RESEARCH ARTICLE

Clinical Evaluation of Stainless Steel and Titanium Elastic Nails for Femur Fracture Repair in Young Dogs

Swaroop R[1*], Manjunatha D R[2], Nagaraju, N[3], Ganga Naik S[4], Shivakumar V[5], Shilpa V T[6], Ramya N M[7]

Abstract

The cross-pollination of knowledge between human and veterinary orthopaedics continues to advance the field, facilitating the development of innovative treatment options for musculoskeletal disorders in animals. This comparative study seeks to delve into the clinical implications and biomechanical aspects associated with the use of two different elastic nails for femur fracture repair in young dogs. The current study involved 12 clinical cases with femoral fractures in dogs of various breeds and genders. Six dogs each were treated with titanium and stainless-steel elastic nails, respectively. Signalment and history were collected which was followed by clinical and radiographic examination to assess the fracture characteristic. Post-operative lameness, radiographic evaluations and complications were recorded on 15th, 30th and 45th post-operative days. Clinical efficacy was notably superior by using titanium elastic nails (TENs). This was evident in terms of ease of application intraoperatively, early weight bearing, reduced surgical duration, suitability for both diaphyseal and distal femoral fractures. However, stainless steel elastic nails (SSENs) were found to be well suitable for diaphyseal transverse femur fractures and offer the advantage of being less expensive.

Key words: Elastic nails, Femur fracture, Stainless steel, Titanium, Young dogs.

Ind J Vet Sci and Biotech (2024): 10.48165/ijvsbt.20.4.11

Introduction

The growing dog population, coupled with the increase in their interactions and activities with humans, has led to a rise in the incidence of accidents and traumas resulting in fractures. Long bone fractures are among the most common orthopaedic injuries encountered in veterinary practice, with the femur being the most affected. The highest number of femoral fractures were reported in dogs less than six months of age and the leading cause of long bone fracture was found to be automobile accidents (43.1%) followed by fall from a height (36.6%) (Kallianpur *et al.,* 2018).

Traditionally, diaphyseal femur fractures in paediatric orthopaedics are treated with casting or traction followed by casting. Over the past two decades, a shift towards rapid mobilization through fixation has gained recognition. The search for an ideal fixation device emphasizes an internal splint that supports the load, maintains alignment until callus formation and avoids damage to growth plates or compromise to blood supply in the femoral head (Flynn *et al.,* 2001). The elastic nailing technique offers a multitude of advantages, such as its minimally invasive nature, prevention of growth plate injuries in paediatric fracture treatment, promotion of early bridging of fracture fragments through callus formation, facilitation of rapid restoration of bone continuity for early weight-bearing and ambulation (Lascombes *et al.,* 2006). This comparative study seeks to delve into the clinical implications and biomechanical aspects associated with the use of stainless steel and titanium elastic nails for femur fracture repair in young dogs.

[1,3,7]Department of Veterinary Surgery and Radiology, Veterinary College Hassan-573202, KVAFSU, Bidar, Karnataka, India.

[2]Department of Veterinary Clinical Complex, Veterinary College Hassan-573202, KVAFSU, Bidar, Karnataka, India.

[4]Department of Veterinary Anatomy, Veterinary College, Gadag-582101, KVAFSU, Bidar, Karnataka, India.

[5]Department of Veterinary Medicine Veterinary College Hassan-573202, KVAFSU, Bidar, Karnataka, India.

[6]Department of Veterinary Pathology, Veterinary College Hassan-573202, KVAFSU, Bidar, Karnataka, India.

Corresponding Author: Swaroop R, Department of Veterinary Surgery and Radiology, Veterinary College Hassan-573202, KVAFSU, Bidar, Karnataka, India. e-mail: swarooprubens7@gmail.com

How to cite this article: Swaroop, R., Manjunatha, D. R., Nagaraju, N., Ganga Naik, S., Shivakumar, V., Shilpa, V. T., & Ramya, N. M. (2024). Clinical Evaluation of Stainless Steel and Titanium Elastic Nails for Femur Fracture Repair in Young Dogs Ind J Vet Sci and Biotech. 20(3), 50-54.

Source of support: Nil

Conflict of interest: The authors declare that there is no conflict of interest.

Submitted 27/03/2024 **Accepted** 25/04/2024 **Published** 10/07/2024

Materials and Methods

The current study involved 12 clinical cases of young dogs with femoral fractures, which were brought to the Department of Veterinary Surgery and Radiology, Veterinary College Hospital, KVAFSU, Hassan (Karnataka, India). This clinical study was duly approved by Institutional Animal

Ethics Committee (HVC/IAEC/06/2023). Details regarding age, sex, breed, body weight, aetiology of fracture, history of other illness, previous injury or orthopaedic disease, duration of the signs and past treatment if any, for the present complaint by the owner were recorded.

The dogs involved in the study were subjected to detailed clinical, physiological and radiographic examinations. Prior to the surgery, the size of the nail was determined by measuring the narrowest diameter of the medullary canal (isthmus) in both orthogonal views obtained through computed radiography. Each nail was chosen to occupy 30-40% of the narrowest medullary canal (Flynn *et al*., 2001). The dogs were pre-medicated with subcutaneous injection of Atropine sulphate @ 0.04 mg/kg b.wt., Inj. Xylazine hydrochloride @ 1 mg/kg b.wt., intramuscular, and intravenous administration of Inj. Butorphanol at 0.2 mg/kg b.wt. Ten min later, induction was initiated with intravenous Inj. Propofol @ 4 mg/kg b.wt. Following induction, the dogs were intubated with endotracheal tubes of suitable size, followed by maintaining with 1-2 % Isoflurane using a Bain and closed circuit with precision vaporizer, along with 100 % oxygen supply.

A standard surgical approach described previously by Jhonson and Piermattei (2004) for femoral fractures repair was followed. The elastic nails were placed similar to the method described by Sodhi *et al*. (2021). The operated limb was supported with modified Robert Jones Bandaging for 2 weeks and the dogs were prescribed with Tab Cefpodoxime @ 5 mg/kg b.wt. BID and Tab Carprofen @ 2 mg/kg b.wt. SID for 5 and 3 days, respectively. Following the surgery, all operated dogs underwent post-operative clinical and radiographic assessments at various intervals, including immediately after anaesthesia recovery, and on the 15th, 30th and 45th post-operative days. The assessment of weight-bearing status was conducted and categorized using a grading system proposed by Aron *et al*. (1991). Lameness was assessed and graded from grade 5 to Grade 0 (Anderson *et al*., 2002). The radiographic appearances of the fracture healing were graded based on callus formation, fracture line and stage of union of the bone, as suggested by Hammer *et al*. (1985).

Results and Discussion

In the current study, dogs less than six months of age were more affected with femur fracture (n=9, 75%) and also the non-descriptive dogs were affected more (n=4, 33.33%). Incidence of male dogs (n=9, 75.00%) was higher than female (n=3, 25.00%). Automobile accidents (n=9, 75.00%) and fall from height (n=3, 25%) were the primary causes. Kallianpur *et al*. (2018) and Bidari *et al*. (2023) observed similar findings in their study. Increased incidence of fractures in young dogs is due to their playful and active nature, coupled with their relative precociousness and inexperience (Simon *et al*., 2010).

Mid diaphyseal transverse fractures of femur accounted for 41.66 % (n=5) followed by distal diaphyseal fractures 33.34 % (n=4) and mid diaphyseal oblique fractures 25.00 % (n=3) in both the groups on preoperative examination. This observation aligned with findings reported by Simon *et al*. (2010) and Kumar *et al*. (2023).

Weight bearing was not seen in any of the dogs on initial presentation. Lameness grading in all dogs is depicted in Table 1. Gradual improvement in weight bearing from second post-operative week onwards was noticed in all the cases. Weight bearing was subtle, consistent and intermittent by 30th day in half of the dogs, remaining dogs exhibited normal limb function. At the end of the 45th day, excellent weight-bearing was demonstrated in five animals in Group A and three in Group B. Early weight bearing was seen in Group A compared to Group B (Fig. 1, 2, E-F). The prompt initiation of weight-bearing after fracture repair is advantageous for swift rehabilitation. Similar findings were observed by Prabhukumar *et al*. (2020), Rahul (2021) and Sodhi *et al*. (2021). The early onset of weight-bearing in Group A could be attributed to the lightweight and biocompatible nature of titanium compared to stainless steel. However, Gupta *et al*. (2023) found no significant difference in lameness scoring status between groups treated with titanium and stainless-steel elastic nails. Post-operative radiographs showed proper alignment of fracture fragments and implants in position. On the 30th day, periosteal callus formation was evident in all cases, accompanied by the presence of slightly visible fracture line. Group B displayed a more pronounced periosteal reaction compared to Group A. The increased amount of periosteal callus observed in Group B, where stainless steel elastic nails were used, could be attributed to the multiple piercings of the opposite cortex at various sites during nail insertion intraoperatively. This may be due to the higher stiffness of stainless-steel elastic nails compared to titanium elastic nails. Similar findings were noted by Gyaneshwar *et al*. (2016).

Endosteal callus formation was evident and there was noticeable remodelling of periosteal callus around the fracture site in all cases, which was consistent with findings reported by Gill *et al*. (2018), Prabhukumar *et al*. (2020) and Rahul (2021). Hunter (2005) noted that the periosteum in young individuals is significantly thicker and exhibits greater biological activity compared to that of adults. In the young, periosteal circulation serves as a vital source of cortical blood supply. Complete bone healing was noticed at 45th post- operative day with a continuous medullary canal and homogeneous bone structure, indicative of Grade I (Fig. 1, 2, A-D). These findings aligned with those reported by Gill *et al*. (2018) and Rahul (2021).

A significant intraoperative challenge encountered was the inadvertent piercing of the opposite cortex of the bone by elastic nails when driven alternately during fracture reduction. Another observed difficulty during the procedure was the splitting of bone fragments, occurring either on the medial or lateral side at the site of pin insertion, with a higher incidence in Group B. Bone splitting might be due to improper bone development in young dogs.

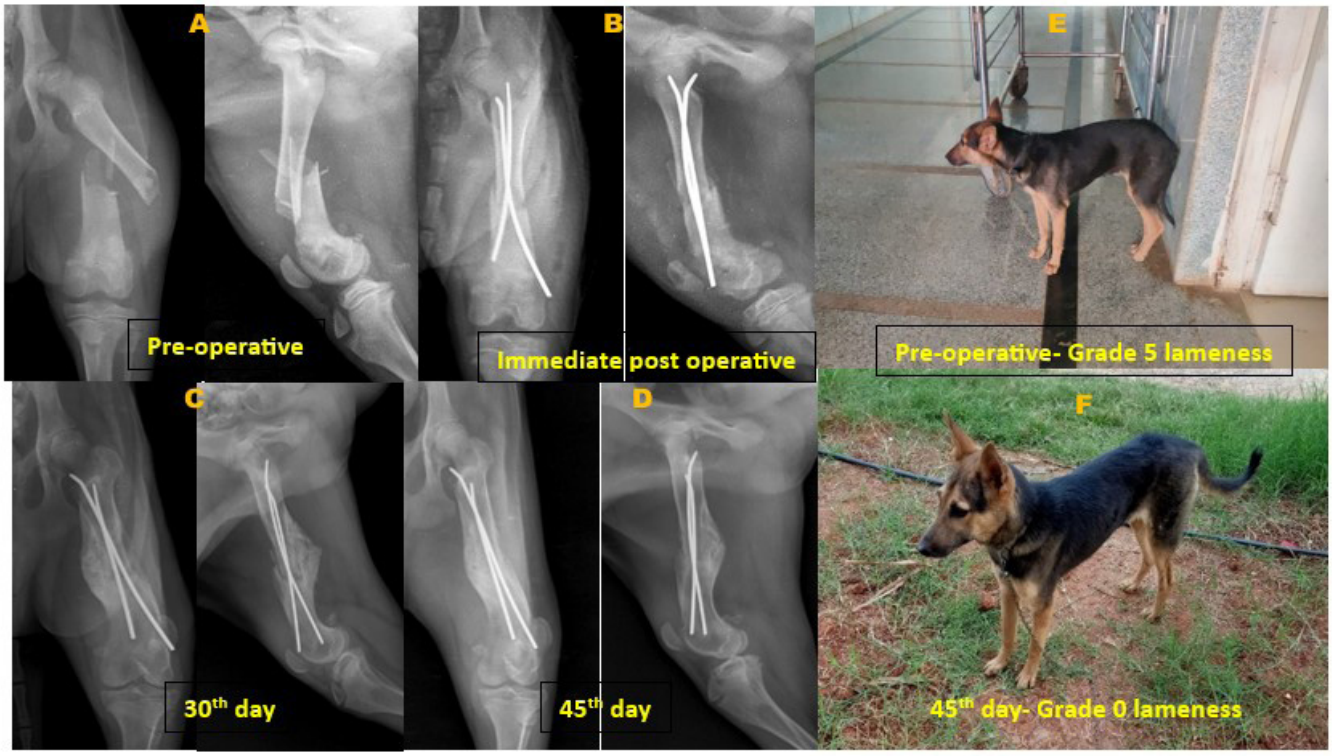

Fig. 1 (A-F): Fracture healing in 4- month old ND dog with femur fracture repaired with stainless steel elastic nail and exhibiting grade 5 lameness on pre operative day to grade 0 on 45th day

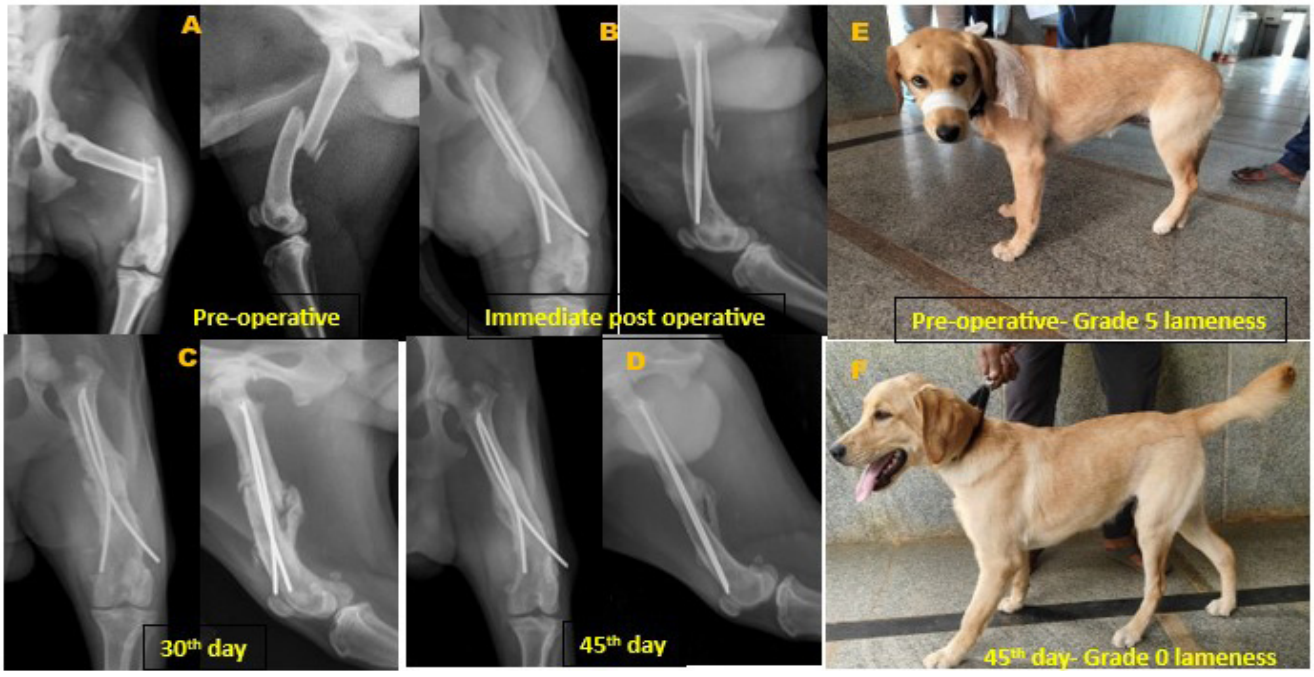

Fig. 2 (A-F): Fracture healing in 7- month - old labrador dog with femur fracture repaired with titanium elastic nail and exhibiting grade 5 lameness on pre operative day to grade 0 on 45th day

Seroma formation was observed at the nail insertion in one case, potentially resulting from irritation at the pin entry site due to the excessive length of the nail protruding beyond the bone cortex. Additionally, distal migration of elastic nails was noted in a few cases within both groups. Similar observations were reported by Saikia *et al.* (2007) and Rahul (2021).

Table 1: Signalment and anamnesis of affected dogs, and lameness grades in Group A and Group B dogs before and after orthopaedic surgery

Group	Case No.	Signalment and anamnesis of affected dogs					Lameness grades				
		Breed	Age (months)	Gender	BW (kg)	Aetiology	Pre-operative	Immediate post-operative	15th day post-operative	30th day post-operative	45th day post-operative
Group A (TENs)	T1	Doberman	7	Male	15.5	Wild boar attack	5	5	3	0	0
	T2	Nondescript	3	Male	5.7	Automobile accident	5	5	3	2	1
	T3	Nondescript	8	Male	10.2	"	5	4	1	0	0
	T4	German Shepard	4	Male	7	Fallen from height	5	3	2	0	0
	T5	Mudhol	3	Male	6.5	Dog bite	5	5	3	0	0
	T6	Doberman	7	Female	17	Automobile accident	5	5	3	2	0
Group B (SSENs)	S1	Labrador	6	Male	21	"	5	5	3	1	0
	S2	Dachshund	4	Male	8.3	Kicked by cow	5	5	4	1	1
	S3	Beagle	5	Female	8	Fallen from height	5	5	5	3	2
	S4	Labrador	5	Female	15.5	"	5	4	2	2	0
	S5	Nondescript	4	Male	8	"	5	4	2	0	0
	S6	Nondescript	6	Male	23.4	Automobile accident	5	5	3	2	2

Grade 0: Normal limb function, Grade 1: Subtle, intermittent weight bearing lameness, Grade 2: Subtle, consistent weight bearing lameness, Grade 3: Obvious weight bearing lameness, Grade 4: Intermittent non-weight bearing lameness, Grade 5: Consistent non-weight bearing lameness.

Conclusion

In conclusion, employing both stainless steel and titanium elastic nails for femoral fracture repair in young dogs provided favourable outcomes. However, the clinical efficacy was notably superior with the utilization of titanium elastic nails (TENs). This was evident in terms of ease of application intraoperatively, early weight bearing, reduced surgical duration, suitability for both diaphyseal and distal femoral fractures. However, stainless steel elastic nails (SSENs) were found to be well suitable for diaphyseal transverse femur fractures and offer the advantage of being less expensive.

Acknowledgement

The authors duly acknowledge Bayer foundation for providing the financial support and Karnataka Veterinary, Animal and Fisheries Sciences University for providing necessary facilities.

References

Anderson, G.M., Lewis, D.D., Radasch, R.M., Marcellin-Little, D.J., Degna, M.T., & Cross, A.R. (2002). Circular external skeletal fixation stabilization of antebrachial and crural fractures in 25 dogs. *Journal of American Animal Hospital Association, 39,* 479-498.

Aron, D.N., Fontz, T.L., Keller, W.G., & Brown, J. (1991). Experimental and clinical experience with an IM pin external skeletal fixator tie-in configuration. *Veterinary and Comparative Orthopaedics and Traumatology, 4,* 86-94.

Bidari, K., Jahangirbasha, D., Dilipkumr, D., & Bhagavantappa, B. (2023). Incidence of long bone fractures in dogs a retrospective study (2016-2021). *The Pharma Innovation, 12*(6), 531-534.

Flynn, J.M., Hresko, T., Reynolds, R.A., Blasier, R.D., Davidson, R., & Kasser, J. (2001). Titanium elastic nails for paediatric femur fractures: a multicentre study of early results with analysis of complications. *Journal of Paediatric Orthopaedics, 2*(1), 4-8.

Gill, K.K., Kumar, Ashwani, Sangwan, Vandana, Anand, Arun, Mahajan, S.K., & Mohindroo, J. (2018). Comparative functional outcome of supracondylar femoral fracture stabilized with cross and end threaded intramedullary pinning in dogs. *Indian Journal of Animal Sciences, 88*(2), 161-169.

Gupta, N., Kumar, A., Sangwan, V., Singh, T., & Gupta, A. (2023). A comparative study between stainless steel and titanium elastic nails in the surgical management of canine juvenile femoral fractures. *Indian Journal of Animal Sciences*, *93*(4), 337-341.

Gyaneshwar, T., Nitesh, R., Sagar, T., Pranav, K., & Rustagi, N. (2016). Treatment of paediatric femoral shaft fractures by stainless steel and titanium elastic nail system: A randomized comparative trial. *Chinese Journal of Traumatology, 19*(4), 213-216.

Hammer, R.R.R., Hammerby, S., & Lindholm, B. (1985). Accuracy of radiologic assessment of tibial shaft fracture union in humans. *Clinical Orthopaedics and Related Research*, *199,* 233-238.

Hunter, J.B. (2005). The principles of elastic stable intramedullary nailing in children. *International Journal of Care Injured*, *36,* 20-24.

Jhonson, K.A., & Piermattei, D.L. (2004). *An Atlas of Surgical Approaches to Bone and Joints of the Dog and Cat.* 4th edn. Saunders, Philadelphia, Pennsylvania, pp. 336-340.

Kallianpur, N., Singh, K., Gopinathan, A., Sarangom, S.B., John, C., Sowbharenya, C., & Sharma, P. (2018). Investigation on relation between factors affecting occurrence and outcome of repair of long bone fractures in 216 dogs. *International Journal of Livestock Research, 8*(2), 225-234.

Kumar, P.A., Jawre, S., & Sowmya, M. (2023). A study on fractures in dogs presented to VCC, Jabalpur, Madhya Pradesh. *International Journal of Veterinary Sciences and Animal Husbandry, 8*(4), 86-91.

Lascombes, P., Haumont, T., & Journeau, P. (2006). Use and abuse of flexible intramedullary nailing in children and adolescents. *Journal of Paediatric Orthopaedics, 26*(6), 827-834.

Prabhukumar, M.D., Dileepkumar, K.M., Devanand, C.B., Venugopal, S.K., Raj, I.V., Anoop, S., Nair, S.S., & Philip, L.M. (2020). Elastic stable intramedullary nailing for fixation of distal diaphyseal fracture of radius in two dogs. *Indian Journal of Veterinary Surgery, 41*(2), 134-136.

Rahul, P.A. (2021). Studies on elastic stable intramedullary nailing for the treatment diaphyseal fracture of femur in skeletally immature dogs. *M.V.Sc. Thesis.* Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar, India.

Saikia, K.C., Bhuyan, S.K., Bhattacharya, T.D., & Saikia, S.P. (2007). Titanium elastic nailing in femoral diaphyseal fractures of children in 6-16 years of age. *Indian Journal of Orthopaedics*, *41*(4), 381-385.

Simon, M.S., Ganesh, R., Ayyappan, S., Rao, G.D., Kumar, R.S., Kundave, V.R., & Das, B.C. (2010). Incidences of pelvic limb fractures in dogs: A survey of 478 cases. *Veterinary World*, *3*(3), 120-121.

Sodhi, H.S., Kumar, A., Anand, A., Sangwan, V., & Singh, O. (2021). Comparison of titanium elastic nailing and end-threaded intramedullary pinning for distal femoral fractures in young dogs. Indian Journal of Animal Research, *57*(9), 1186-1193.