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Comparison of Titanium Elastic Nails with Traction and Spica Cast in Treatment of Children's Femoral Shaft Fractures

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Abstract: Titanium Elastic Nails (TEN) are commonly used to stabilize femoral fractures in school-aged children, but there have been few studies assessing the risk of traditional traction and application of spica cast. The aim of this study was to compare of titanium elastic nails with traction and spica cast in treatment of children's femoral shaft fractures. A group of thirty children aged 6-12 years with one-sided femoral shaft fracture were randomly allocated either to traction with spica casting group or titanium elastic nails group and were followed up to 1 year. Factors such as age, sex, time needed for walking with aids, time needed for independent walking, time needed for callus formation, time absent from school, time spent in hospital, malunion, malalignment and wound complication were recorded and compared. Fifteen patients (10 boys, 5 girls) with a mean age of 8.33±1.63 years were treated by traction and spica casting. The other 15 (9 boys, 6 girls) with a mean age of 8.73±1.53 years underwent surgery using TEN. Mean absence time from school, length of hospital stay, time needed for walking with and without help and angular deviation (varus or valgus) were significantly lower in the group treated by TEN (p-value<0.05). Time needed for callus formation was significantly lower in spica casting group (p-value<0.001). No statistically significant difference was observed between the two groups regarding malunion wound complications and hospital charges. The results indicated that a child in whom a femoral fracture is treated with TEN achieves recovery milestones significantly faster than a child treated with traction and spica cast.

Key words: TEN, spica cast, femoral fractures

INTRODUCTION

Although, femoral shaft fractures constitute fewer than 2% of all fractures in children and adolescents, their treatment has produced many pieces of literature and years of controversy (Bandyopadhyay and Mukherjee, 2013; Palmu *et al*., 2013). Prevailing opinion has favored nonoperative and operative treatment and a variety of techniques have been advocated to avoid complications such as nonunion, limb-length discrepancy, malalignment, osteonecrosis and growth disturbance (Juengteerapanich *et al*., 2012; Ruiz-Mejia *et al*., 2012). Currently, operative methods of treatment generally are favored to allow early ambulation and shorter hospital stays and to avoid detrimental psychological and social effects often associated with prolonged nonoperative treatment and to avoid complications (Brousil and Hunter, 2013; Wilson *et al*., 2012). Options for operative fixation include external fixators, flexible and locked intramedullary nails and compression and bridge plating. Although, all of these can obtain good results in particular situations, there is no clear consensus of the indications for each (Miller *et al*., 2012; Volpon *et al*., 2012). The purpose of treating femoral shaft fractures is to achieve complete union so that one can restore all of the limb's natural functions. Traction with spica cast and closed reduction is applied in children under 6 years old and in this age group is followed by more complications such as malunion, leg-length discrepancy and quadriceps weakness and at least 2 months absence from school (Gordon and O'Donnell, 2012; Lascombes *et al*., 2012). Complications of traction and spica cast have led to the introduction of flexible intramedullary fixation as an adaptable technique for the stabilisation of femoral shaft fractures in patients with immature skeleton (Yang *et al*., 2012; Song *et al*., 2012). Children with a fractured femur have traditionally been treated with weeks of traction and a body cast, but over the past few years, titanium elastic nails have become a relatively common treatment option (Pfeifer *et al*., 2012; Melisie *et al*., 2012). TEN is a new method that used since nearly two decades ago in Europe and USA. As there is high incidence of avascular necrosis

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of the femoral neck following intramedullary nailing, TEN has widened in treating femoral shaft fractures (Eichinger *et al*., 2012; Park and Kim, 2012). This study aimed at comparing the titanium elastic nails with traction and spica cast in treatment of children's femoral shaft fractures.

MATERIALS AND METHODS

This study is a randomized clinical trial comparing the trial group (treated by TEN) with the comparison one (treated by traction and spica cast). From January 2011 to January 2013, all the children of 6-12 years old with mean age of 8.53±1.32 with non-comminuted one-sided diaphyseal fractures of the femoral shaft who had been admitted to department of orthopeadics, Shohada hospital Tabriz were entered into the study. Patients suspected of pathologic or comminuted fractures, abdominal or pelvic injury, major injury of the soft tissue, vessels or nerves of the afflicted limb, head or spinal injury, children who suffered complications after general anesthesia; those with systemic infection were excluded from the study. Patients who satisfied the above criteria were divided into two groups randomly by using random allocation software. The first group underwent TEN (group A) and the other underwent spica casting under general anesthesia (group B). Before implementing the treatment method, the operation steps and information of the second surgical and high complication rate were explained to the patients as well as their parents. Written consent was obtained from all the patients' parents. In TEN group operation was done under general anesthesia on a fracture table. After a linear incision, opening the fascia, and passing the muscle fibers, a hole was opened in the bone and enlarged. Then, each titanium elastic nail was retrogradely placed through the distal part of the femur. Each nail was 40% of the canal diameter at the narrowest site of the femoral shaft. Patients in the spica cast group were treated with skeletal traction for about 3 weeks and then with a spica cast. The traction pin was inserted in the distal part of the femur in the operating room and under general anesthesia. Control radiography was carried out after the traction and later at 1-week intervals. The pin was removed after sufficient callus consolidation had been achieved and a one-and-a-half hip spica was applied in the operating room under general anesthesia. The cast was maintained for about 1 month; after cast removal, patients were referred for physical therapy for initial gait training and additional physical therapy if a satisfactory range of motion was not achieved. The patients were followed up at least for 1 year regularly and data such as age, sex, type of fractures, time spent in hospital, time needed for pain relief, time needed for walking without help, time needed for callus formation, hospital charges, malunion, angular deviation (varus, valgus, anteroposterior angle), quadriceps strength, motion of hip and knee joints, leg-length discrepancy and the state of operation wound were comprised. All patients were monitored thoroughly on a regular basis by physical examination and X-ray imaging. SPSS™-15 was used as the statistical program. Continuous variables are reported as means±SD. Categorical variables are presented as percentages. The association between 2 factor variables was estimated using) 2 analysis. Fisher exact test was also used for association between qualitative and quantitative variables. A p-value of <0.05 was considered significant.

RESULTS

One hundred and twenty patients of 6 -12 years age group with fractures of the middle part of the femur were allocated into either of these groups: 60 patients (40 boys, 20 girls) with a mean age of 8.33±1.63 years were treated by traction and spica casting. The other 60 (36 boys, 24 girls) with a mean age of 8.73±1.53 years underwent surgery using TEN (Table 1). None of the patients suffered from accompanying traumas especially of the head, spinal column, pelvis and abdomen and there was no sign of nervous or vascular injury or a major soft tissue one. In all patients, fractures were of diaphyseal, closed and one-sided type and most were transverse (46.7% in the trial group and 40% in the comparison one). Since nail was placed distal to trochanter, it had not affected the trochanter growth. After one year the quadriceps strength was 5/5 in all patients meaning that all of them were able to raise their legs against the pressure of physician's hand. The length inequality of the lower limb was stated in 32(53.30%) patients with spica cast since it was not recorded in TEN groups. An Anterior-posterior angulation was recorded in 12(20%) patients with spica cast while it was stated in 4(6.7%) patients of TEN groups. Varus or valgus was seen in 16(26.6%) patients with spica cast since it was recorded in 8 (13.3 %) patients in TEN groups. Time needed for walking without help and angular deviation (varus, valgus or anteroposterior angle) were significantly lower in the group treated by TEN (p<0.00).

Table 1: Demographic characteristics of the study population

Characteristic	TEN (n = 60)	Spica cast (n = 60)
Age	8.73±1.53	8.33±1.63
Sex		
Boy	40 (66.6%)	36 (60%)
Girl	20 (33.3%)	24 (40%)
Height (cm)	130±12.32	133±11. 48
Weight (kg)	24.32±8.14	25.28±7.64

TEN: Titanium elastic nails

Table 2: Comparison of TEN with traction and spica casting

Index	Spica cast	TEN	p-value
The mean time absent from school (day)	63±12	25.4±2.3	<0.001
The mean time spent in hospital (day)	18.28±3.47	6±1.77	<0.001
The time needed for pain palliation (day)	7.4±1.5	6.87± 2.29	0.13
The time needed for walking with aids (day)	73±2.89	6.6±0.99	<0.001
The time needed for independent walking (day)	73.07±2.2	52.53±5.4	<0.001
The time needed for callus formation (day)	16±3.85	24.93±0.88	<0.001
Malunion	48 (80%)	16 (26.6%)	<0.001
The length inequality of the lower limb	32 (53.3%)	0(0%)	<0.001
Varus or valgus*	16 (26.6%)	8 (13.3%)	0.0679
Ant-pos angle	12 (20%)	4 (6.7%)	0.0575
Limitation of range of motion in knee joint**	12 (20%)	0 (0%)	0.0003
Wound complication after operation	0 (0%)	4 (6.7%)	0.1187
Cost (US dollar)	503.37±12.61	472.78±9.65	0.0001
Parent Satisfaction 40 (66.6) 28 (46.6) 0.0271, *The acceptable amount of varus or valgus in the age range of 6-11 is at most 10 degree, **The range of motion in knee joint is 0-130			

Time needed for callus formation was significantly lower in spica casting group ($p<0.001$).Only four of the patients treated by TEN suffered minor wound infection that was cured by oral antibiotic. No statistically significant difference was observed between the two groups regarding time needed for pain relief, malunion (Table 2). The cost of treatment with spica cast was 503.37±12.61 $ since it was 472.78±9.65 $ in TEN group. This difference was statistically significant. ($p<0.001$) (Table 2) Forty (66.6%) parents of children undergone TEN were satisfied of the procedure since this satisfaction was existed in 28 (46.6%) of spica cast group. This difference was statistically significant ($p = 0.0271$).

DISCUSSION

Femoral shaft fractures in children are common and frequently require hospitalization.1,2 Traditionally femoral shaft fractures in children have been treated by some form of initial traction followed by spica cast immobilization (Kumar *et al*., 2011; Hariga *et al*., 2011). Horizontal traction was advocated by Buck in the 1860s. Bryant, however, advocated vertical traction. Hamilton, practicing in the 1890s, recommended splint treatment for femoral shaft fractures. Spica casting was begun in the 1890s at Johns Hopkins University. In 1940, Kuntscher described intramedullary nailing (Lohiya *et al*., 2011; Fakoor *et al*., 2011; Flynn *et al*., 2011; Park *et al*., 2012). Blount recommended casting with or without traction and believed that surgery was almost never needed. More recently, better results were reported when adolescents and children with head injuries are treated operatively in comparison to those treated nonoperatively (Furlan *et al*., 2011; Ellis *et al*., 2011; Jauquier *et al*., 2010; Hosalkar *et al*., 2011). Many procedures have been proposed for pediatric femoral shaft fractures, but there is no consensus on any of these methods. Most researchers in the last 20 years have investigated the efficacy of spica cast in treatment of femoral shaft fractures. TEN is a new procedure that recently used for this issue (Altay *et al*., 2011; Heideken *et al*., 2011). In this study, mean absence time from the school and length of hospital stay were significantly lower in TEN group compared with spica cast group. Tsang and Adedapo (2011) have reported the same results. Bar-On *et al*. (2011) concluded that there is no statistically significant difference between the two groups regarding leg-length discrepancy and malunion. In this study, no statistically significant difference was observed between the two groups regarding anteroposterior angle and malunion too, only varus and valgus were higher in the spica cast group. The difference between the results can be attributed to discrepancies in: sample size, age and children's weight, mechanism of injury and facilities of treatment centers. Such earlier recovery milestones have also been shown by Zhou *et al*. (2011). They also reported that patients treated by TEN begin to walk earlier. This study concluded that time needed for callus formation is significantly lower in the spica cast group. According to Akinyoola *et al*. (2011) mean time needed for callus formation in spica casting and TEN is 6 and 7-10.7 weeks, respectively. The reason is that spica casting is done after primary callus formation. Time spent in hospital in the TEN group was significantly lower compared with the spica cast group. Wu *et al*. (2011) have reported the same results. These results concerning time needed for pain relief, wound complication and restoration of joint's range of motion are similar to those of the Shemshaki *et al*. (2011). Garner *et al*. (2011) showed complications were higher in the traction and casting group in comparison with the group undergoing surgery.

CONCLUSION

This study concluded that TEN is the choice procedure for treating femoral shaft fractures in children of 6-12 years age group.

REFERENCE

Akinyoola, A.L., O.O. Orekha, F.O. Taiwo and A.O. Odunsi, 2011. Outcome of non-operative management of femoral shaft fractures in children. Afr. J. Paediatr. Surg., 8: 34-49.

Altay, M.A., C. Erturk, H. Cece and U.E. Isikan, 2011. Mini-open versus closed reduction in titanium elastic nailing of paediatric femoral shaft fractures: A comparative study. Acta Orthop. Belg., 77: 211-217.

Bandyopadhyay, R. and A. Mukherjee, 2013. Short term complications of titanium elastic nail in the treatment of diaphyseal fracture of the femur in children(). Open Orthop. J., 7: 12-17.

Bar-On, E., E. Lebel, Y. Kreiss, O. Merin and S. Benedict *et al*., 2011. Orthopaedic management in a mega mass casualty situation. The Israel defence forces field hospital in haiti following the January 2010 earthquake. Injury, 42: 1053-1059.

Brousil, J. and J.B. Hunter, 2013. Femoral fractures in children. Curr. Opin. Pediatr., 25: 52-57.

Eichinger, J.K., C.S. McKenzie and J.G. Devine, 2012. Evaluation of pediatric lower extremity fractures managed with external fixation: Outcomes in a deployed environment. Am. J. Orthop. (Belle Mead NJ), 41: 15-19.

Ellis, H.B., C.A. Ho, D.A. Podeszwa and P.L. Wilson, 2011. A comparison of locked versus nonlocked Enders rods for length unstable pediatric femoral shaft fractures. J. Pediatr. Orthop., 31: 825-833.

Fakoor, M., S. Mousavi and H. Javherizadeh, 2011. Different types of femoral shaft fracture; different types of treatment: Their effects on postoperative lower llimb discrepancy. Pol. Przegl. Chir., 83: 477-481.

Flynn, J.M., M.R. Garner, K.J. Jones, J. DItalia and R.S. Davidson *et al*., 2011. The treatment of low-energy femoral shaft fractures: A prospective study comparing the walking spica with the traditional spica cast. J. Bone Joint Surg. Am., 93: 2196-202.

Furlan, D., Z. Pogorelic, M. Biocic, I. Juric and D. Budimir *et al*., 2011. Elastic stable intramedullary nailing for pediatric long bone fractures: Experience with 175 fractures. Scand. J. Surg., 100: 208-215.

Garner, M.R., S.B. Bhat, I. Khujanazarov, J.M. Flynn and D. Spiegel, 2011. Fixation of length-stable femoral shaft fractures in heavier children: Flexible nails vs rigid locked nails. J. Pediatr. Orthop., 31: 11-16.

Gordon, J.E. and J.C. O'Donnell, 2012. Tibia fractures: What should be fixed? J. Pediatr. Orthop., 32: S52-S61.

Hariga, H., M. Mousny and P.L. Docquier, 2011. Leg length discrepancy following femoral shaft fracture in children: Clinical considerations and recommendations. Acta Orthop. Belg., 77: 782-787.

Heideken, J.V., T. Svensson, P. Blomqvist, Y. Haglund-Akerlind and P.M. Janarv, 2011. Incidence and trends in femur shaft fractures in Swedish children between 1987 and 2005. J. Pediatr. Orthop., 31: 512-519.

Hosalkar, H.S., N.K. Pandya, R.H. Cho, D.A. Glaser, M.A. Moor and M.J. Herman, 2011. Intramedullary nailing of pediatric femoral shaft fracture. J. Am. Acad. Orthop. Surg., 19: 472-481.

Jauquier, N., M. Doerfler, F.M. Haecker, C. Hasler, P.Y. Zambelli and N. Lutz, 2010. Immediate hip spica is as effective as, but more efficient than, flexible intramedullary nailing for femoral shaft fractures in pre-school children. J. Chil. Orthop., 4: 461-465.

Juengteerapanich, S., P. Udomkiat and B. Mahaisavariya, 2012. Heterotopic ossification after closed femoral nailing. J. Med. Assoc. Thai., 95: S99-S103.

Kumar, S., S.K. Roy, A.K. Jha, D. Chatterjee, D. Banerjee and A.K. Garg, 2011. An evaluation of flexible intramedullary nail fixation in femoral shaft fractures in paediatric age group. J. Indian Med. Assoc., 109: 416-417, 425.

Lascombes, P., A. Nespola, J.M. Poircuitte, D. Popkov, A. de Gheldere, T. Haumont and P. Journeau, 2012. Early complications with flexible intramedullary nailing in childhood fracture: 100 cases managed with precurved tip and shaft nails. Orthop. Traumatol. Surg. Res., 98: 369-375.

Lohiya, R., V. Bachhal, U. Khan, D. Kumar and V. Vijayvargiya *et al*., 2011. Flexible intramedullary nailing in paediatric femoral fractures. A report of 73 cases. J. Orthop. Surg. Res., Vol. 6. 10.1186/1749-799X-6-64

Melisie, F., E. Krug, J.W. Duijff, P. Krijnen and I.B. Schipper, 2012. Age-specific treatment of femoral shaft fractures in children. Ned. Tijdschr Geneeskd, Vol. 156.

Miller, D.J., D.M. Kelly, D.D. Spence, J.H. Beaty, W.C. Warner Jr and J.R. Sawyer, 2012. Locked intramedullary nailing in the treatment of femoral shaft fractures in children younger than 12 years of age: indications and preliminary report of outcomes. J. Pediatr. Orthop., 32: 777-780.

Palmu, S.A., M. Lohman, R.T. Paukku, J.I. Peltonen and Y. Nietosvaara, 2013. Childhood femoral fracture can lead to premature knee-joint arthritis. Acta Orthop., 84: 71-75.

Park, H. and H.W. Kim, 2012. Treatment of femoral shaft fracture with an interlocking humeral nail in older children and adolescents. Yonsei Med. J., 53: 408-415.

Park, K.C., C.W. Oh, Y.S. Byun, J.K. Oh and H.J. Lee *et al*., 2012. Intramedullary nailing versus submuscular plating in adolescent femoral fracture. Injury, 43: 870-875.

Pfeifer, R., B.A. Zelle, P. Kobbe, M. Knobe and R.L. Garrison *et al*., 2012. Impact of isolated acetabular and lower extremity fractures on long-term outcome. J. Trauma Acute Care Surg., 72: 467-472.

Ruiz-Mejia, O., J. Pimentel-Rangel, D. Escudero-Rivera, G. Valle-de Lascurain and J.A. Oribio-Gallegos, 2012. Management of shaft fractures with elastic titanium nails in pediatric patients. Acta Ortop. Mex., 26: 162-169 [Article in Spanish].

Shemshaki, H.R., H. Mousavi, G. Salehi and M.A. Eshaghi, 2011. Titanium elastic nailing versus hip spica cast in treatment of femoral-shaft fractures in children. J. Orthop. Traumatol., 12: 45-48.

Song, K.S., K. Ramnani, C.H. Cho, K.C. Bae, K.J. Lee and E.S. Son, 2012. Ipsilateral femoral neck and shaft fracture in children: A report of two cases and a literature review. J. Orthop. Traumatol., 10.1007/s10195-012-0188-9

Tsang, K.S. and A. Adedapo, 2011. Cannulated screw fixation of fracture neck of femur in children with osteogenesis imperfecta. J. Pediatr. Orthop. B, 20: 287-290.

Volpon, J.B., M.M. Perina, R. Okubo and D.A. Maranho, 2012. Biomechanical performance of flexible intramedullary nails with end caps tested in distal segmental defects of pediatric femur models. J. Pediatr. Orthop., 32: 461-466.

Wilson, C.H., C.S. Smith, D.M. Gay and E.A. Loveless, 2012. Submuscular locked plating of pediatric femur fractures. J. Surg. Orthop. Adv., 21: 136-140.

Wu, Q.Z., J. Zhang and S.H. Lan, 2011. Clinical outcomes of elastic intramedullary nail fixation and external fixation for the treatment of pediatric femoral shaft fractures. Zhongguo Gu Shang, 24: 146-148 [Article in Chinese].

Yang, M.X., Y.L. Chi, C. Wang, L.J. Sun and J.D. Zhang, 2012. [Case-control study on therapeutic effects of elastic stable intramedullary nails in the treatment of stable and unstable fractures of femoral shaft in children]. Zhongguo Gu Shang, 25: 116-119.

Zhou, Y., X.C. Qu, Z.Y. Fang, X. Liu, X.H. Pan and F. Feng, 2011. Comparison of efficacy between bridge wire splints and Bryant traction for the treatment of femoral shaft fractures in children. Zhongguo Gu Shang, 24: 236-239 [Article in Chinese].