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TORSION DEFORMITIES AFTER TRACTION TREATMENT OF FEMORAL FRACTURES IN CHILDREN

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The torsion of both femurs was investigated in 55 patients who had been treated 5–13 years earlier at the age of 1–16 years for femoral shaft fractures. By comparing the anteversion angle of the contralateral hips, determined by the Rippstein method, torsion deformities exceeding 10 degrees were found in the fractured femur of 10 patients. The maximum deformity found was + 27 degrees. None of the patients had complaints due to the torsion deformity. Deformities appeared more frequently in patients treated with adhesive overhead traction of the fractured leg than in patients treated with wire traction with the limb on an oblique frame. However, the difference was not highly significant ($0.05 < P < 0.10$). There was no correlation between age at the time of injury and torsion abnormalities and no correlation between the length of the observation period and the residual deformity, indicating growth correction. Examination of the rotational mobility of the hips was found to be a suitable screening test in the diagnosis of deformities exceeding 10 degrees. Radiological investigation of the anteversion angle of the femoral neck is necessary in the final assessment of a torsion deformity.

Key words: femoral fracture; children; torsion deformities; growth correction

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Numerous studies of the development of axial deformities following femoral fractures in children have been performed. Most of these studies (Conwell 1929, Stray 1938, Neer & Cadman 1957, Barfod & Christensen 1958, Staheli 1967, Burwell 1969 and Griffin et al. 1972) have dealt with the problems of discrepancy of bone length and angular deformities. Little attention has been paid to torsion deformities following the traditional traction treatment methods in these fractures. Vontobel et al. (1961) seem to be the first investigators to have tackled this problem by means of radiological determination of the anteversion deformity of the fractured femur. They found that significant torsion deformities may develop as a result of traction treatment. More recently only a few studies have dealt with this problem (Hupfauer & Balan 1971, Parvinen et al. 1973). The purpose of the present study was to present additional information about the occurrence of torsion deformities after traction treatment of femoral fractures in children.

MATERIAL AND METHODS

During the years 1963–1970, 102 children with dislocated femoral shaft fractures were treated in Surgical Department II, Ullevål University Hospital, Oslo. The material consists of 55 of

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Table 1. Material

Total number of patients		55
Patients treated with adhesive traction		15
Patients treated with wire traction		40
Age at injury		1–16 years
	mean	6.5 „
Observation period		5–13 years
	mean	8.0 „

these patients who were available for re-examination 5 to 13 years after injury. Their age at the time of injury varied between 1 and 16 years. All were treated conservatively. Most children under 3 years of age were treated by vertical adhesive traction of the fractured extremity only. All children older than 3 years, with the exception of two, were treated with tibial or femoral Kirschner wire traction with the limb resting on an oblique frame (Table 1).

Methods of investigation

Radiological examination. The anteversion angle of the femoral neck of both femurs was determined using the projections described by Rippstein (1955). For this technique two projections are required: one AP-projection of the hips in neutral position and one AP-projection of the neutrally rotated hips in a position of 90 degrees flexion and 20 degrees abduction. The apparent caput-collum-diaphysis angles (CCD-angles) and anteversion angles (AV-angles) were measured in the respective radiographs with a roentgen-ischiometer in accordance with Müller (1957). The true AV-angles were then calculated from the apparent CCD- and AV-angles using the conversion table of Rippstein (1955).

Ten healthy young adults served as controls. In none of the controls did the anteversion angles of the two hips differ more than 5 degrees.

Clinical investigation. The patients were questioned regarding function and complaints. Their gait was studied in order to detect torsion deformities. The rotational mobility of the hips was examined with the patients in the prone position, their knees flexed 90 degrees. The range of rotational mobility of the hips was measured with a device with 5 degree steps, the nearest step on the scale being recorded as internal and external rotational mobility when the legs were turned maximally outwards and inwards, respectively.

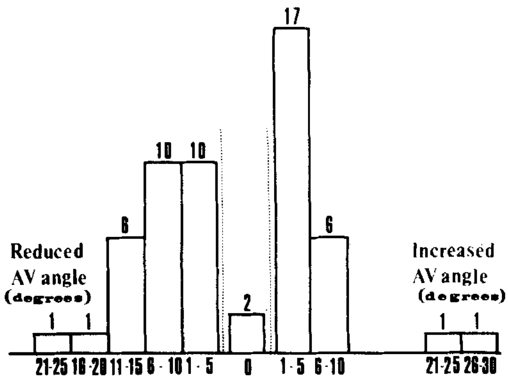

Figure 1. Difference in the anteversion angles (AV-angles) of the fractured and the contralateral femurs. The figures over the columns indicate the number of patients.

RESULTS

In 26 of the 55 cases the anteversion angles of the contralateral hips calculated from the X-rays differed more that 5 degrees. The difference exceeded 10 degrees in ten cases and 15 degrees in four (Figure 1). The largest calculated difference was 27 degrees. The relationship of the difference in the contralateral angles of anteversion to the age of the patients at injury and to the method of traction is shown in Figure 2. There was no significant correlation between the difference in femoral neck anteversion of the contralateral hips and the age at injury (Spearman rank test, $R_s = -0.1044$, $n = 55$, $P > 0.5$). In patients treated with adhesive traction the anteversion angles differed more than 10 degrees in 5 of the 15 patients. A corresponding difference was found in only 5 out of the 40 patients treated with wire traction. Thus treatment with adhesive traction tended to give a greater number of rotational deformities than wire traction. However, the difference was not highly significant ($X^2 = 3.17$, $0.05 < P < 0.100$).

The relationship between the difference in the femoral neck anteversion of the contralateral hips and the length of the follow-up period is shown in Figure 3. There was no significant correlation between these two

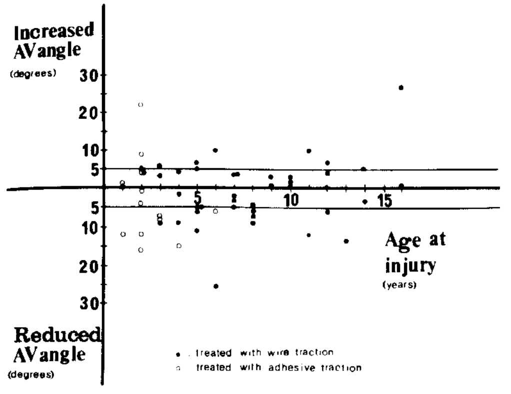

Figure 2. Difference in the AV-angle of the fractured and the contralateral femur related to age at injury.

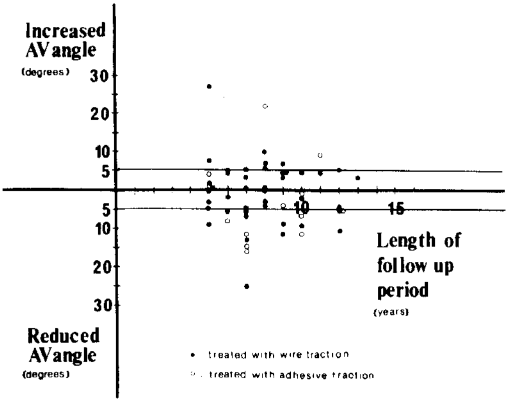

Figure 3. Difference in the AV-angle of the fractured and the contralateral femur related to the length of the follow-up period.

factors (Spearman rank test, $R_S = 0.0886$, $n = 55$, $P > 0.10$).

None of the patients had complaints which could be attributed to torsion deformity of the fractured femur. A markedly abnormal foot angle was observed in only one patient. This was in a boy with a decreased anteversion of the femoral neck of 25 degrees. The radiographs of the hips of this patient are shown in Figure 4.

In patients in whom the AV-angle of the contralateral hips differed by more than 10 degrees, the abnormal anteversion of the fractured femur was associated with an expected change in internal or external rotation of at least 10 degrees (Table 2). Smaller abnormalities in anteversion were not consistently accompanied by change in the range of rotational mobility.

DISCUSSION

Radiological measurement of femoral neck anteversion by the Rippstein method is well standardized. However, inadequate position-

Table 2. Difference in rotational mobility in relation to the difference in AV-angles in patients in whom the AV-angle of the fractured femur differed by more than 10 degrees from that on the contralateral side

Case	Difference in AV-angle (degrees)	Difference in internal rotation (degrees)	Difference in external rotation (degrees)
1	−11	−10	0
2	−12	0	+10
3	−12	−10	+10
4	−12	− 5	+15
5	−13	−15	+15
6	−15	−10	+10
7	−16	−10	0
8	−25	−20	+10
9	+22	+15	0
10	+27	+20	−15

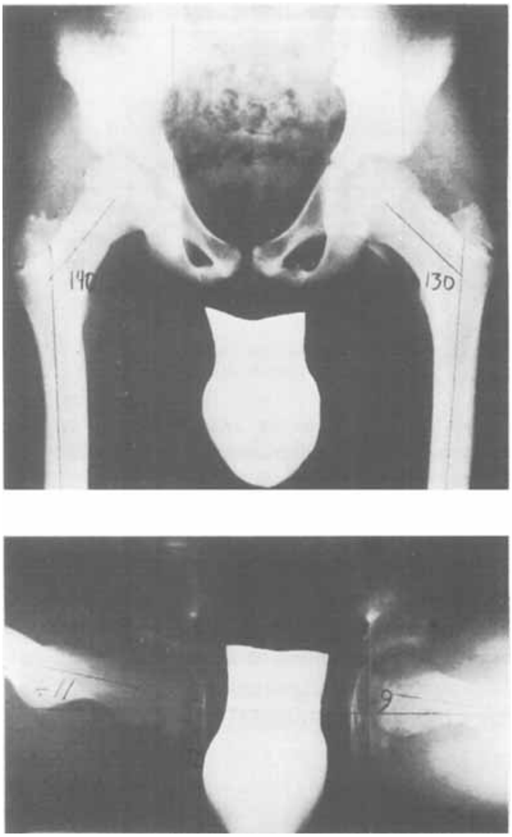

Figure 4. Radiographs of the hips of a 13-year-old boy 7 years after wire traction treatment for fracture of the right femur. A. AP-projection of the hips in neutral position showing the apparent CCD- angles. B. AP-projection of neutrally rotated hips in a position of 90 degrees flexion and 20 degrees abduction showing the apparent AV-angles.

By calculation the AV-angle of the right femur was found to be reduced by 25 degrees.

ing of the hips may lead to errors in the determination of the AV-angles (Gross & Haike 1970). If the method is used to determine the torsion deformities following fractures, as in the present study, a normal biological variation in the torsion axis of the contralateral femurs has to be taken into account. The results of our investigation of normal hips indicate that differences between the anteversion angles of the contralateral hips exceeding 5 degrees could indicate torsion abnormalities. Accordingly, torsion deformities occurred in approximately 50 per cent of the patients. In only 10 of the 55 patients did the deformities exceed 10 degrees. In 4 patients the deformity was greater than 15 degrees. These results are in accordance with those presented by Vontobel et al. (1961) and Hupfauer & Balan (1971), and with those published by Yano & Sawada (1975).

The large number of torsion abnormalities among patients treated with unilateral adhesive overhead traction indicates that it is difficult to maintain the correct torsion axis of the fractured femur by this method. However, the finding of torsion deformities of up to 27 degrees in patients treated with wire traction show that even traction on an oblique frame may lead to considerable deformity.

There was no significant difference concerning the degree and frequency of torsion deformities in relation to the length of the observation period. This indicates that no significant growth correction of the torsion deformities had taken place more than 5 years after femoral fracture in children. Whether some correction may take place during the very first years after healing of the fracture, however, has not been investigated in the present study. Nevertheless, the findings support the statement of Vontobel et al. (1961) that an abnormal rotational axis following femoral fractures in children is poorly corrected during growth.

A poor correlation was found between abnormal femoral neck anteversion of the fractured femur and abnormal rotational mobility of the hip in patients with a femoral neck anteversion deformity of less than 10 degrees. This might be partly due to an inaccurate investigation technique. Secondary changes in or around the hip joint of the fractured femur might also be of some importance. It is worth noting, however, that all cases with torsion deformities exceeding 10 degrees were accompanied by an expected change in either the internal or external rotation of 10 degrees or more. This indicates that measurement of the rotational mobility may be used as a screening test in the diagnosis of marked torsion deformities. Radiological determination of the anteversion angles of the hips has then to be performed if marked differences are found in the rotational mobility of the contralateral hips.

Some torsion deformity is usually well tolerated after fracture of the femur. However, marked deformity may lead to disturbed function and late arthrosis in the hip or in the knee and ankle joint (Weber 1963). According to Müller (1957) retroversion of more than 2 degrees and anteversion of more than 30 degrees may cause degenerative changes in the hip joint. Probably the adaption to a torsion deformity is to some extent individual.

Weber (1963) has introduced a special traction table for treatment of femoral fractures in children. Bilateral femoral traction is applied with hips and knees flexed 90 degrees and the hips abducted 20 degrees. This method should enable a radiological determination of the rotational displacement and a graded correction of the rotational axis. Eighteen out of 28 cases treated by this method showed torsion deformities of less than 10 degrees at follow-up, while none of the remaining cases showed deformities of more than 18 degrees (Weber 1969). Comparing these results with those of the present study, the Weber method might perhaps appear slightly superior in the prevention of marked torsion deformities. The number of observations of the materials compared are too few to draw any definite conclusions

REFERENCES

Barfod, B. & Christensen, J. (1958) Fractures of the femoral shaft in children with special reference to subsequent overgrowth. *Acta chir. scand.* **116,** 235–250.

Burwell, H. N. (1969) Fractures of the femoral shaft in children. *Postgrad. med. J.* **45,** 617–621.

Conwell, E. (1929) Acute fractures of the shaft of the femur in children. *J. Bone Jt Surg.* **11,** 593–647.

Griffin, P. P., Anderson, M. & Green, W. T. (1972) Fractures of the shaft of femur in children. Treatment and results. *Orthop. Clin. N. Amer.* **3,** 213–224.

Gross, F. & Haike, H. (1970) Bestimmung der Genauigkeit und der Fehlerquellen des Rippsteinchen Verfahrens zur Messung der Antetorsion des coxalen Femurendes. *Arch. orthop. Unfall-Chir.* **67,** 234–243.

Hupfauer, W. & Balan, J. (1971) Die konservative Behandlung kindlicher Oberschenkelfrakturen und ihre Ergebnisse. *Mschr. Unfallheilk.* **74,** 441–456.

Müller, M. E. (1957) *Die hüftnahen Femurosteotomien* Thieme, Stuttgart.

Neer, C. S. & Cadman, E. F. (1957) Treatment of fractures of the femoral shaft in children. *J. Amer. med. Ass.* **163,** 634–637.

Parvinen, T., Viljanto, J., Paananen, M. & Vilkki, P. (1973) Torsion deformity after femoral fracture in children. A follow-up study. *Ann. Chir. Gynaec. Fenn.* **62,** 25–29.

Rippstein, J. (1955) Zur Bestimmung der Antetorsion des Schenkelhalses mittels zweier Röntgenaufnahmen. *Z. Orthop.* **86,** 345–360.

Staheli, L. T. (1967) Femoral and tibial growth following femoral shaft fracture in childhood. *Clin. Orthop.* **55,** 159–163.

Stray, K. (1938) *Klinske og røntgenologiske efterundersøkelser av femurfrakturer hos barn.* Faedrelandsvennen, Kristiansand.

Vontobel, V., Genton, N. & Schmid, R. (1961) Die Spätprognose der kindlichen dislozierten Femurschaftfraktur. *Helv. chir. Acta* **28,** 655–670.

Weber, B. G. (1963) Zur Behandlung kindlicher Femurschaftbrüche. *Arch. orthop. Unfall-Chir.* **54,** 713–723.

Weber, B. G. (1969) Fractures of the femoral shaft in childhood. *Injury.* **1,** 65–68.

Yano, S. & Sawada, M. (1975) Rotationsfehler nach kindlichen Femurschaftfrakturen. *Z. Orthop.* **113,** 119–129.

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