

Original Research Article

Outcome of femoral shaft fracture in paediatric age group with titanium elastic nail

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ABSTRACT

Background: Femoral shaft fractures are among the most serious and disruptive injuries in children, not only physically but also emotionally—for both the child and their family. Traditionally, such fractures were treated with conservative methods like traction and casting. However, with evolving medical practices and increasing emphasis on early mobility, surgical options like titanium elastic nailing system (TENS) have become more popular, especially in older children.

Methods: This prospective study was conducted at Government Medical College, Kota, between December 2022 and November 2023, involving 30 children aged 4 to 14 years with femoral shaft fractures treated using TENS. We evaluated healing time, complication rates, functional outcomes, and overall effectiveness of this technique.

Results: Most fractures (96%) were managed successfully with closed reduction. The average time to fracture union was 8 weeks, and most children could bear full weight by that time. By 12 weeks, nearly 90% regained full range of knee movement. Minor complications like skin irritation and superficial infection occurred in a few cases but were easily managed. Importantly, no child developed severe complications such as delayed union, non-union, or avascular necrosis.

Conclusions: Using Flynn's criteria, 87% of children had excellent outcomes, while the rest had satisfactory results. No poor outcomes were observed. Our findings suggest that TENS is a safe, minimally invasive, and highly effective method for treating femoral shaft fractures in children, allowing quicker recovery, early mobility, and a return to normal life with minimal complications.

Keywords: Elastic nail, Femur shaft, Flynn criteria, Intramedullary nailing

INTRODUCTION

Femoral shaft fractures are common injuries in paediatric age group and represent nearly 1.6%-2% of all bony injuries in children. Femoral shaft fracture are disabling injuries and need an immediate patient care.

Treatment ranges from strictly nonsurgical methods (e.g. Close reduction with spica cast or traction followed by casting) to surgically stabilization (using intramedullary device, external fixation or internal fixation with plate &

screw). Nonsurgical management has been the standard of case for most children historically. Surgical treatment was limited to open failure or patient with head injury or multiple injury by Bar-On et al.¹

The transition from non-surgical to surgical treatment of femoral shaft fractures in childhood is not sudden. The economic condition of patient, prolonged immobilisation required for patients managed conservatively with traction, the family's ability to take care of the child in spica and psychological implication of trauma in

adolescents. Taking all these factors under considerations, these injuries are managed more aggressively.

There are variety of techniques such as external fixation, intramedullary nailing, elastic nailing, plate fixation available for managing femur shaft fracture.

With the use of external fixator, there are high incidence of pin tract infection, refracture after removal of external fixator & stiffness of the knee joint. Also, the external fixator is more uncomfortable and difficult for the child by Linhart et al.²

With the use of rigid nails in children there is a high incidence of abnormalities at the proximal end of the femur including coxa valga, arrest of growth of greater trochanter, thinning of the neck of the femur because of damage to trochantero- cervical growth plate by Gonzalez et al.³ There is also an increased risk of AVN of femoral head with the use of rigid intramedullary nails in children and adolescents by Thometz et al.⁴

Over the past few years there has been a marked increase in the use of flexible intramedullary fixation in the management of fractures of long bones in children by Barry et al.⁵

In the mid-19th century, Ivory pins were used for this purpose and were then gradually supplemented by various metal devices. These were generally rigid implants. The school of rigid intramedullary fixation was typified by the Kuntscher nail, which achieved greater stability in all planes by occupying the entire medullary cross-sectional area of the bone. However, its use in growing children was limited by the difficulties encountered in trying to avoid the physis by Barry et al.⁵

Rush nail was introduced at about the same time as the Kuntscher nail. It was fore runner of modern elastic medullary fixation in that the objective was to achieve three-point fixation on the inner aspect of the cortex unlike the stiff K-nail, the rush nail was slightly flexible and it was intended that it should be pre-bent to the appropriate configuration before insertion. However, rotational stability was poor and in the most situation the flexibility was insufficient to allow insertion point in the metaphysis which were well away from the active physis in children by Barry et al.⁵

The main objective of the study is to evaluate the outcome, time taken for union of fracture and complication with use of TENS.

METHODS

This is a prospective study carried out to evaluate the outcome, time taken for union of fracture and complication with use of TENS.

Patients of fracture shaft femur in children between 4-14 years admitted in New Medical College Hospital Kota and associated hospitals, will be considered for the study. All patients will be taken up for surgery within seven days of their injury. Informed consent will be taken from all patients prior to surgery.

Study period of this study will be of one year (from December 2022 to November 2023). Software Epi info 2023 was used for statistical analysis of data.

Patients will be selected on basis of inclusion and exclusion criteria as under.

Inclusion criteria

Inclusion criteria were closed fracture shaft of femur; age four to fourteen years; both male and female; patient willing for operative procedure; displaced fracture; with or without comminution.

Exclusion criteria

Exclusion criteria were age below 4 years to above 14 years; compound fracture; pathological fractures; other associated fracture.

Initial management and resuscitation

Patients were received in the department of accidental emergency and vital parameters were monitored. Any associated limb, chest, abdominal and head injuries were ruled out. An intravenous line was established, analgesic injection was administered and fluid replacement was done. Skin traction on Thomas splint was applied. Radiograph of the fracture femur including hip and knee was taken in AP and lateral view.

Preoperative assessment and planning

On admission to the ward, a detailed history of the injury including the mode and severity of injury was taken. Vitals were monitored and fluid and blood transfusion was given if required.

Radiographs were studied carefully to classify the fractures according to the site, pattern and comminution.

According to site: (Dencker's classification)

Dencker's classification divides the anatomical site into three segments: proximal third, middle third, and distal third, according to the location along a structure's length, such as a bone, vessel, or tract.

According to pattern

Patterns are classified based on transverse, oblique, spiral, comminuted, segmental.

The comminuted fractures were classified according to WINQUIEST and HENSEN classification (1984) for comminution.

Grade I: comminuted fractures

A grade I comminuted fractures is one in which very small bone has broken off. This bone fragment makes very little difference in fracture stability and the fracture can be treated, as it was non – comminuted.

Grade-II: comminuted fractures

In a grade II comminuted fracture, the fragment is larger than in grade I fracture but there is still at least 50% contact of the abutting cortices which prevent shortening and helps to control rotation.

Grade-III: comminuted fractures

A grade III comminuted fracture has less than 50% cortical contact or poor purchase of the nail in either the proximal or the distal femur, thus rotation, translation and shortening in this grade is very unstable.

Grade-IV: comminuted fractures

A grade IV comminuted fracture has lost its circumferential buttress of the bone. There is not fixed contact between the proximal and the distal fragments to prevent shortening. It is multifragment fracture.

The preoperative preparation

Preoperative investigations including hemoglobin; TLC, DLC blood sugar, serum urea, serum creatinine, chest X-ray and ECG were done as a part of pre anesthetic evolution.

Preoperative part preparation consisted of cleaning of the whole affected limb with povidone iodine scrub and covering with sterile bandage, 12 hours prior to the operation.

500 mg to 1.5 mg cefuroxime injection was given according to patient's age immediately before surgery.

Cleaning of the whole affected limb with providence iodine scrub was done again immediately before surgery.

Instrument set & nails

Nail instrument set typically includes curved AWL, nail bending iron, nail impactor, slotted hammer, mallet, T handle, extractor hook, nail cutter, nail set diameter.

TEN: 2.5mm, 3mm, 3.5mm, 4mm diameter.

Length: 45cm.

Operative technique

After administering appropriate anaesthesia patient was placed supine on a radiolucent fracture table with opposite leg widely abducted. Two nails were used one from medial and one from lateral side. Nail diameter measured 40% the narrowest diameter of diaphysis. Both nails were of equal diameter.

Determination of nail length and diameter

Length was measured by placing the nail on draped thigh. The lateral nail should extent from distal femoral physis to 1 cm distal to greater trochanteric physis and medial nail should extent from the distal femoral physis to 2cm distal to capital femoral physis.

Nail diameter

Width of the canal was measured at the narrowest point of the diaphysis in both AP and lateral view. Nail diameter measured 40% of the narrowest diameter (Flynn et al).¹⁰

Bending of nails

Nails were prepared by bending them at 45 degrees about 2cm from proximal end of facilitate is entry into the medullary canal and were also bent into an even curve over their entire length. The apex of the bend was lie at the fracture site and the depth of curvature would be about three times the diameter of the femoral canal.

Medial & lateral insertion site was chosen 2 to 2.5 cm proximal to distal femoral physis. A small (2-3 cm) incision was made in the skin and fascia and a small awl was used to create an oval defect in the metaphyseal cortex 2-2.5 cm proximal to physis. Then the prepared nail was inserted from the medial and lateral side and driven up to the level of the fracture. At this point the fracture was reduced and nails driven across the fracture site. Traction was released after the nails have crossed the fracture and used manual compression if necessary to prevent distraction. Lateral nail should rest 1cm distal to greater trochanter physis and medial nail should rest 2cm distal to capital femoral physis. Distally nails were cut so that 1cm of the nail remain outside the cortex.

Post operative protocol

Antibiotic: injection cefuroxime 500mg -750mg was given at 4 pm, 12 midnight and 8 am on the next day.

Injection diclofenac sodium: 1-2cc IM SOS.

Dressing was checked at 48 hours.

Static quadriceps exercise was started 24 hours after the operation.

Knee bending exercise: gentle knee bending exercise was started on 1st or 2nd postoperative day.

Patients were discharged after 48 hours and called after 2 weeks of postoperative period for stitch removal.

After stitch removal, patients were called for follow up after every 2 weeks up to two months and subsequently at monthly interval.

Patients were assessed on subjective ground clinically and radiologically at each follow up.

Timing of weight bearing was individualized depending on comminution, stability of reduction and rigidity of fixation.

Flynn's criteria. TENS outcome score (Flynn et al).¹⁰

Table 1: Flynn's criteria (TENS outcome score).

Results (variables at 24 weeks)	Excellent	Satisfactory	Poor
Limb-length inequality	<1.0 cm	<2.0 cm	>2.0 cm
Malalignment	5 degrees	10 degrees	>10 degrees
Pain	None	None	Present
Other complications	None	Minor and resolved	Major and lasting morbidity

Ethical approval

Ethical Committee approval was taken from member Secretary Institutional Ethical Committee Government Medical College Kota.

RESULTS

The youngest patients were 5 years old and the eldest was 14 years old with an average age of 9.7 years.

Table 2: Age distribution.

Age (in years)	No. of cases	Percentage
4-6	3	10
7-9	9	30
10-12	17	57
13-14	1	3
Total	30	100

The average time of union was 8 weeks range from 6-10 weeks.

The union of the fracture was assessed by standard radiological and clinical criteria. Absence of pain on walking was the clinical indicator of union.

Table 3: Time of union.

Time (weeks)	No. of patient	%
6	4	13
8	23	77
10	3	10
Total	30	100

Table 4: Full weight bearing.

Time (weeks)	No. of patient	%
6	3	10
8	19	63
10	8	27
Total	30	100

Most of the patients (73%) started full weight bearing up to 8 weeks. The average period for full weight bearing was 8 weeks.

Table 5: Full range of knee movement.

Time (weeks)	No. of patient	%
6	1	3
8	12	40
10	8	27
12	5	17
>12	4	13
Total	30	100

Majority of patients (87%) achieved full range of knee movement up to 12 weeks. One fifth of total had terminal restriction of knee flexion (20-30) before nail removal but after nail removal complete knee flexion occur.

Table 6: Limb length discrepancy.

Lengthening	No. of cases	%
<1 cm	5	17
1-1.5 cm	1	3

Clinically lengthening was noticed in 20% of cases with an average of 1 mm & no one had shortening.

Table 7: Correlation of age with lengthening.

Age (in years)	Lengthening	%
4-8 (total 9 cases)	4	13
9-14 (total 21 cases)	2	7

Lengthening was more common (13%) up to 8 years of age. In patients with more than 8 years of age lengthening was seen in only 7% cases.

Angulations were seen in about one fifth cases and no one had more than 10 degree angulation.

Table 8: Malalignment.

Angulation	No. of fracture	%
5°	3	10
10°	2	7

Table 9: Complication.

Complication	No. of cases	%
Soft tissue inflammation at nail entry portal	2	6.66
Superficial infection at nail enter portal	1	3.33
skin ulceration at nail entry portal	1	3.33

There was no case of delayed union, non-union, deep infection, nail bending or breakage, proximal migration of nail, iatrogenic fracture, avascular necrosis of femoral head, and damage to greater trochanter physis.

Table 10: Final result.

Outcome	No. of cases	%
Excellent	26	87
Satisfactory	4	13
Poor	0	0
Total	30	100

Results were excellent in 87% cases while satisfactory in 13% cases. No patient had poor results. In satisfactory group all 4 patients had angulation of 10° which might improve with long follow up.

DISCUSSION

In recent years, the best results of treatment of fracture of femoral shaft in children have been achieved by TENS, as it is a simple, safe, minimal invasive, associated with almost 100% healing with excellent alignment of fracture fragments, negligible complication rate, shorter hospital stay & early functional recovery including early weight bearing with rapid return to daily activities & school. It avoids long & uncomfortable immobilization. Cosmetic damage is minimal, being limited to small scar at the sites of introduction of nails.

Based on this concept a number of studies have been conducted. The present study comprises of 30 cases (30 fractures) of fracture shaft femur in children (age ranges from 4-14 years), which were treated with TENS Nail & followed up in the Department of Orthopedics GMC Medical Collage & Hospital, Kota during the period "December 2022 to November 2023".

The patients between the age group of 4-14 years were included in this study. This age group was selected because patients between the age group of 4-14 years spontaneously correct angular malalignment only slightly

by Kissel et al.⁶ Also, problems like knee stiffness and shortening occurred in children above 8 years who were treated with conservative methods by Mann et al.⁷ Children below age of 4-5 years tolerate traction, prolonged bed rest and immobilization without any significant adverse social or functional sequelae. Also, anatomical reduction is usually not necessary as deformities tend to correct with growth in cases of young children by Mann et al.⁷ The age range of patients included in this study was similar to that conducted by Cramer et al (5-15 years), Ligier et al (5-16 years) and Flynn et al (4-16 years).⁸⁻¹⁰ The age group of patients in the study conducted by Mann et al was 9-15 years.⁷

The average age of the patients was 9.7 years. This age group was greater than the mean age of 8.5 years in study conducted by Cramer et al and 9.5 years in study conducted by Flynn et al, but lesser than the study conducted by Ligier et al where it was 10 years and Mann et al where the mean age group was 12.7 years.⁷⁻¹⁰

The average time of full weight bearing was 8 weeks. The average time of full weight bearing in study conducted by Flynn et al was 8.5 weeks, while that in study conducted by Mann et al was 8.6 weeks.^{7,10}

In the present series callus was first noted on follow up radiographs at an average of 4 weeks. This was similar to the study conducted by Flynn et al (4 weeks) but greater than the study conducted by Cramer et al (3 weeks).^{8,10}

The average time of union was 8 weeks. In the study conducted by Galpin et al the average time of union was 9.1 weeks.¹¹ In the study conducted by Cramer et al all fractures were healed within 12 weeks.⁸

As in Flynn et al, Mann et al, Cramer et al, in our study too there was no case of delayed union & non-union.^{7,8,10}

In the present study majority of patient 87% achieved full range of knee movement up to 12 weeks. One fifth of total patients had minor loss of knee flexion (20°-30°) before nail removal but after nail removal complete knee flexion occurred. Similar findings was noted in the study conducted by Bar-On et al & Cramer et al.^{1,8}

In our study lengthening was seen in 6 (20%) patients. In 5 patients lengthening was 1 cm while in 1 patient lengthening was 1.5 cm with an average lengthening was 1 mm. In the study conducted by Ligier et al, the average lengthening was 1.2 mm while in the study conducted by Cramer et al the average lengthening was 7 mm.^{8,9} However no lengthening was seen in study conducted by Mann et al & Bar on et al.^{1,7}

Angulation was seen in 6 (20%) patients in this study. No patient had angulations of more than 10°. Angulations of more than 5° was seen in the study conducted by Flynn et al in 10.2% cases, Ligier et al in 22.4%.^{9,10} In Mann et al in 31% cases.⁷

Skin irritation at the entry portal due to prominent nail was noted in 5 cases (16.6%) in this study. In one case (3.33), it resulted in skin ulceration. Similar result was seen in the study conducted by Flynn et al who noted this complication in 6.8% of cases.¹⁰

One patient in this study was found to have superficial infection at the entry portal of the nails, which subsided by 4 weeks after antibiotic therapy. Similar complication was seen in study conducted by Ligier et al who noted in one case (0.8%).⁹ No infection was reported by Mann et al.⁷

All cases were assessed by Flynn's criteria. We noted excellent results in 26 cases (87%) and satisfactory result in 4 cases (13%). No patient showed poor result. In the study conducted by Flynn et al excellent result was seen in 38 cases (65.5%), satisfactory result in 18 cases (31.3%) and poor result in case (1.7%).¹⁰ In the study conducted by Galvankar et al excellent result were seen in 15 patient (71%), satisfactory result in 5 patient (24%) and poor result in one patient (5%).¹² In a study conducted by Donati et al, excellent results were obtained in 79.2% of patients and satisfactory results in remaining 20.8% and nil case with poor result.¹³

Heinrich et al reported excellent results in all 78 cases treated with Enders nails without any significant complications.¹⁴ Bar-On et al also reported excellent results with flexible nails and reports that the results were better than those with external fixators.¹ Kissel et al reported results of enders nailing to be superior to the conventional methods of treatment.⁶

The treatment of femoral shaft fractures in children with TENS compares favourably to many other forms of treatment options available to treat these fractures. Bar-on et al reported pin track infections and delayed union in cases treated with external fixators, however this complication did not occur in cases of intramedullary nail fixation.¹ They concluded that flexible intramedullary nailing was better option than external fixators for management of these fractures. Large exposure, periosteal stripping, delayed union, plate breakage, stress fractures after the plate removal are few complications seen in cases of compression plate fixation, which are not seen in cases of intramedullary nail fixation. Gregory et al compared flexible intramedullary nailing with rigid nailing in these fractures and noted no statistically significant difference in final outcome.¹⁵ They however noted that flexible nailing required much less operative time and less fluoroscopy time. Also, the estimated cost of using Ender nails is much less than Russell Taylor interlocking nails.

Loss of alignment and fixation failure could be a problem with Enders nails due to relatively less rigid fixation as compare to TENS nails. Also being a load-sharing device, no risk of relative osteopenia at the ends of bones occurred, as seen in load shielding external fixation devices, hence no refracture occur after nail removal.

Crawford et al compared use of TENS in 42 children with use of ender nails in 50 children to determine if one nail type is superior to the other.¹⁶ We demonstrated significantly faster healing (callus formation) and faster return to full weight-bearing in patients treated with TENS than in patients treated with Ender nails.

Flynn et al stated that the ideal device to treat pediatric femoral shaft fractures would be a simple, load sharing internal splint allowing mobilization and maintenance of alignment for a few weeks until bridging callus forms.¹⁰ Thus the aim to fix fractures of diaphysis of femur in children with intramedullary nails is to encourage formation of bridging periosteal callus.

TENS provides a combination of elastic mobility and stability. The elastic mobility provided by these nails allows micromotion thus promoting external bridging callus formation. The periosteum is not fracturing hematoma or the risk of infection. Callus formation is twice as fast as with conventional methods.

The treatment of the paediatric femur fracture, however continue to evolve. For many reasons, the adolescent group poses a great challenge to the treating surgeons. The traditional method of traction and spica casting can be effective but is more difficult in older children due to their size, slower healing rate, and limited potential for remodelling. Operative stabilization can simplify management but carries the attendant risks of surgery, particularly injury to the functioning physis.

The use in fracture of shaft of femur in children has expanded the treatment options for patients with multiskeletal or multisystem injuries, especially head injury patients, where nursing care with conservative treatment is quite cumbersome.

The limitations to our study were a sample size and a follow-up for a short period of time, so long term affects couldn't be studied.

CONCLUSION

Cases of femoral shaft fractures, which were studied, were treated by elastic stable intramedullary nailing. These cases were followed up for an average period of thirteen month. The youngest patient was five-year-old & the eldest patient was fourteen-year-old with an average age of 9.7 year. Time of union ranged from 6-10 weeks with an average duration of 8 weeks. The average period of full weight bearing was 8 weeks. Majority of patients (87.5%) had full range of knee movement up to twelve weeks. Lengthening was seen in 6 (20%) patients. In majority of the patients (5 case), lengthening was one cm while in one patient lengthening was 1.5 cm. Out of the six patients in which lengthening was seen, four patients were less than eight years old. Angulation was seen in six patients. In three cases angulation was 5° while in three cases angulation was 10°. No one had more than 10° deformity.

The commonest complication encountered in this series was soft tissue inflammation at nail insertion site in two (6.66%) cases, followed by superficial infection in one (3.33%) case & skin ulceration at nail insertion site in one case (3.33%). Result was excellent in 87% cases while satisfactory in 13% cases. No patient had poor results. All four patients in satisfactory group had angulation of equal to or more than 10°, which might improve with long follow up. Based on our research findings and results, we conclude that elastic stable intramedullary nailing (ESIN) technique is an ideal method for treatment of femoral shaft fractures in the children in the age group of four to fourteen years. It is a simple, easy, rapid and effective method for management of paediatric femoral fractures with reasonable time to bone healing. Use of ESINs for definitive stabilization of femoral shaft fractures in children is a reliable, minimally invasive, and physal protective treatment method.

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REFERENCES

1. Bar-On E, Sagiv S, Porat S. External fixation or flexible intramedullary nailing for femoral shaft fracture in children. *J Bone Joint Surg.* 1997;79:975-8.
2. Linhart WE, Ropposch A. Elastic stable intramedullary nailing for unstable femoral fractures in children: preliminary results of a new method. *J Trauma.* 1999;47:372-8.
3. Gonzalez-Herranz P, Burgos-Flores J, Lopez-Mandejare JA, Rapariz JM, Ocete JG, Amaya S. Intramedullary nailing of the femur in children. Effects. on the on the proximal end. *J Bone Joint Surg.* 1995;77:262-6.
4. Thometz JG, Lamdan R. Osteonecrosis of the femoral head after intramedullary nailing of a fracture of the femoral shaft in an adolescent. *J Bone Joint Surg.* 1995;77:1423-6.
5. Barry M, Paterson JMH. Flexible intramedullary nails for fracture in children. *J Bone Joint Surg (Br.).* 2004;86:947-53.
6. Kissel EU, Miller ME. Closed ender nailing of femur fractures in older children. *J Trauma.* 1989;29:1585-8.
7. Mann DC, Weddington J, Davenport K. Closed Ender nailing of femoral shaft fractures in adolescents. *J Pediatr Orthop.* 1986;6:651-5.
8. Cramer KE, Tornetta P, Spero C, Moraliakbar H, Teefy J. Ende Rod fixation of femoral shaft fractures in children. *Clin Orthop.* 2000;376:119-23.
9. Ligier JN, Metaizeau JP, Prevot J, Lascombes P. Elastic stable intramedullary nailing of femoral shaft fractures in children. *J Bone Joint Surg.* 1988;70:74-7.
10. Flynn JM, Hresko T, Reynolds RA, Blasier RD, Davidson R, Kasser J. Titanium elastic nails for pediatric femur fractures: a multicenter study of early results with analysis of complications. *J Pediatr Orthop.* 2001;21(1):4-8.
11. Galpin RD, Wilis RB, Sabano N. Intramedullary nailing of pediatric femoral fractures. *J pediatr Orthop.* 1994;14(2):184-9.
12. Galvenkar A, Patond KR. Elastic stable intramedullary fixation of pediatric femoral fractures: An alternative to intramedullary fixation of pediatric femoral fractures: An alternative to titanium nails. Delhi. *J Orthop.* 2004;1:59-62.
13. Donati F, Mazzitelli G, Lillo M, Menghi A, Conti C, Valassina A, et al. Titanium elastic nailing in diaphyseal femoral fractures of children below six years of age. *World J Orthop.* 2017;8(2):156-62.
14. Heinrich SD, Drvaric D, Darr K, MacEwen GD. The operative stabilization of pediatric diaphyseal femur fractures with flexible intramedullary nail: a prospective analysis. *J Pediatr Orthop.* 1994;14:50-7.
15. Gregory P, Sullivan JA, Herndon WA. Adolescent femoral shaft fractures: Rigid versus flexible nails. *J Trauma.* 1995;18:645-9.
16. Crawford AH, Wall EJ, Mehlman CT, et al. Titanium vs. stainless steel elastic nail fixation of femur fractures: is there a difference? Paper presented at: Annual Meeting of the Pediatric Orthopaedic Society of North America; May 14, 2005; Ottawa, Canada.

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