from X-ray picture to prevent femoral head lesion of the epiphysis. Furthermore, a piece of Kirschner pin was introduced to prevent lateral rotation, which was inserted in a full length of femoral neck (Fig.5). Then the incision was closed, and the leg was immobilized by a single hip spica plaster.

**RESULTS**

This young patient had no evidence of infection, continuous pain, rotational deformity or limb shortening after operation. Postoperative X-ray picture showed that the fracture attained anatomical reduction and the screw was in a good position, which was far from the epiphysis of the trochanters and the femoral head. Preoperative sign of pen-point-like narrowing of the femoral neck (due to rotation of the femoral neck) disappeared in the posterior-anterior view of X-ray picture (Fig.5). The pathological examination showed that the tissues in the fracture region were normal osseous tissues without any pathological or tumorous signs (Fig.6). A three-month follow-up showed that the fracture united well with the normal osteotylus in X-ray picture (Fig.7). Therefore, the fracture was further proved to be caused by a traumatic but not a pathological reason.

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**Fig.1.** Femoral shaft fracture history six years ago. **Fig.2.** A doctor in a county hospital fixed the femoral shaft fracture with a long intramedullary nail through the piriformis fossa. **Fig.3.** Six years later, a secondary basocervical fracture with a slight trauma in the same femur occurred. The bone density of the fracture region is heterogenous and the femoral neck is narrowed in the basocervical region, which makes it look like a pathological fracture. **Fig.4.** The basocervical fracture. The bone density of the fracture region increases and osseous sclerosis is observed in the fracture ends, which makes it look like a pathological or old fracture.

**Fig.5.** After fracture reduction, we took the pedicle bone flap of quadratus femoris and performed ilium bone transplantation to impact the space of the fixture and fixed the fracture with a screw and a kirschner pin. **Fig.6.** The pathological examination shows that the tissues in the fracture region are normal osseous tissues without any pathological or tumorous signs. **Fig.7.** A three-month follow-up after operation shows that the fracture unites well with the normal osteotylus in X-ray picture.
DISCUSSION

Several reports have described a series of complications after femur fracture fixed with intramedullary nails through the piriformis fossa or the tip of the greater trochanter in children, such as osteonecrosis of the femoral head, coxa valgus or varus deformity, premature epiphysis fusion or growth arrest of the proximal part of the femur.\(^1\)\(^{-}\)\(^4\)\(^{-}\)\(^5\) Few articles have mentioned about the question of developmental femoral neck narrowing induced by operation of femoral shaft fracture fixed with intramedullary nails (from Medline). Miettinen et al\(^6\) made an experimental study on growing dogs with intramedullary nails fixing femoral shaft osteotomy. Their results implied slight narrowing of the femoral neck, but without any functional disability for 48 weeks of following up. Gordon et al\(^7\) evaluated the radiographic changes in the proximal part of the femur following intramedullary nailing through the lateral trochanteric area at a minimum of two years postoperatively in 25 affected extremities. In this report, all children involved in this procedure did not suffer clinically important femoral neck narrowing (narrowing <1% of the diameter of femoral neck) for more than two years of following up.

When evaluating the X-ray picture of this case, there was an intensive impression of making us to diagnose it as pathological fracture, but from the history of the ipsilateral femoral shaft fracture and intramedullary nailing fixation through the piriformis fossa, we could not exclude a speculation that the operation which he accepted years ago may result in some developmental problems in the femoral neck. The impression of the fracture ends during the operation incorporated with the pathological examination, proving the tissues in the fracture region being normal osseous tissues, which could prove our speculation of the developmental disturbance in the femoral neck induced by the operation of femoral intramedullary nailing fixation through the piriformis fossa to be true. The intramedullary nail, which applied in the early femoral shaft fracture in this study, was inserted through the piriformis fossa but not through the tip of the greater trochanter, and the epiphysis of the proximal femur (epiphysis of the greater trochanter and the femoral head) should not be invaded. The later complication of narrowing neck may be due to the following reasons: (1) The initial surgery (when inserting the intramedullary nail) destroyed the blood supply of the proximal femur. (2) When passing through the stress shielding, the intramedullary nail affected the osteoblasts and osteoclasts induced by the stress effect, which makes subsequent abnormal bone development. And (3) the interior fixation causes long-term rejection and immune and/or inflammatory factors disturbing the normal development of the neighbouring epiphysis and jam the development of value-added procedures. However, the blood supply, stress, and other local environments, are closely linked to the normal bone development, growth and ossification. A severely weak femoral neck cannot bear even a slight trauma, so fracture occurs ultimately. Our young patient provided us a rare case and also gave all orthopedic surgeons an impressed implication that the selection of intramedullary nailing fixation through the piriformis fossa to treat the femoral fracture in children should be care of this kind of complication, narrow neck and secondary fracture.

REFERENCES


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