The treatment of femoral shaft fractures in children: a systematic overview and critical appraisal of the literature

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Authors' objectives
To conduct a critical systematic overview of the literature on the treatment of paediatric femoral shaft fractures to determine if any method of treatment can be recommended over others.

Searching
MEDLINE (1966-1996) was searched using the keywords 'femoral fracture'. In addition, the bibliographies of retrieved articles were searched along with the studies personally known to the author. Only English language studies were retrieved.

Study selection
Study designs of evaluations included in the review
All studies comparing two or more interventions that included 10 or more participants, e.g. randomised controlled trials (RCTs) and cohort studies. Case reports or case summaries were excluded.

Specific interventions included in the review
Treatments for femoral fractures including different types of traction, early/late application of hip spica cast (including 'pontoon casts', and internal fixations (nails and plates). Interventions were compared with each other. Studies were excluded if they considered the treatment of fractures of the hip or distal femoral growth plate or the treatment of pathologic fractures.

Participants included in the review
Children with femoral fractures including three age groups: preschool (birth to 5yrs), child (6-12yrs) and adolescent (13-18yrs). Studies primarily focusing on patients over 16yrs of age were also excluded. Eight of the studies included in the review considered children of different age groups, three considered only adolescents, two considered children of different ages groups, but only head injured children and two did not provide age criteria. The upper age limit of eligibility varied between 10 and 17yrs.

Outcomes assessed in the review
Time in hospital (days), duration of immobilisation (days), malunion rates (limb-length discrepancy, malangulation and malrotation), average cost (or charges) and complications. Studies that examined the etiology, imaging or pathophysiology of femoral fractures were excluded. Studies were also excluded if they reported exclusively on either the injuries associated with femoral fractures or the complications of treatment.

How were decisions on the relevance of primary studies made?
This is a single author review. The author does not state how the papers were selected for the review, or if any other individuals helped to perform the selection.

Assessment of study quality
Studies were assessed according to standard criteria (see Other Publications or Related Interest no.1) and strategies used to reduce bias (susceptibility bias, performance bias, detection bias and transfer bias) as outlined by Feinstein (see Other Publications of Related Interest no.2). The following criteria were used: inclusion/exclusion criteria stated, assessment of prognostic factors performed, treatment standardised, treatment choice explained, adjustment for cointerventions used, blinded assessment, similar assessment times, functional assessment performed and appropriate statistical analyses used. In addition studies were assessed to determine if all (rather than just one or more) aspects of malunion were reported, if composite malunion rates were provided, if complications were reported and if children's function (in addition to malunion rates) was assessed. This is a single author review. The author does not state if any
other individuals helped to perform the validity assessment. Studies were assessed blindly by removing all identifying information (authors and institutions) from the articles. Points were awarded for each of the fifteen quality criteria resulting in a final quality score of between 0 and 15 (see Other publications of Related Interest no.1).

Data extraction
This is a single author review. The author does not state how the data were extracted for the review or if any other individuals helped to perform the data extraction. However, the following data were extracted: bibliographic details, study design, participant numbers and description, inclusion/exclusion criteria, validity issues, methods of outcome determination, outcome data, and % follow-up.

Methods of synthesis
How were the studies combined?
A narrative synthesis was used.

How were differences between studies investigated?
Some limited differences between the studies are discussed qualitatively.

Results of the review
Fifteen cohort studies (n=1063 participants in total) were included. No RCTs were identified. Of the fifteen studies, six compared traction of different types, with immediate or early application of a hip spica cast including 'pontoon' casts; eight studies compared non-operative treatment (early application of a hip spica cast or traction) with internal fixation (plates and nails); and one compared traction with early application of hip spica cast and internal fixation.

Children having early application of a hip spica cast had an average hospital stay of 11 days (range from 5 to 29 days), average charges of Can$5784 (range from Can$590 to Can$1,800), average rates of limb-length discrepancy (greater than 2cm) of 3% (range from 0 to 25%), angulatory malunion rates (greater than 10 degrees) of 8% (range from 0 to 19%) and rotational malunion rates (greater than 10 degrees) of 13% (range 0 to 5%). The costs and malunion rates of early application of a hip spica cast were lower than for traction. Internal fixation (including intramedullary nails) had low angulatory malunion rates compared with early application of a hip spica cast but higher over-lengthening rates (greater than 2cm) of 25% (range from 5% to 100%) and mean rotational malunion rates (greater than 10 degrees) of 25% (range from 11 to 32%).

Analysis of the data was limited by a number of issues: outcomes used to evaluate treatment were inconsistent between studies; studies suffered from methodological problems; the methods of evaluating malunion were inconsistent between studies.

Quality of studies:
The studies suffered from a number of methodological problems. None of the studies adjusted for baseline differences between the intervention groups; and in none of the studies was the outcome of treatment ascertained blind to the treatment intervention; none of the studies formally assessed patient-based outcomes such as function or behavioural disturbances; many of the studies only selectively reported on type of malunion, such as limb-length discrepancy.

Cost information
Yes. The reported cost (or charges) for treatment ranged from Can$5784 for the early application of a hip spica cast to Can$10,410 for traction.

Authors' conclusions
Early application of a hip spica cast was associated with a shorter duration of hospital stay and low rates of malunion compared with traction. Internal fixation gave low rates of angulatory malunion compared with early hip spica casting.
but high rates of overlengthening. The preferred treatment for children with femoral fracture will await the results of randomised clinical trials.

**CRD commentary**
This is a clearly reported review with well-defined inclusion/exclusion criteria. However, the literature search was limited to only one electronic database along with searching the bibliographies of retrieved studies and the author's own records. There was no attempt to locate unpublished studies and only English language studies were included in the review, thereby increasing the risk of publication bias. There was also little information about the methods used to select studies, assess their validity and extract data. In particular, it was not clear how many individuals were involved in these processes, though it seems likely that only one person was involved, as this is a single author review. This may result in the introduction of bias.

No randomised controlled trials were identified and differences between the studies prohibited meta-analysis. Instead the studies were appropriately summarised in data tables and appropriately combined in a narrative synthesis. However, it was not clear whether the cohort studies were retrospective or prospective. Overall, the author's findings would appear to be reasonable considering the data presented, but the conclusions should be viewed with caution considering the limitations outlined above and those highlighted by the author.

**Implications of the review for practice and research**
**Practice:** The author does not state any implications for practice.

**Research:** The author states that 'the preferred treatment for children with femoral fracture awaits the results of randomised clinical trials'. Studies should: consider baseline differences between the different intervention groups; consistent outcomes should be used; all types of malunion outcomes should be reported to allow comparisons between different studies; and consistent methods of evaluating malunion should be used (i.e. either clinical or radiographical).

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**Other publications of related interest**

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Record Status
This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.