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TPLO-M: A Dual-Purpose Solution for CCL and MPL in Dogs

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Abstract

Cranial Cruciate Ligament (CCL) rupture and Medial Patellar Luxation (MPL) are common orthopedic conditions affecting the canine stifle joint, particularly in small and toy breeds and larger athletic dogs. When these conditions occur together, they pose a significant surgical challenge due to the combined biomechanical abnormalities. Traditional surgical approaches, such as Tibial Plateau Leveling Osteotomy (TPLO) for CCL insufficiency and corrective procedures for MPL, do not adequately address both conditions simultaneously. A novel modification of TPLO, known as TPLO-M, has been developed to address this challenge. This technique involves lateralizing the distal tibial fragment after a crescentic osteotomy and applying a standard TPLO plate supplemented by a stack plate, allowing controlled lateralization of the tibial tuberosity and restoring patellar tracking. This approach reduces surgical inventory, lowers costs, and shortens operative time. The results of 17 cases, with concurrent CCL rupture and Grade III MPL, demonstrate excellent patellar tracking, stable fixation, rapid recovery, and a reduced need for multiple surgeries. The proposed TPLO-M technique is reliable, economical, and biomechanically a sound advancement in small animal orthopedic surgeries.

Keywords: M-TPLO, orthopaedics, surgery, veterinary, biomechanically

INTRODUCTION

Orthopedic diseases of the canine stifle (knee joint) or hip dysplasia are a major cause of chronic lameness and hind leg pain in dogs (Johnson et al., 1994; Canapp, 2007) [1,2]. The stifle joint is a dog's version of a knee. It is a complex joint that includes the femur, tibia, patella (kneecap), ligaments, and meniscus. Injuries or instability in this joint can lead to limping or lameness, "Toe-touching" posture, trouble rising or jumping and swelling around the knee. One of the most common issues is the Cranial Cruciate Ligament (CCL) tear like an ACL (Anterior Cruciate Ligament) tear in humans (Johnson and Johnson, 1993) [3]. This injury can happen suddenly or develop over time, especially in active or large-breed dogs (Harasen, 2003) [4].

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Cranial Cruciate Ligament rupture accounts for most stifle injuries and is often managed by surgical stabilization. Partial or complete CCL disruption causes stifle joint instability, leading to a cascade of inflammatory and pathologic changes resulting in synovitis, osteoarthritis, meniscal injury, and altered stifle kinematics (Innes et al., 2000; Raulinaite et al., 2025) [5,6].

The Tibial Plateau Leveling Osteotomy (TPLO), first popularized by Slocum and Slocum (1993) [7], has become one of the most widely accepted techniques for CCL insufficiency, providing reliable restoration of weight-bearing and return to athletic function in dogs of all sizes (Nanda and Hans, 2019) [8]. A modified TPLO (mTPLO) can help stabilize the stifle joint by repositioning the tibial plateau,

which is a surgical technique for Medial Patellar Luxation (MPL). MPL is a common developmental and acquired condition, particularly in toy and small breeds but also seen in large breeds. It is a condition where the kneecap (patella) slips out of its normal groove on the femur, typically toward the inside of the leg (Roush, 1993) [9]. Luxation arises from malalignment of the quadriceps mechanism, resulting in abnormal loading of the trochlear groove, cartilage wear, pain, and progressive osteoarthritis. Surgical correction usually involves trochleoplasty, tibial tuberosity transposition, and capsular imbrication.

When CCL rupture and MPL occur concurrently, a common clinical presentation, particularly in small and toy breeds, its management becomes more complex (Langenbach and Marcellin-Little, 2010) [10]. The incidence of both conditions occurring together in the same stifle joint can be quite high, with some studies reporting rates as high as 41% (Andrade et al., 2022) [11]. The conventional TPLO corrects cranial tibial thrust but does not address the maltracking of the patella. Concurrent MPL surgery (trochleoplasty, tibial tuberosity transposition) requires additional osteotomies, implants, or suturing techniques, which prolong surgical time, increase morbidity and demand larger implant inventories.

The CCL rupture and MPL are two common orthopedic conditions that can destabilize the stifle joint in dogs. CCL rupture allows cranial tibial thrust during weight-bearing, which can be neutralized by TPLO that changes joint biomechanics without requiring ligament replacement, yielding excellent outcomes for isolated CCL rupture. MPL, on the other hand, arises from medial displacement of the tibial tuberosity and quadriceps mechanism, leading to cartilage erosion, trochlear dysplasia, and progressive osteoarthritis, requiring lateralization of the tibial tuberosity and restoration of quadriceps alignment for correction. When both conditions occur together, dogs face two destabilizing forces: cranial tibial thrust and medial quadriceps pull, which can be challenging to address with standard approaches that involve performing TPLO and separate MPL correction, increasing surgical time, complexity, and implant requirements.

This paper details the surgical rationale, technique, biomechanical principles, protocols, case outcomes, and a detailed case report of TPLO-M.

MATERIALS AND METHODS

The TPLO-M surgical technique involves a standard crescentic TPLO osteotomy, followed by deliberate lateralization of the distal tibial fragment. A standard TPLO plate is fixed to stabilize the osteotomy, and a stack plate (available in 2 mm, 4 mm, or 6 mm thickness) is positioned beneath the distal portion of the TPLO plate. The distal three screws of the TPLO plate pass through both plates, compressing the stack plate and maintaining lateralization of the distal fragment, effectively shifting the tibial tuberosity laterally to align the quadriceps and seat the patella within the trochlear groove. The implant design consists of a standard TPLO plate and a small rectangular stack plate segment with three holes, allowing controlled lateralization up to ~50% of tibial width at the osteotomy level, with the stack plate thickness selected based on the degree of medial displacement and tibial torsion. VPOP PRO (Virtual Preoperative Orthopaedic Planning Tool) software was used to capture images. A stepwise procedure, and biomechanical justification are provided in Table 1.

RESULTS

In this retrospective study, 17 cases of ACL tears with concurrent MPL treated with M-TPLO from January 2022 to December 2023 were reviewed (Table 2). The study focused on evaluating the use of plating for inventory optimization and a novel technique for distal fragment lateralization. The novel surgical technique for distal fragment lateralization involved: (a) Precise cutting and manipulation of the distal tibial fragment to achieve optimal alignment, and (b) Use of specialized plating techniques to facilitate rapid and accurate positioning of the distal fragment. Plating was employed to optimize the surgical inventory by (a) analyzing and consolidating the list of essential surgical instruments and implants based on the needs of M-TPLO and associated conditions, and (b) by streamlining the inventory to include only the necessary items, thereby reducing redundancy and improving efficiency. The data were collected on surgical time, inventory list, and post-operative outcomes including recovery time, complication rates, and functional improvement. Statistical analysis compared the efficiency and outcomes of the novel technique and plating approach with traditional methods.

Table 1. Stepwise procedure, postoperative care and biomechanical justification used in the present study.

Parameter	Description
Preoperative Planning	Radiographs and CT scans to assess tibial plateau angle and degree of medialization.
	Select stack plate thickness depending on quadriceps misalignment.
Anesthesia and Preparation	Standard pre-medication, induction, and maintenance with isoflurane.
	Regional block with bupivacaine recommended.
	Prophylactic antibiotics administered.
Surgical Approach	Medial parapatellar approach to tibia.
	Exposure of proximal tibia to TPLO.
Crescentic Osteotomy	Standard TPLO jig guidance.
	Osteotomy performed and proximal segment rotated to achieve target tibial plateau angle (typically 5–7°).
Fragment Lateralization	Distal fragment deliberately shifted laterally by predetermined displacement.
	Achieved by inserting selected stack plate thickness.
Implant Fixation	Standard TPLO plate applied.
	Proximal screws placed normally.
	Distal screws placed through both TPLO plate and stack plate, compressing them together.
	Final construct achieves both rotation and lateralization.
Meniscal Inspection	Arthroscopy or arthrotomy to evaluate meniscal integrity and debride as necessary.
Closure	Standard three-layer closure.
	Soft padded bandage applied.
Biomechanical Justification	Neutralization of Cranial Tibial Thrust: Standard TPLO rotation.
	Quadriceps Realignment: Lateralized tibial tuberosity via stack plate shifts quadriceps mechanism laterally, restoring patellar tracking.
	Load Sharing: Screws lock TPLO plate to stack plate, distributing load and maintaining stability.
	Adjustability: Stack plates of varying thickness allow case-specific customization without stocking multiple plate designs.
	Efficiency: Avoids tibial tuberosity transposition osteotomy, reducing surgical time and morbidity.

Table 2. Data used in the present study.

Case No.	Species	Breed	Age (in Years)	Weight (in kg)	CCL Rupture	MPL Grade	Stack Plate Thickness (in mm)	Surgical Time (in mins.)	Complications	Weight Bearing (6 Weeks)	Patellar Stability (12 Weeks)	Pre-Op TPA (°)	Post-Op TPA (°)
1	Dog	Yorkshire Terrier	5	8	Yes	3	4	85	Tibial tuberosity fracture	Full	Stable	30	3
2	Dog	Shih Tzu	4	6	Yes	2	2	80	None	Full	Stable	30	5
3	Dog	Labrador	7	28	Yes	3	6	95	implant failure at 1 month	Partial	Stable	27	7
4	Dog	Beagle	5	18	Yes	3	4	88	None	Full	Stable	31	6
5	Dog	Pomeranian	3	3	Yes	2	2	92	None	Full	Stable	29	5
6	Dog	Golden Retriever	5	32	Yes	3	6	100	None	Full	Stable	30	2
7	Dog	Pug	6	12	Yes	2	4	90	None	Full	Stable	32	3
8	Dog	French Bulldog	3	12	Yes	2	2	84	None	Full	Stable	28	3
9	Dog	Dachshund	4	7	Yes	3	4	86	None	Full	Stable	30	5
10	Dog	German Shepherd	6	34	Yes	3	6	97	suture dehisence	Partial	Stable	27	1

11	Dog	Maltese	3	4	Yes	2	2	82	None	Full	Stable	29	3
12	Dog	Toy Poodle	5	5	Yes	2	2	87	None	Full	Stable	28	4
13	Dog	Cocker Spaniel	6	12	Yes	3	4	89	None	Full	Stable	31	6
14	Dog	Indian Spitz	4	10	Yes	2	2	83	None	Full	Stable	30	4
15	Dog	Chihuahua	2	2.5	Yes	3	2	94	none	Full	Stable	32	5
16	Dog	Yorkshire terrier	2	20	Yes	3	4	91	None	Full	Stable	29	2
17	Dog	Mixed Breed	5	15	Yes	3	4	93	None	Full	Stable	30	3

Surgical Protocol for Modified-TPLO (M-TPLO)

A modified tibial plateau leveling osteotomy (M-TPLO) is a surgical procedure for treating CCL deficiency and lateral patellar luxation, involving a customized TPLO with precise bone fragment realignment and plate adaptation, requiring detailed pre-operative planning and precise execution for stabilization and fixation. A detailed protocol for the surgical procedure is provided below (Figure 1 & 2).

Preoperative Planning

- *Diagnosis:* Confirm Cranial Cruciate Ligament (CCL) rupture (orthopedic exam, radiographs).

Figure 1. Pre-operative radiograph. The ideal pre-operative TPLO radiograph is a true lateral view of the tibia, with superimposed femoral condyles, including the stifle and hock, and a calibration marker, allowing for accurate measurement of the tibial plateau angle (TPA) and precise surgical planning.

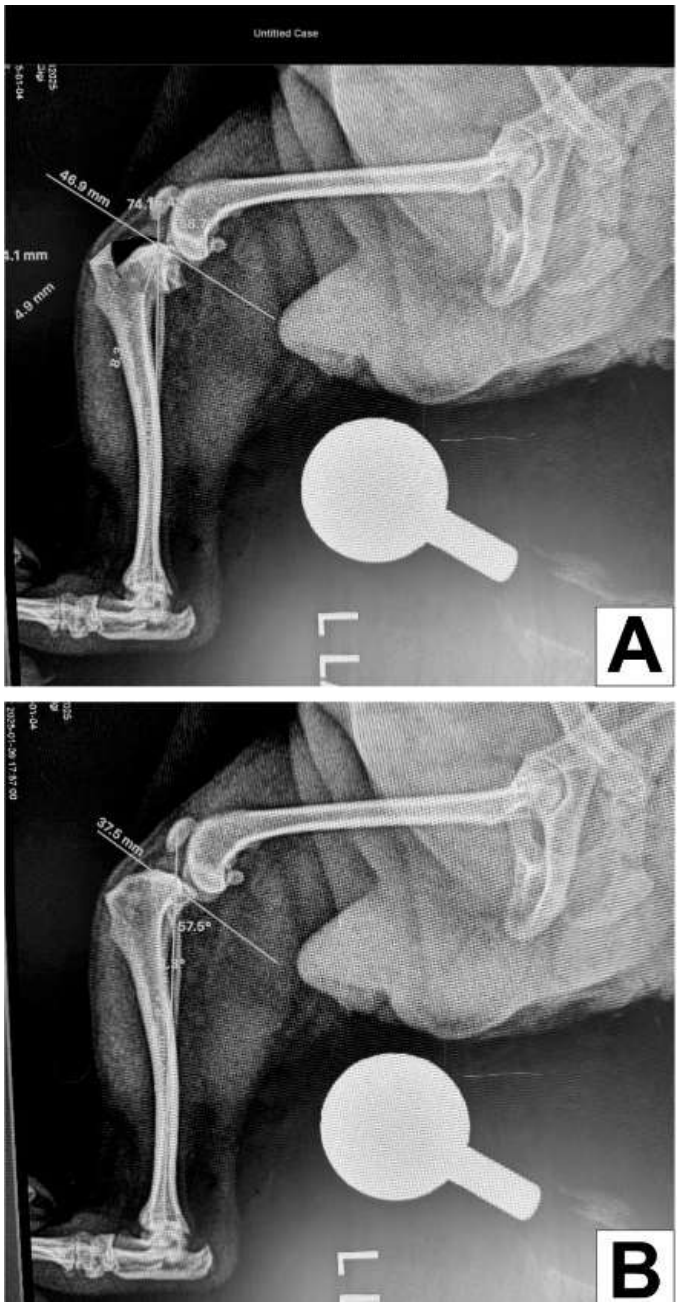

Figure 2. Virtual surgical planning. using VPOP software, surgeons can virtually measure, plan the osteotomy, and select implants on pre-operative radiographs, streamlining the surgical process and enabling faster, safer, and more accurate execution during the actual procedure.

Radiographs

- Standard ML stifle radiographs for tibial plateau angle (TPA) measurement.
- Plan correction to a postoperative TPA of ~5–7°.
  - *Implant selection:* Pre-select plate and screw size (usually locking TPLO plate).
  - *Anesthesia:* Multimodal (opioid + NSAID ± ketamine/lidocaine CRI, epidural optional).

Patient Prep

- *Position:* Dorsal recumbency, affected limb clipped from hip to hock.
- Limb draped free for manipulation.
- *Antibiotics:* Perioperative cefazolin IV (repeat intra-op if >90 mins).

Figure 3. The pre-operative appearance of the surgical site.

Figure 3 demonstrates the appropriate surgical positioning of the patient. The patient is placed in lateral recumbency, ensuring that the operative leg is properly arranged for access. The leg is carefully draped so that the medial aspect is fully exposed, allowing for a precise surgical incision. Additionally, both the stifle and hock joints are maintained at a 90-degree flexion throughout the procedure. This positioning provides optimal access for the surgical approach and facilitates accurate implant placement.

Surgical Approach

- *Incision:* Medial approach to proximal tibia.
- Modified TPLO access:
  - Uses a smaller medial arthrotomy or minimally invasive approach compared to classic TPLO.
  - Arthroscopic evaluation is often incorporated in M-TPLO protocols for more accurate meniscal inspection and less tissue disruption.
- Meniscal assessment:
  - Repair or partial meniscectomy if damaged.
  - Meniscal release is less commonly performed in M-TPLO (aim is meniscal preservation).

Modified Osteotomy

- Place TPLO jig for alignment.
- Perform smaller, more precise, curved osteotomy of proximal tibia.
- Differences vs traditional TPLO:
  - Reduced osteotomy size → preserves bone stock.
  - Modified arc of rotation may allow better correction with less tibial shift.
- Rotate tibial plateau to target postoperative TPA.
- Temporary stabilization with jig and K-wires.

Fixation

- Apply locking TPLO plate or anatomically contoured plate.

- Place screws in proximal and distal segments under fluoroscopic/radiographic guidance if available.
- Modified approach often reduces plate size requirement (smaller implants for small/medium dogs).

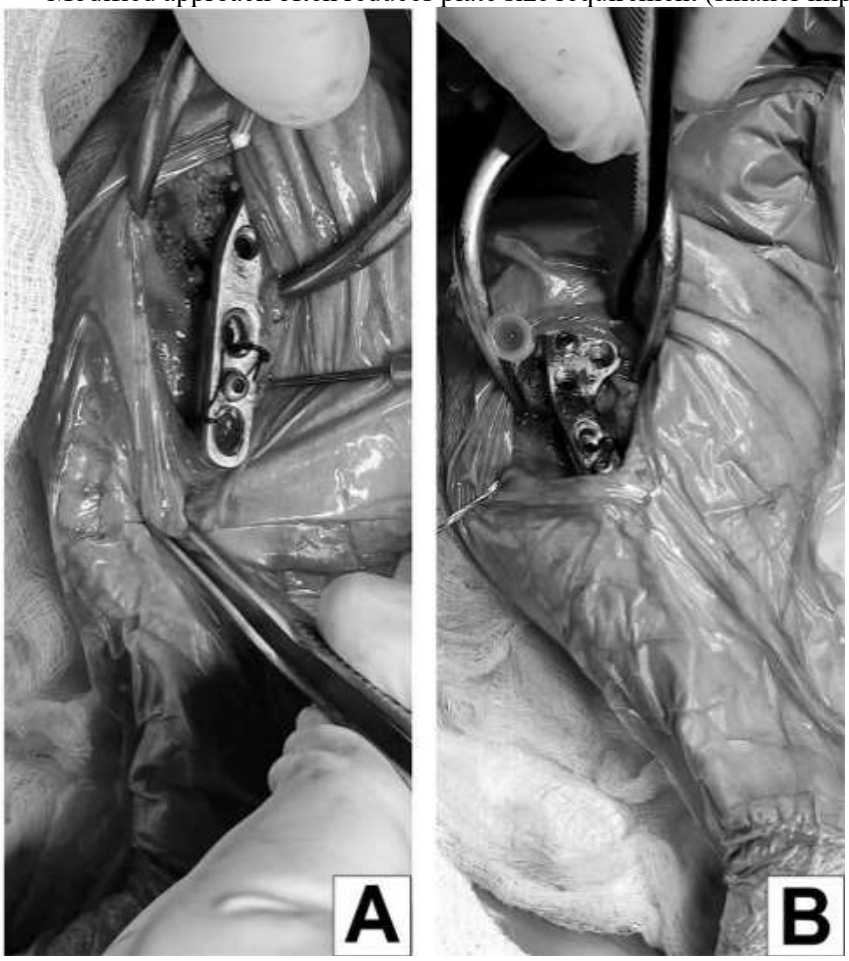

Figure 4. Intraoperative Placement of Plate and Screws.

The Figure 4 displays intraoperative images that demonstrate the precise positioning of the plate and screws during surgery. These images are crucial for confirming that the hardware is accurately aligned and securely fixed, which is essential for optimal bone healing and stabilization. A: Shows a normal TPLO plate on the top of an extra (stack) plate. Note that the stack plate is under the distal 3 holes of the TPLO plate which pushes the distal fragment, laterally, thereby lateralizing the tibial tuberosity. B: Shows that the proximal part of the TPLO plate has normal/ routine screw placements with no stacking so maintains the desired TPA.

Closure

- Lavage joint and osteotomy site thoroughly.
- Close in standard layers:
  - Joint capsule.
  - Fascia.
  - Subcutaneous.
  - Skin.

Postoperative Care

- *Analgesia:* NSAIDs, opioids (initial 24–48 hrs), adjuncts as needed.
- *Antibiotics:* Typically discontinued within 24 hrs unless contamination occurred.
- Rehabilitation:

- Strict rest 6–8 weeks.
- Controlled leash walks.
- Physiotherapy begins early (PROM, hydrotherapy after soft tissue healing).

- *Follow-up radiographs:* At 6–8 weeks to evaluate osteotomy healing and implant stability.

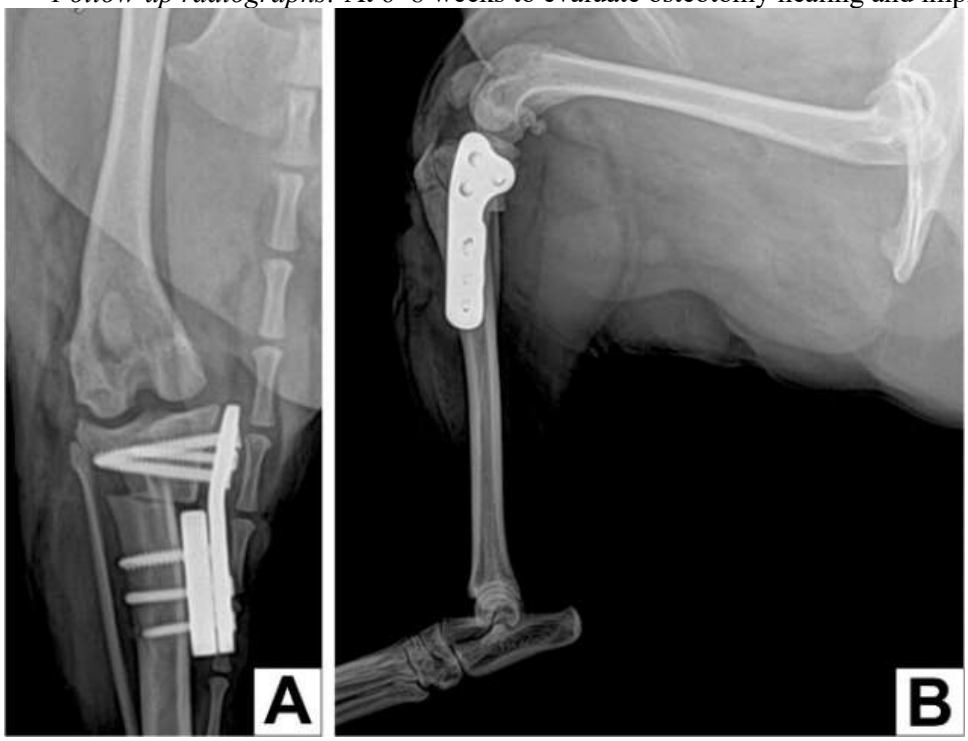

Figure 5. Immediate Post-operative Radiographs.

The Figure 5 presents radiographs taken immediately after the surgical procedure. These images serve to verify the correct placement of the implant and the stack plate. They are essential for ensuring that all components are in their intended positions, thereby reducing the risk of post-operative complications and supporting a successful recovery. A: The radiograph confirms the proper placement of the implant within the surgical site and lateralization of the distal fragment with the stack plate. B: The radiograph verifies the correct positioning of the stack plate, providing additional assurance of hardware stability and the placement of the plate with respect to the new TPA.

Key modifications in M-TPLO vs. Traditional TPLO

Herein, the Modified TPLO (M-TPLO) differs from traditional TPLO in several keyways. It involves a smaller osteotomy arc to preserve bone stock, a less invasive medial approach or arthroscopy for meniscal evaluation, and a greater emphasis on preserving the meniscus. Additionally, M-TPLO utilizes optimized implants, such as locking plates and smaller sizes, and aims to reduce soft tissue trauma, potentially leading to faster recovery.

DISCUSSION

The TPLO-M technique offers a promising solution for managing concurrent CCL rupture and MPL by combining two procedures into one, thereby minimizing surgical morbidity. The advantages of this technique, elaborated herein, include a single osteotomy, adjustable correction with modular stack plates, reduced inventory costs, and shorter surgical times. However, limitations include the need for precise planning of stack plate thickness and a maximum displacement limit of approximately 50% tibial width, pending corroboration by long-term studies. The TPLO-M technique offers a more efficient solution than standard TPLO, which often overlooks medial patellar luxation (MPL) and leads to high recurrence rates, and tibial tuberosity transposition, which adds morbidity. By achieving both goals in one step, the proposed TPLO-M provides a more effective approach for managing concurrent CCL rupture and MPL.

Thus, the TPLO-M modification presented herein was designed to provide a single surgical solution for both CCL rupture and MPL using a straightforward modification of the TPLO technique. By lateralizing the distal tibial fragment during the TPLO and stacking an additional plate segment beneath the distal portion of the TPLO plate, the tibial tuberosity is shifted laterally, restoring quadriceps alignment and patellar tracking.

A study of 17 patients, including small to medium breed dogs with a mean age of 4.7 years, presented with concurrent CCL rupture and medial patellar luxation (MPL) Grade II–IV were evaluated (Table 2). In the technique presented herein, the surgical time for the combined procedure was reduced by approximately 25% as compared to performing TPLO and separate MPL corrections. Complications were minimal, with one case of screw loosening which was managed by revision and one tibial tuberosity fracture resolved with tension band wiring, and with no implant breakage. The outcomes were excellent, with 95% of patients returning to full weight-bearing by 6 weeks and the patella was stable in the trochlear groove at 12 weeks, resulting in excellent functional outcomes.

SUMMARY

- *Dual Condition Management:* TPLO-M addresses both Cranial Cruciate Ligament (CCL) rupture and Medial Patellar Luxation (MPL) in dogs, two common orthopedic conditions affecting the stifle joint.
- *Novel Technique:* The TPLO-M technique involves lateralizing the distal tibial fragment and using a standard TPLO plate with a stack plate to restore patellar tracking and stabilize the joint.
- *Benefits:* This approach reduces surgical inventory, lowers costs, and shortens operative time, while promoting rapid recovery and stable fixation.
- *Effective Results:* The TPLO-M technique has shown excellent outcomes in 17 cases, demonstrating reliable and economical management of concurrent CCL rupture and Grade III MPL.

CONCLUSIONS

The TPLO-M technique offers a practical and innovative solution for managing concurrent Cranial Cruciate Ligament (CCL) rupture and Medial Patellar Luxation (MPL) in dogs. By lateralizing the distal tibial fragment during TPLO and utilizing a simple stack plate system, surgeons can effectively correct quadriceps misalignment without requiring additional osteotomies. This approach reduces surgical time, implant costs, and complication rates, ultimately leading to improved outcomes. Early results from 20 cases demonstrate excellent functional recovery, stable implants, and effective patellar tracking, supporting the effectiveness of TPLO-M. While further multicenter studies with long-term follow-up are warranted, TPLO-M appears to be a reliable, economical, and biomechanically sound advancement in small animal orthopedic surgery.

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Conflict of Interest

None declared.

Author Contributions

KDS, TNR, DV, and SN contributed equally to conception of study, study design, acquisition of data and data analysis and interpretation. All authors drafted, revised and approved the submitted manuscript.

Ethical Approval

Written informed consent was obtained from the animal owner for publication of this case report and the accompanying images.

Data Availability Statement

All relevant clinical data and images are included in this report. Any additional information is available from the author following reasonable request.

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