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RESEARCH ARTICLE

A multidimensional impact assessment of hands-on training in fracture fixation for veterinary practitioners

Hari Prasad Aithal[1]*, Amol K. Bhalerao[2], Sanghratna V. Bahire[2], Samir Kumar Das[1], Kiran N. Bhilegaonkar[3] and Dwaipayan Bardhan[4]

Training and Education Centre, ICAR-Indian Veterinary Research Institute, Shivajinagar, Pune- 411005 (Maharashtra)

[1]Principal Scientist, [2]Senior Scientist, [3]Principal Scientist and Station In-charge, Training and Education Centre, ICAR-IVRI, College of Agriculture Campus, Shivajinagar, Pune; [4]Principal Scientist and Head, Division of Livestock Economics, Statistics and Information Technology, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly-243 122 (Uttar Pradesh)

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An impact analysis was conducted on 210 veterinary professionals from 17 Indian states and Nepal who participated in a series of 12 hands-on training programmes on various fracture fixation techniques, held between March 2017 and January 2024. Participants included veterinary officers, private practitioners, university faculty, and recent graduates. The objective was to enhance theoretical knowledge and practical skills in fracture management. Training effectiveness was evaluated both immediately (178 respondents) and in the long term (127 respondents, 6 months to 7 years post-training). Post-training assessments showed a 25% improvement in subject knowledge (from 54% to 79%). Feedback was overwhelmingly positive, with 96% rating the programme as excellent or very good, and 92.7% finding it highly relevant. Instructor ratings were similarly high.

Long-term feedback confirmed sustained impact: over 95% rated the training as excellent or very good, and 98.4% felt the objectives were fully met. Participants reported significant gains in surgical skills, confidence, and clinical application. Many successfully treated 50 to over 1,000 fracture cases, improving animal welfare outcomes. Financially, more than 80% reported increased monthly income post-training, with some earning up to ₹1 lakh, and a few earning between ₹1–10 lakh or more. Additionally, 78% shared their knowledge with peers, extending the programme's impact.

In conclusion, these training programmes significantly advanced veterinary surgical capabilities, improved economic outcomes, and enhanced animal welfare. They serve as an effective model for skill-based capacity building in the veterinary sector.

Keywords: Fracture Fixation; Hands-on Training; Impact Assessment; Veterinary Professionals

Veterinary education and practice in India are continually evolving to meet the growing demands and emerging challenges in animal healthcare delivery. The number of veterinary colleges is steadily increasing, and the undergraduate curriculum has been broadened to encompass health management of companion animals, livestock, and wildlife (Shiksha, 2025). Despite these developments, practical surgical training, particularly in advanced procedures, remains limited. Undergraduate training primarily focuses on routine soft tissue surgeries such as ovariohysterectomy and castration, with relatively little exposure to orthopedic procedures. However, newly graduated veterinarians are frequently required to perform a wide range of surgical interventions, including fracture management, often in resource-constrained clinical settings and with limited mentorship.

Orthopaedic surgery is a rapidly advancing field, with continuous innovations in implants, instrumentation, and fixation techniques (Vaishya *et al*., 2025). Fractures of long bones represent one of the most common orthopaedic conditions encountered in veterinary clinical practice (Aithal *et al*., 1999). Effective management of fractures requires specialized knowledge, technical skills, and ongoing professional training. In many instances, veterinarians acquire orthopaedic surgical skills through experiential learning in clinical practice rather than structured training programmes. This situation highlights a significant gap in both undergraduate veterinary education and continuing professional development.

Various educational approaches have been adopted worldwide to enhance orthopaedic surgical skills among trainees and practicing clinicians. These include the use of synthetic bone models, cadaveric specimens, and computer-based or simulator-assisted training platforms (Bauer, 1993; Inaparthy *et al*., 2013; Losco *et al*., 2017; Wixted *et al*., 2021; Brown *et al*., 2023; Howard *et al*., 2023). While each method offers distinct advantages for skill development, there is currently no clear consensus regarding the most effective strategy for optimizing surgical training outcomes.

In India, structured continuing education in veterinary orthopedics remains limited. A training needs assessment conducted among veterinary officers in Maharashtra identified a substantial gap in hands-on training, particularly in fracture fixation techniques (Das *et al*., 2018). To address this need, the Training and Education Centre of ICAR-IVRI, Pune initiated a series of orthopaedic training programmes in 2017 targeting government veterinarians, private

*Corresponding author; E-mail: aithalhp@gmail.com

practitioners, and recent graduates.These programmes were designed to strengthen practical surgical competence through a combination of theoretical lectures, clinical demonstrations, and cadaver-based hands-on training focused on fracture fixation and related orthopedic procedures.

Systematic evaluation of continuing veterinary education programmes is essential to assess their effectiveness and guide improvements in training design. However, most available reports primarily describe training activities or participant satisfaction, with limited emphasis on long-term outcomes (Moore, 2003; Caple, 2005). The impact of advanced surgical training, particularly in veterinary orthopaedics, therefore remains insufficiently documented.

The present study was undertaken to address this gap by retrospectively evaluating the immediate and long-term impacts of a hands-on fracture fixation training programmes conducted for veterinary professionals. The assessment covered a period ranging from six months to seven years following training. Programme effectiveness was evaluated using pre- and post-training knowledge assessments together with participant reflections to capture perceived professional benefits. The analysis focused on improvements in theoretical knowledge, surgical competence, professional confidence, financial outcomes, and broader contributions to animal health and welfare.

Materials and Methods

Design and implementation of training programmes

The training programmes were conducted in accordance with the mandate of the Centre and were duly approved by the Director ICAR-IVRI. Practical demonstrations were performed on clinical cases of bone fractures, mainly in dogs and cats presented to the District Veterinary Polyclinic, Aundh, Pune (Maharashtra). All surgical procedures were carried out with informed consent from the animal owners by experienced faculty members, primarily the lead instructor. As no experimental procedures were involved, ethical committee approval was not required and the study was considered exempt. Cadavers used for hands-on training were obtained with permission from the Pune Municipal Corporation, and all remains were disposed of through incineration following the practice sessions.

Twelve training programmes conducted between March 2017 and January 2024 were included in the study, with durations of 6 days (n=1), 5 days (n=8), 4 days (n=1), and 2 days (n=2). The programmes covered a range of basic and advanced fracture fixation techniques, including external, internal, and external skeletal fixation (ESF), with particular emphasis on internal fixation in small animals. Each programme included lectures on bone biology, surgical instrumentation, anaesthetic management, principles and techniques of fracture fixation, complications, and rehabilitation. Practical demonstrations on clinical cases included application of splints and bandages, casts, modified Thomas splints, intramedullary (IM) pinning techniques, tension band wiring, dynamic and locking compression plates, interlocking nails, and various ESF configurations (linear, circular, and epoxy-pin). These demonstrations were followed by supervised hands-on practice on cadavers to reinforce the techniques.

Written assessment

A written assessment was done to evaluate participants' subject knowledge immediately before and after the training. A standardized set of 25 questions, comprising multiple-choice and True/False items, covering core subject content was used across all programmes. The same set of questions was employed for a surprise post-training test conducted at the conclusion of each programme. Answer sheets from both pre- and post-training assessments were scored, and the results were converted into percentages for comparative analysis.

Questionnaires

At the outset, informed consent was obtained from all participants for the anonymous use of their data for research purposes. Two questionnaires, administered before and after the training, were designed to assess the programme's impact on participants' knowledge, skills, and confidence. Data were collected using a structured evaluation tool aligned with the four levels of the Kirkpatrick Model: Reaction, Learning, Behaviour, and Results (Kirkpatrick and Kirkpatrick, 2016).

The pre-training questionnaire was used to collect demographic details (name, gender, qualifications) and assessed participants' prior experience and confidence in performing orthopedic procedures such as external fixation, internal fixation, and ESF.

The post-training questionnaire, administered face-to-face at the end of the programme, served as the evaluation form and comprised three sections. Section I gathered feedback on the programme's quality, content, instructor, and relevance using a five-point scale (Excellent to Poor). Section II assessed agreement with statements on educational value, faculty expertise, training resources, and practical sessions. Section III captured overall evaluation, whether expectations were met, key takeaways, and suggestions for improving the course content and duration through open-ended responses.

The long-term feedback form, emailed to participants 6 months to 7 years after completion of the training, comprised five sections. Section I collected general information such as name, date, and title of the training attended. Section II focused on external fixation techniques, Section III addressed internal fixation techniques, and Section IV covered ESF methods, where participants rated their ability and

confidence before and after training and assessed their skills in different procedures. Section V evaluated the overall impact of the training on professional practice. Participants also provided qualitative feedback on the strengths, shortcomings, and suggestions for improvement.

Criteria for inclusion of participants

Questionnaires were distributed to all participants who attended hands-on training in fracture fixation techniques between March 2017 and January 2024, both before and after the training sessions. Only respondents who provided complete information were included in the study. A total of 178 participants with complete posttraining data, assessed immediately after the training, and 127 respondents who submitted a full set of information on the long-term impact via Google forms were included in the analysis.

Continued mentorship

To facilitate ongoing support and mentorship, a dedicated WhatsApp group was created exclusively for all participants of the training programmes. This platform served as a continuous channel for guidance, discussion, and peer-to-peer learning. Participants were encouraged to actively post their queries and share any challenges they encountered while handling day-to-day clinical cases. In response, they received timely advice on appropriate treatment options and strategies from both trainers and fellow group members. Moreover, after applying a specific technique learned during the training, participants were encouraged to share noteworthy case reports within the group, detailing the diagnosis, treatment steps, and follow-up outcomes for the benefit of their colleagues.

Statistical analysis

Quantitative data from the structured questionnaires were extracted and analyzed using Microsoft Excel. Descriptive statistics (frequencies, percentages, and means) were used to summarize participant demographics and responses. The efficacy of the training was evaluated using Paired Samples t-tests to compare: mean self-assessment scores for knowledge, skill, and confidence before and after training; and the average number of fracture cases treated per year before and after training for different techniques (External, Internal, and ESF techniques) in both small and large animals. Qualitative data from open-ended questions were analyzed thematically to identify common suggestions and areas for improvement.

Results and Discussion

The aim of the present study was to evaluate the impact of hands-on training in fracture fixation techniques on practicing veterinarians. The assessment considered both the immediate outcomes, in terms of improvements in knowledge, technical skills, and confidence, and the longer-term effects of the training programmes.

In total, 210 participants from 17 different Indian states and the neighbouring country of Nepal took part. The majority of participants were from Maharashtra (n=100) and Karnataka (n=53), followed by Telangana and Kerala (n=8 each), Andhra Pradesh (n=7), and Gujarat and West Bengal (n=5 each). Further, most of the participants were from metropolitan cities such as Mumbai and Bengaluru, likely due to their geographical proximity to Pune, where the training was conducted. This also reflects the growing pet population and the increasing demand for advanced veterinary care in urban centres. However, the participants represented a wide geographic range - from Jammu and Himachal Pradesh in the north, to Kerala in the south; Assam and Sikkim in the northeast, to Gujarat in the west. This widespread participation not only underscores the national popularity and credibility of the programme, but also suggests a broader shift in socio-economic conditions and pet ownership trends across various Indian cities. It indicates that interest in advanced veterinary training is no longer limited to major metropolitan areas, but is expanding into a wider range of regions as pet care becomes a higher priority among diverse populations.

Most trainees were male (n=164; 78.1%), however, it is noteworthy that a significant proportion of participants were female (n=46; 21.9%), including in a session conducted exclusively for women. This challenges the traditional perception that private veterinary practice, particularly in areas such as orthopaedic procedures, is predominantly male-dominated. The relatively high number of female participants reflects a positive and evolving trend in the profession, indicating increased gender diversity and greater participation of women in advanced, hands-on clinical fields. This shift may be attributed to changing societal norms, growing confidence among female veterinarians, and increased opportunities for specialized training and career development in veterinary practice.

In terms of professional background, the majority were private veterinary practitioners (46.5%) or officers from state animal husbandry departments (41.8%). Others included recent veterinary graduates or postgraduates, university faculty, and veterinarians working with NGOs. This highlights a significant need for skill development among practicing veterinarians, particularly in areas where undergraduate training may not provide sufficient hands-on experience.

Participants had a broad range of professional experience ranging 0-5 years: 39 (30.23%); 6-10 years: 29 (22.83%); 11-15 years: 26 (20.47%); 16-20 years: 8 (6.30%); 21-26 years: 13 (10.24%); 26-30 years: 8 (6.30%); >30 years: 4 (3.15%). This indicates that, although interest in specialized fracture fixation training is higher among young and early-career professionals, a considerable number of experienced practicing veterinarians are also keen to learn the latest techniques.

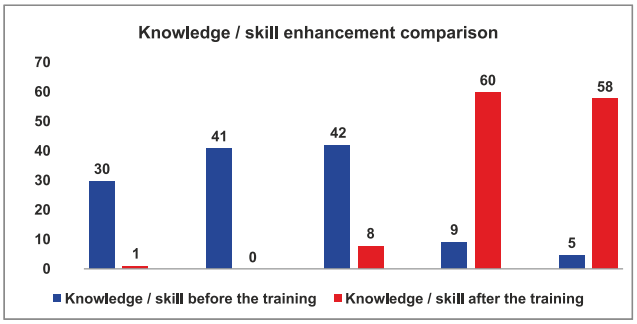

Fig. 1: Comparison of knowledge/skill before and after obtaining the training (n=127).

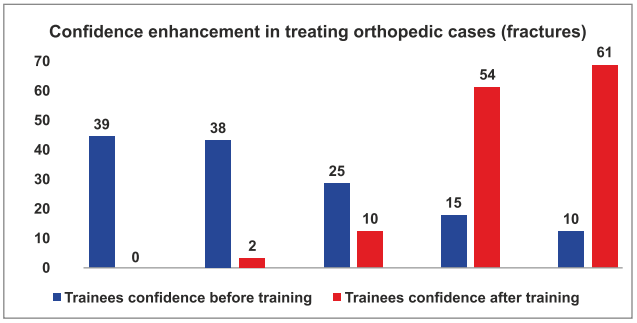

Fig. 2: Confidence gain in treating orthopaedic cases after the training (n=127).

Immediate impact (n=178)

The immediate impact of the training, assessed through identical pre- and post-programme written tests, demonstrated a substantial improvement in participants' subject knowledge. The average scores increased by 25%, from 54% pre-training to 79% post-training, indicating the training's effectiveness in enhancing conceptual understanding and retention.

Feedback collected immediately after the training indicated a highly positive response from participants. A total of 97.2% rated the programme content as either excellent (88.2%) or very good (9.0%) (Table 1). Similarly, the overall quality of the programme was rated as excellent by 71.3% and very good by 24.7% of participants. All participants agreed that the training was a valuable educational experience, with 91.6% strongly agreeing and 8.4% agreeing (Table 2). Participants also felt that the content covered was worthwhile, with 80.3% strongly agreeing and 19.7% agreeing. The hands-on exercise sessions were regarded as very well organized (strongly agree - 64.0%, agree - 35.4%), and the training materials provided were considered both interesting and useful (strongly agree - 80.3%, agree - 19.7%).

Trainees gave exceptionally positive feedback regarding the quality of instruction. The lead trainer was rated as excellent by 93.3% of participants and very good by 6.7% (Table 1). The faculties were acknowledged for their strong subject-matter expertise, with 86.5% strongly agreeing and 13.5% agreeing that they demonstrated thorough knowledge (Table 2). All participants affirmed that the training met their expectations. The overall learning experience was rated as excellent by 78.1% and very good by 18.5% (Table 1).

Long-term impact (n=127)

Feedback collected from trainees between six months and seven years after completing the training programme further underscores its long-term impact. Over 95% of respondents rated the training as either excellent (85.8%) or very good (9.4%). Additionally, 98.4% confirmed that the training objectives were fully met, with the majority either strongly agreeing (74%) or agreeing (24.4%). Most participants reported their knowledge and skills before the training as very low (23.6%), low (32.3%), or medium (33.1%). Following the training, these levels increased significantly (P=0.000), with 47.2% rating their knowledge as high and 45.7% as very high (Table 3; Fig. 1). Similarly, confidence in managing fracture cases improved significantly (P=0.000), from very low (30.7%), low (29.9%), or medium (19.7%) before training to high (42.5%) or very high (48.0%) afterward (Fig. 2).

External fixation of fractures, often referred to as conservative treatment, is the most commonly used method among veterinary practitioners, primarily due to its relative simplicity and lower cost (Leighton, 1991). Most participants already had experience with basic techniques such as splint and bandage application, as well as traditional plaster casting. However, the majority of trainees initially reported very low (39.4%) or low (30.7%) ability to treat fractures by external fixation prior to the training, but after completing the programme, these levels

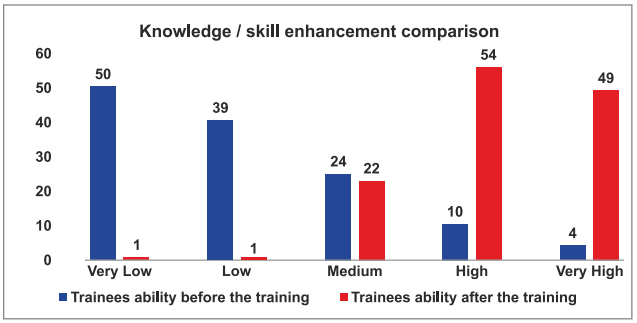

Fig. 3: Trainees' ability to treat fracture cases using external fixation techniques, before and after the training (n=127).

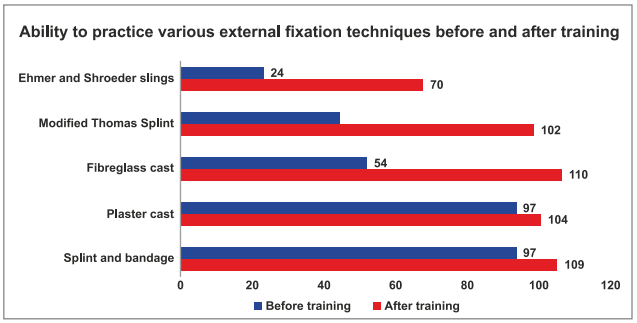

Fig. 4: Trainees' ability to practice different external fixation techniques, before and after the training (n=127).

improved significantly (P=0.000) (Fig. 3). Further, the training significantly enhanced their proficiency and precision in performing these procedures. Importantly, the number of participants capable of applying fiberglass casts, a more modern and effective alternative to traditional plaster (Wilson and Vanderby Jr., 1995), nearly doubled following the training (Fig. 4). In addition, the programme helped build confidence and competence in performing less commonly used yet highly effective external fixation techniques, such as the modified Thomas splint, Ehmer sling, and Schroeder-Thomas sling. The average number of small animal cases treated using external fixation techniques increased from 42.24 (±14.460) cases before training to 58.65 (±17.354) cases after (Table 4). For large animals, this number rose from 10.70 (±4.249) to 17.58 (±4.824) cases. Nearly all trainees reported confidence in treating appropriate fracture cases using external fixation, with 66.9% fully confident and 32.3% somewhat confident. This suggests that the training not only reinforced foundational skills but also expanded the therapeutic repertoire of practitioners, enabling them to adopt more common and diverse methods in their clinical practice.

Internal fracture fixation techniques, such as intramedullary (IM) pinning and bone plating (Nunamaker, 1985), are typically underutilized by many practicing veterinarians, often due to a lack of training and confidence in performing these more advanced procedures. A primary motivation for most participants attending the training was to build competence and confidence specifically in internal fixation methods. Accordingly, the main objective of the programme was to provide hands-on training in basic internal fixation techniques, including IM pinning and bone plating, while also introducing participants to more advanced and modern approaches such as interlocking nailing and dynamic/locking compression plating (DCP/LCP) (Frigg, 2001; Wheeler *et al.*, 2004; Barnhart and Maritato, 2018).

Post-training evaluations showed a marked improvement in participants' self-reported ability to perform internal fixation procedures (Fig. 5). The proportion of trainees capable of performing basic IM pinning increased substantially, from approximately 65% before the training to 90% afterward. Additionally, there was a significant rise in proficiency with more complex procedures such as cross-pinning, tension band wiring, dynamic compression plating, and locking compression plating (Fig. 6). Notably, over 21% of participants acquired the skills necessary to perform interlocking nailing, a complex technique that is relatively uncommon in routine veterinary practice. Nearly all trainees reported confidence in managing suitable fractures using internal fixation techniques, with 54.3% fully confident and 44.1% somewhat confident, particularly in small animal cases. These outcomes strongly indicate that the primary objective of the programme, to enhance knowledge, technical skills, and confidence in internal fracture fixation, was successfully achieved.

Compared to large animal cases, most participants reported greater confidence and more frequent use of internal fixation techniques in small/companion animals (Table 4), with only four participants not having treated any, and one treating over 150 cases annually. While the number of large animal cases treated with internal fixation nearly doubled following the training, the overall number remained relatively low, with 58 participants not having treated any, and one treating over 400 cases annually. This can largely be attributed to the fact that the majority of participants were small animal practitioners primarily treating companion animals, with limited exposure to large animal fracture cases. This trend also highlights a broader issue within the veterinary field, there appears to be limited interest in large animal orthopaedic practice. This may be due to the greater challenges involved in managing fractures in large animals (Nuss, 2014), including logistical difficulties, higher physical demands, and the generally lower financial return compared to small animal practice. As a result, fewer veterinarians are specializing in large animal orthopaedics, further limiting the availability and advancement of such services.

External skeletal fixation (ESF) techniques offer several advantages in fracture management, particularly in veterinary practice. These include rigid fixation, facilitation of early ambulation, minimal

Table 1: Opinion of participants about the overall content, instructions, relevance and learning experience (n=178).

Parameters	Number of participants (%)				
	Excellent	**Very Good**	**Good**	**Fair**	**Poor**
Programme Content	157 (88.2%)	16 (9.0%)	4 (2.2%)	1 (0.6%)	-
Major instructor/s	166 (93.3%)	12 (6.7%)	-	-	-
Programme in general	127 (71.4%)	44 (24.7%)	7 (3.9%)	-	-
Relevance to your needs	128 (71.9%)	37 (20.8%)	13 (7.3%)	-	-
Overall learning experience	139 (78.1%)	33 (18.5%)	6 (3.4%)	-	-
Opinion on boarding and lodging	25 (14.0%)	35 (19.7%)	91 (51.1%)	23 (12.9%)	4 (2.3%)

Table 2: Opinion of participants about the conduct of training (n=178).

Participants' opinion	Number of participants (%)			
	Strongly agree	Agree	Disagree	Strongly disagree
It was a very good education experience	163 (91.6%)	15 (8.4%)	-	-
Like to take another programme presented in similar way	140 (78.7%)	36 (20.2%)	2 (1.1%)	-
The material covered was worthwhile	143 (80.3%)	35 (19.7%)	-	-
The faculty demonstrated a thorough knowledge of the subject	154 (86.5%)	24 (13.5%)	-	-
The training material supplied was quite interesting and useful	139 (78.1%)	39 (21.9%)	-	-
The exercise sessions were well organised	114 (64%)	63 (35.4%)	1 (0.6%)	-
Like to recommend the course to the other colleagues	154 (86.5%)	24 (13.5%)	-	-
Not much gained by participation in the course	-	1 (0.6%)	39 (21.9%)	138 (77.5%)

invasiveness, and the ability to effectively manage severely comminuted, open, and infected fractures, conditions that are often challenging to treat using conventional methods. Additionally, ESF systems are relatively easy to remove, and their external metallic components can be reused, making them a cost-effective option, especially in resource-limited settings. As a result, the adoption of ESF techniques is steadily gaining popularity among veterinary practitioners (Aithal *et al*., 2023).

The training programme significantly enhanced participants' ability to perform ESF procedures (Fig. 7). Notably, around 94% of the participants reported feeling confident in managing fracture cases using ESF methods post-training. The number of participants proficient in linear and epoxy-pin fixation nearly doubled, while those capable of performing the more complex and technically demanding circular ESF technique increased dramatically, from approximately 4% to 44% (Fig. 8). These outcomes underscore the effectiveness of the training in both imparting theoretical knowledge and facilitating practical skill development in ESF application. Among the various techniques, epoxy-pin fixation emerged as particularly popular due to its simplicity, ease of application, and cost-effectiveness in field conditions (Aithal *et al*., 2019). The average number of small animal cases treated using ESF techniques rose from 2.87 (±0.830) before training to 28.13 (±16.801) after training (Table 4), with one participant treating over 1,500 cases and another over 150 cases annually. The number of participants who had not treated any ESF cases in small animals dropped from 80 before training to 20 afterward. For large animals, the average cases treated increased significantly (P=0.000) from 0.802 (±0.219) (with 100 participants untreated) to 5.01 (±1.101) (with 54 participants untreated), including one trainee treating over 150 cases annually. Notably, the training resulted in a significant increase in the number of large animal cases managed using ESF techniques, despite its primary focus on fracture fixation in small animals. This indicates a growing readiness and willingness among veterinary professionals to adopt ESF methods in large animal practice, reflecting a positive shift toward more advanced and adaptable approaches in large animal orthopedic care.

Another significant impact of the training was a large number of animal cases treated for fractures, directly contributing to pain relief, reduced suffering, and overall improvement in animal welfare. Nearly all participants either began managing fracture cases

Table 3: Perceived impact of training on trainees knowledge/skill, confidence and their ability to treat fractures by different external (EFT), internal (IFT) and external skeletal fixation (ESF) techniques (n=127).

Overall perception	Mean score (±SE)[@]		Difference	t-value	p-value
	Before	After			
Knowledge/skill	2.36 ± 0.093	4.37 ± 0.061	2.01 ± 0.111	-20.91	0.000
Confidence in treating fractures	2.36 ± 0.113	4.38 ± 0.063	2.02 ± 0.129	-17.75	0.000
Ability to treat fractures by EFT	2.04 ± 0.097	4.18 ± 0.071	2.14 ± 0.120	-21.28	0.000
Ability to treat fractures by IFT	1.816 ± 0.090	4.182 ± 0.076	2.304 ± 0.117	-26.812	0.000
Ability to treat fractures by ESF	1.64 ± 0.081	3.88 ± 0.094	2.24 ± 0.124	-22.71	0.000

[@]5 point continuum: very low=1 to very high=5

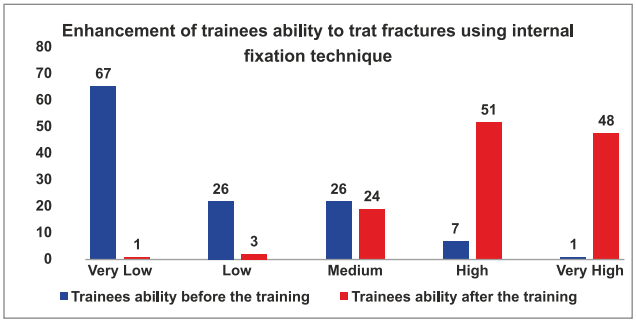

Fig. 5: Trainees' ability to treat fracture cases using internal fixation techniques, before and after the training (n=127).

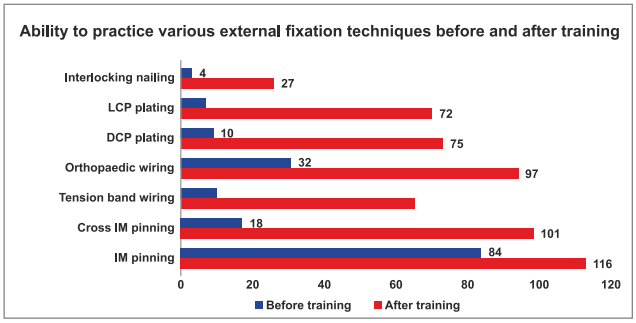

Fig. 6: Trainees' ability to practice different internal fixation techniques, before and after the training (n=127).

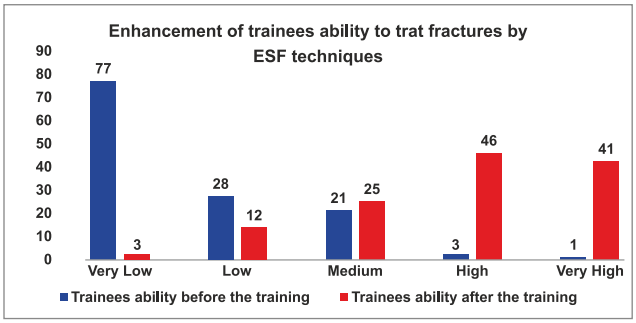

Fig. 7: Trainees' ability to treat fracture cases using external skeletal fixation techniques, before and after the training (n=127).

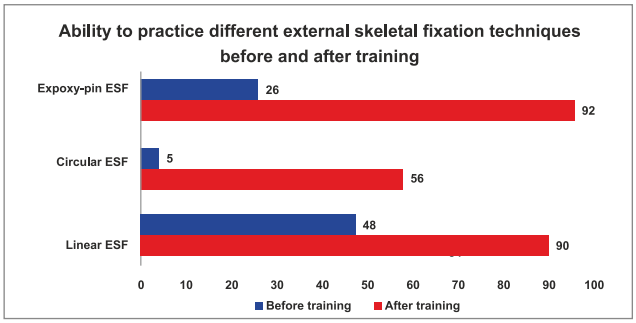

Fig. 8: Trainees' ability to practice different external skeletal fixation techniques, before and after the training (n=127).

following the training or significantly enhanced their existing treatment approaches. As a result, a substantial number of animals received care (Table 5). While the study did not assess the quality or outcomes of the treatments provided, it is reasonable to assume that the training contributed to improved clinical practices and treatment effectiveness. Rayner *et al.* (2025) also reported sustained improvements in workplace practices and patient care following a skills-based training programme, with a corresponding positive impact on animal welfare. Their study evaluated the long-term effects on the working practices of veterinarians in India who attended a canine surgical neutering course.

The acquisition of new skills and knowledge through the training clearly translated into financial benefits, particularly for those in private practice. A majority of the trainees (over 81%) reported an increase in their monthly income (Table 5), with some earning significantly more, over Rs. 1,00,000 per month. One of the key motivations for attending the training was the opportunity to handle more orthopaedic cases and thereby enhance income. Feedback from participants strongly indicates that the training successfully met this objective. However, approx-imately 18% of participants reported no increase in income, likely because most of them were government veterinary officers, who are either not engaged in or are restricted from private practice.

The overall impact of the training on the trainees' professional careers was rated as very high by 57.60% and high by 33.60% of participants (Fig. 9). The training programme not only enhanced individual competencies but also facilitated a significant horizontal transfer of knowledge and skills among professional peers. Majority of participants (about 78%), reported sharing the knowledge and skills they acquired during the training with their colleagues or students. Notably, around 70% of these individuals went on to train up to 10 others, thereby amplifying the impact of the programme beyond its direct participants. In effect, the initiative functioned as a 'training of trainers' programme, enabling a broader dissemination of expertise and benefiting a much larger professional community. This ripple effect highlights the programme's role in fostering a culture of continuous learning and capacity building within the sector.

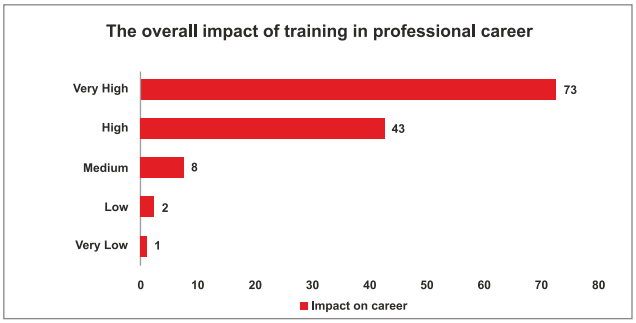

Fig. 9: Overall impact of training in the professional career of the participants (n=127).

Table 4: Number of fracture cases treated (Mean ± SE)in small and large animals by using different external (EFT), internal (IFT) and external skeletal fixation (ESF) techniques before and after training (n=127).

Different Fixation Techniques	Average number of fracture cases treated				
	Before training	After training	Difference	t-value	p-value
In small animals by EFT	42.24 ± 14.460	58.65 ± 17.354	16.41 ± 22.589	-0.852	0.396
In large animals by EFT	10.70 ± 4.249	17.58 ± 4.824	6.89 ± 6.429	-1.278	0.204
In small animals by IFT	10.58 ± 2.423	48.35 ± 16.443	37.77 ± 16.621	-2.30	0.023*
In large animals by IFT	2.46 ± 1.272	5.78 ± 3.232	3.31 ± 3.474	-1.35	0.179
In small animals by ESF	2.87 ± 0.830	28.13 ± 16.801	25.27 ± 16.829	-1.510	0.135
In large animals by ESF	0.802 ± 0.219	5.01 ± 1.101	4.21 ± 1.123	-4.187	0.000**

* indicates significant at 5% level, ** indicates significant at 1% level

The training programme's popularity and effectiveness were reflected in the overwhelmingly positive response from the participants. Nearly 90% expressed a strong interest to attend future programmes, citing the acquisition of new surgical skills, the practical approach to bone fixation, and increased confidence through hands-on learning. Over 97% indicated they would recommend the training to colleagues, highlighting high satisfaction and perceived value. Consistently high demand, early registrations, and persistent waiting lists further underscore the programme's strong reputation and national reach.

Participants identified hands-on experience, skill development, and enhanced confidence as the most valuable aspects. Their appreciation of the instructors' dedication and supportive approach emphasizes that successful training depends not only on infrastructure and content but also on mentorship, enthusiasm, and a learner-centric environment.

The study has certain limitations. Training duration varied (2–6 days), and participants differed widely in experience, background, and prior exposure to clinical practice. Programme content, though centered on core techniques, was not fully uniform. Outcomes were based on self-reported data, which may be influenced by recall and response biases, and only complete responses were analyzed, potentially distorting results. Clinical outcomes such as surgical success and complication rates were not assessed, and the follow-up period (6 months to 7 years) lacked uniformity, limiting consistency in long-term evaluation.

The teaching model of integrating classroom sessions, live surgical demonstrations, and cadaver-based hands-on training proved effective in delivering structured, individualized learning. This approach enables more structured and effective surgical training compared to unstructured encounters or unguided "discovery learning" (Kenton, 2006; Jeffree and Clarke, 2010; Carlile, 2012). Cadaveric practice offered realistic anatomical experience, while live surgical observation and expert interaction enhanced technical skills and confidence. Continued engagement via WhatsApp facilitated mentorship, peer learning, and reflective practice. Similar improvements in surgical performance following structured training have been reported by Egol *et al*. (2015).

The participants also expressed interest in advanced modules, including Total Hip Replacement (THR), Tibial Plateau Leveling Osteotomy (TPLO), Tibial Tuberosity Advancement (TTA), and management of pelvic and spinal conditions. This highlights the need to continually update the curriculum by incorporating recent advancements in

Table 5: Overall impact of trainings in the professional career of participants and number of animals relieved of pain, suffering, and average increase in their monthly income (% distribution of participants across response categories, n=127).

Impact in professional career (%)	Very high (57.60)		High (33.60)	Fair (6.40)	Low (1.60)	Very Low (0.80)
Number of animals relieved of pain & suffering and life saved (%)	≥ 0 and < 10 (9.60)		>10 and <50 (40.00)	>50 and <100 (35.20)	>100 and <1000 (12.00)	>1000 (3.20)
Increase in earnings (₹/month) on account of skills gained (%)	Nil (18.40)	>1,000 and <10,000 (32.00)	> 10,000 and < 50,000 (32.80)	> 50,000 and < 1,00,000 (13.60)	>1,00,000 and < 10,00,000 (2.40)	>10,00,000 (0.80)

veterinary orthopaedics, to meet the needs of aspiring trainees while ensuring enhanced surgical proficiency and improved patient outcomes.

Conclusions

This study demonstrated that hands-on training in fracture fixation techniques significantly enhanced veterinarians' knowledge, technical skills, and confidence. The traditional educational model, combining classroom instruction, live demonstrations, and cadaver-based practice, proved especially effective in bridging the gap between theoretical knowledge and clinical application. Overwhelmingly positive participant feedback, sustained high demand, and strong word-of-mouth promotion underscore the programme's relevance and impact. These findings highlight the critical role of structured, experiential learning in veterinary surgical education and suggest that such training models are essential for developing more competent and confident practitioners.

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