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RESEARCH ARTICLE

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Diagnosis and surgical correction of patellar luxation in eight dogs

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Eight client-owned dogs with symptoms of patellar luxation were physically examined, evaluated for lameness, and were graded according to severity. Radiographic evaluation of the affected stifle joint was done using mediolateral, craniocaudal and skyline projections to evaluate luxation, trochlear sulcus angle, and medial and lateral trochlear inclination angles. Appropriate surgical treatment was planned with various surgical procedures such as trochlear wedge recession, trochlear block recession, trochlear ridge augmentation and retinacular imbrication. Platelet rich plasma was injected into the joint to promote healing in one case, and in another case platelet rich fibrin was used as a biological glue to the resected articular cartilage graft. Based on the findings, it was concluded that early recognition and tailored management reduce chronic lameness and significantly improve functional outcomes in dogs affected with patellar luxation; whereas combination of proper surgical procedures restores patellar alignment in higher grades of luxation.

Keywords: Patellar luxation, Sulcus angle, Trochlear block recession, Trochlear inclination angles, Trochlear ridge augmentation, Trochlear wedge recession

Patellar luxation is one of the most frequently encountered orthopaedic disorders in dogs and is characterized by displacement of the patella from the femoral trochlear groove, often resulting in varying degrees of hindlimb lameness and gait disturbance (Rezende *et al.,* 2016; Di Dona *et al.,* 2018; Sapora, 2025). In most canine patients, patellar luxation is considered a developmental disorder rather than a consequence of trauma, and it is commonly associated with conformational and skeletal abnormalities that disrupt the normal alignment of the quadriceps mechanism (Davis, 2018; Rantén, 2018; Sasaki *et al.,* 2022).

Abnormal development of the stifle extensor apparatus during the growth period can alter the anatomical relationship among the quadriceps muscle group, patella, patellar ligament, trochlear groove, tibial tuberosity, distal femur, and proximal tibia (Di Dona *et al.,* 2018; Bosio *et al.,* 2025). These changes predispose the joint to progressive patellar instability and may further contribute to secondary osseous deformities (Rezende *et al.,* 2016; Di Dona *et al.,* 2018; Yadav *et al.,* 2025). The severity of patellar luxation is generally classified using a four-grade system based on the degree of displacement and ease of reduction (Sapora, 2025).

Accurate diagnosis depends on a comprehensive clinical evaluation, including detailed assessment of gait, posture, and orthopaedic examination, supplemented by radiographic imaging to determine the grade of luxation and associated skeletal deformities. (Di Dona *et al.,* 2018; Garnoeva, 2023). Clinical presentation may vary widely, ranging from incidental or subclinical instability in mildly affected dogs to severe bilateral luxation in which patients may be unable to extend the stifle properly, leading to marked impairment of locomotion (Davis, 2018; Curuci *et al.,* 2023).

The present study aimed to evaluate suitable treatment options for different grades of canine patellar luxation through precise diagnosis and the application of available surgical procedures, including combined techniques for advanced cases, supported by detailed clinical and radiographic examinations with intraoperative findings.

Materials and Methods

The present study included eight dogs diagnosed with patellar luxation. Clinical evaluation was performed by patellar manipulation to assess patellar instability and displacement of the patella from the trochlear groove. Lameness was categorized as weight-bearing, intermittent, or non-weight-bearing. Clinical signs assessed included sudden stifle flexion or flicking, semiflexion of the affected hind limb, abnormal limb placement, angular limb deformities such as varus and valgus, and gait abnormalities including bunny hopping, crouched posture (Fig.1A), skipping gait, and circumduction. Abnormal limb position and posture were observed in all cases. Among the eight cases, five were Grade III and three were Grade IV luxations, with five lateral and three medial luxations.

Radiographic evaluation of the stifle joint was performed using standard mediolateral, craniocaudal, and skyline (tangential) views. From the skyline view, sulcus angle (SA), lateral trochlear inclination (LTI) angle, and medial trochlear inclination (MTI) angle were measured (Fig. 1B).

Surgical approach to the stifle joint was made through a craniolateral skin incision in all cases. After skin, subcutaneous, and fascial dissection, arthrotomy was performed. Synovial fluid was aspirated before arthrotomy for analysis. All dogs underwent surgical correction using a combination of osseous and soft

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Fig. 1: (A) A case of patellar luxation; (B) Measurement of sulcus angle (SA), lateral trochlear inclination (LTI) angle, and medial trochlear inclination (MTI) angle from the skyline view radiograph of stifle.

tissue procedures. Trochlear wedge recession sulcoplasty (TWRS) was used as the principal technique (Boscio *et al.,* 2025) (Fig. 2) in all cases except case 7, where trochlear block recession was performed. Soft tissue balancing was accomplished by medial or lateral retinacular imbrication with corresponding release of the opposite retinaculum (Yadav *et al.,* 2025), depending on the direction of patellar luxation. Case 7 also received platelet rich plasma (PRP) injection as an adjunctive treatment. In case 8, TWRS was combined with an augmentation procedure (Garnoeva, 2023), platelet rich fibrin (PRF) placement, and medial retinacular imbrication to enhance stabilization.

Synovial fluid samples were collected aseptically from the affected joints of all study animals for routine physical evaluation and assessment of hyaluronic acid quality (Gupta *et al.,* 2023). Immediately after aspiration, each sample was subjected to gross examination. The colour, clarity, consistency, and volume of the synovial fluid were noted and documented for each case. Variations in colour were recorded as ranging from straw to yellow, dark yellow, and light red, while clarity was categorized based on visual appearance as transparent or turbid.

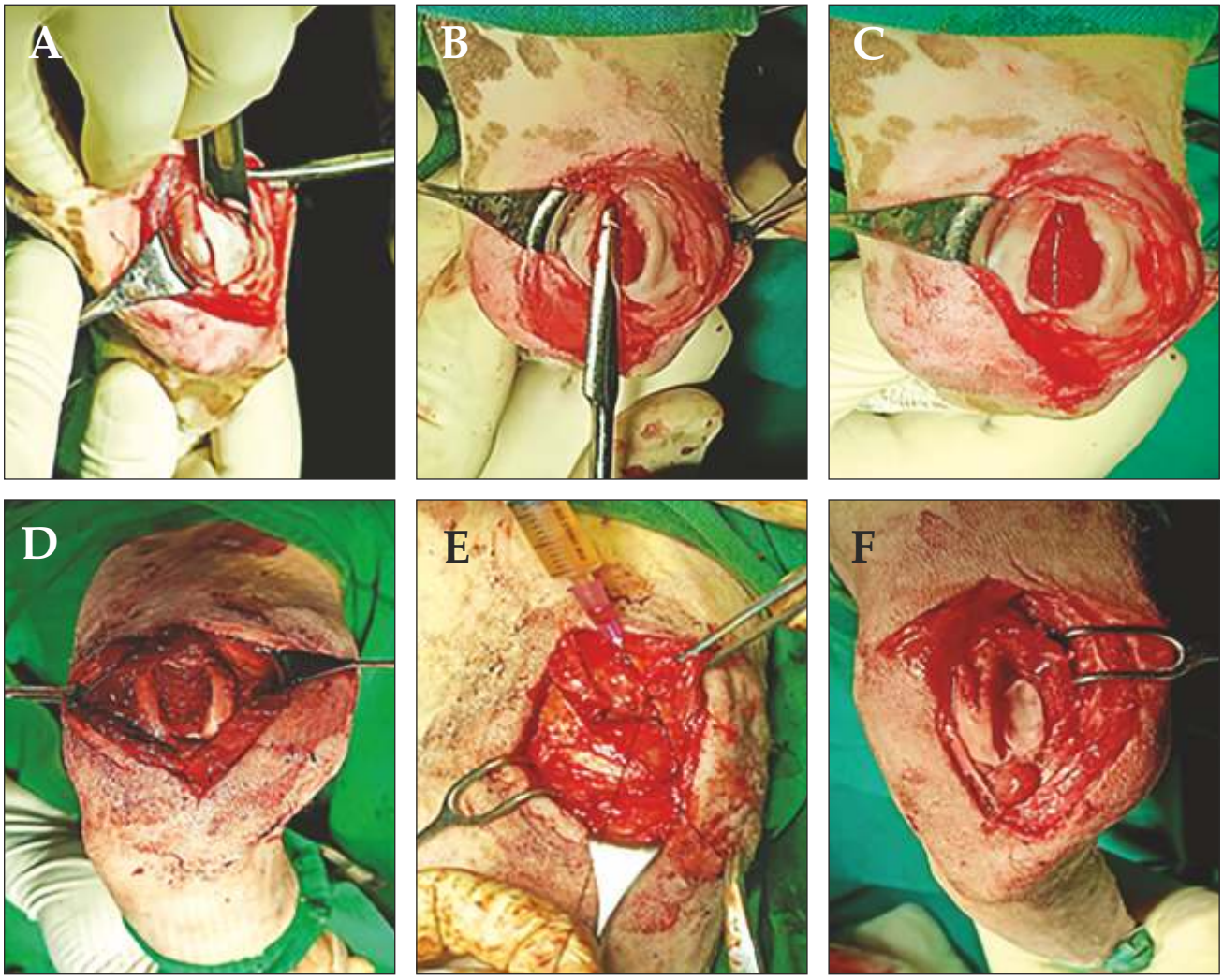

Fig. 2: (A) Resecting wedge-shaped cartilage; (B) Deepening trochlear groove; (C) Trochlea after deepening groove; (D) Trochlea after TBR; (E) Injecting PRP into joint; and (F) Placement of autograft with TWRS.

Table 1: Details of the dogs regarding age, sex, breed, body weight, and limb involved in selected cases.

Case No.	1	2	3	4	5	6	7	8
Age	4 yr	2.5 yr	1 yr	2.5 yr	4 m	4 m	2 yr	5 yr
Sex	Female	Male	Male	Male	Male	Male	Male	Male
Breed	Indian mongrel	Husky	Pug	Indian mongrel	Indian mongrel	Indian mongrel	Indian mongrel	Indian mongrel
Body weight (kg)	14.3	21	9	17.5	4.5	4.5	26	11.3
Limb involved	Left	Right	Left	Left	Right (bilateral)	Left (bilateral)	Right	Right

To assess the quality of hyaluronic acid in the synovial fluid, a mucin clot test was performed. In this procedure, synovial fluid was mixed with 2.5% acetic acid and the resulting clot formation was evaluated visually. The clot quality was graded according to its compactness and integrity as good, poor, or very poor. In the present study, the mucin clot reaction was graded as good in four cases, poor in three cases, and very poor in one case.

In addition, a string test was carried out to estimate the viscosity of the synovial fluid. A small quantity of fluid was allowed to stretch between two surfaces, and the maximum length of the thread formed before breaking was measured in centimetres. The recorded string test values ranged from 0.2 cm to 2 cm. All observations obtained from gross examination and viscosity assessment were used to characterize the physical properties of the synovial fluid and to provide supportive information regarding the condition of the joint.

Gross morphological alterations observed in the articular cartilage and associated joint structures of the eight dogs included thickening and hyperaemia of the joint capsule, abnormal blood accumulation and pooling in the periarticular tissues, and degenerative changes in the articular cartilage such as fragility, erosion, brittleness, fraying, and a rough, irregular surface. Additional changes comprised distortion of the trochlear ridges, a shallow or flattened trochlear groove, trochlear dysplasia, trochlear condylar hypoplasia, osteophyte formation including periarticular osteophytes and osteophyte deposition on the lateral femoral condyle, sclerosis and erosion of the subchondral bone, thickened and avascular subchondral tissue, and eburnation of the femoral condyles.

Postoperative management included administration of inj. ceftriaxone (20 mg/kg body weight, i.v.) twice daily and inj. butorphanol (0.1–0.2 mg/kg, i.v.) once daily for 2 days. Antiseptic dressing using povidone iodine was performed, followed by application of a Robert Jones bandage extending from above the stifle up to the hock, reinforced with a caudal metal splint to provide additional support and immobilization (Yadav *et al.*, 2025). The bandage was changed on alternate days until suture removal. Skin sutures were removed on the 12th postoperative day. Thereafter, mild physiotherapy, consisting of flexion and extension of the stifle joint, was initiated. From the 15th postoperative day, controlled leash walking was advised and continued for a period of four weeks.

The data obtained for the various parameters were subjected to standard statistical analysis using one-way ANOVA. The analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 26.0 and Microsoft Excel version 16.0.

Results and Discussion

The details of the dogs included in study are presented in table 1. Based on the history reported by the owners and the findings of physical examination, the etiology of patellar luxation in various cases was recorded and presented in table 2. The details of grading of patellar luxation and type of luxation are presented in table 3.

Table 2: Etiology of patellar luxation in selected cases.

Case No.	Etiology
1	Traumatic
2	Developmental
3	Congenital
4	Developmental
5	Congenital (bilateral deformity)
6	Congenital (bilateral deformity)
7	Traumatic
8	Congenital

Table 3: Gradation and type of patellar luxation in dogs under study.

Case No.	Gradation of luxation	Type of luxation
1	Grade III	Medial
2	Grade III	Lateral
3	Grade III	Medial
4	Grade III	Lateral
5	Grade IV (bilateral deformity)	Lateral
6	Grade IV (bilateral deformity)	Lateral
7	Grade III	Medial
8	Grade IV	Lateral

Table 4: Tangential parameters measured on skyline radiographs in the study.

Case No.	Sulcus angle (SA°)	Lateral trochlear inclination angle (LTI °)	Medial trochlear inclination angle (MTI °) 22
1	130	28	22
2	151	8	13
3	151	17	18
4	159	10	12
5	160	9	11
6	168	9	3
7	112	39	29
8	150	8	22

Radiographs revealed medial patellar luxation in three cases and lateral patellar luxation in five cases based on displacement of patella out of trochlear groove to either medial or lateral side, respectively. Flattened or shallow trochlear groove in six cases (case 2, 3, 4, 5, 6 and 8), reduced height of trochlear ridges in seven cases (case 1, 2, 3, 4, 5, 6 and 8), periarticular osteophyte formation in four cases (case 3, 4, 7 and 8) and osteoarthritic changes in stifle in one case (case 7) were observed on radiographs. Tangential parameters measured on skyline views are presented in table 4. All cases showed abnormal radiographic values along with patellar displacement.

The details of surgical techniques performed in dogs are presented in the table 5. Postoperative evaluation of the eight dogs included in the study showed a progressive and favourable functional recovery (Di Dona *et al.,* 2018; Sapora, 2025) following surgical correction of patellar luxation. Normal weight bearing with normal limb angulation was achieved by the 15th postoperative day in cases 1, 2, 3, 5, 6, 7 and 8, while early complete weight bearing with full paw contact and normal limb alignment was observed as early as on the 3rd postoperative day in cases 2, 5, 6 and 7. Lameness scores were recorded preoperatively and at regular postoperative intervals to evaluate functional recovery following surgical intervention. Based on the first weight-bearing day, recovery was earliest on the 3rd postoperative day in cases 1, 2, 5, 6 and 7, and by the 7th postoperative day in cases 3, 4 and 8, indicating satisfactory early postoperative limb use in most dogs.

Radiographic evaluation further supported the favourable postoperative outcome in these eight dogs. Immediate postoperative and follow-up radiographs typically showed appropriate positioning of the patella within the trochlear groove during the healing period. Temporary non-visualisation of the patella within the trochlear groove was observed in case 4 and case 6 on the 15th postoperative day, and in case 2 on the 30th postoperative day; however, these complications were subsequently corrected by revision surgery through imbrication, following which proper patellar positioning within the groove was restored. Minor radiographic changes such as mild patellar tilt in case 6 and mild soft tissue swelling in case 7 were also observed. Measurements of the sulcus angle, medial trochlear inclination, and lateral trochlear inclination on skyline radiographs indicated an overall improvement in postoperative trochlear alignment (Garnoeva, 2023). In all the cases indicated correction of patellar luxation was successfully done with good clinical and functional recovery.

Table 5: Details of surgical combination procedures

Case No.	Surgical procedures
1	TWRS + lateral retinacular imbrication + medial retinacular release
2	TWRS + medial retinacular imbrication+ lateral retinacular release
3	TWRS + lateral retinacular imbrication+ medial retinacular release
4	TWRS + medial retinacular imbrication+ lateral retinacular release
5	TWRS + medial retinacular imbrication + lateral retinacular release
6	TWRS + medial retinacular imbrication + lateral retinacular release
7	TBR + PRP infusion + lateral retinacular imbrication + medial retinacular release
8	TWRS + trochlear ridge augmentation with autologous osteochondral graft + PRF placement + medial retinacular imbrication

Statistical analysis of the eight cases was interpreted primarily using the mean and standard deviation values of the selected clinical and radiographic parameters. Among the preoperative tangential radiographic measurements, the mean sulcus angle was 149.64±15.68°, whereas the mean lateral trochlear inclination angle was 14.09±9.64° and the mean medial trochlear inclination angle was 16.36±7.48°. The markedly higher mean sulcus angle in comparison with the trochlear inclination angles indicated clear variation in trochlear morphology among the affected stifles prior to surgical correction.

Lameness was assessed clinically and graded using a numerical scoring system ranging from 0 to 5, where 0 represented a normal gait and 5 represented non-weight-bearing lameness (Bosio *et al.,* 2025). The descriptive statistics of postoperative lameness grading demonstrated a favourable clinical trend in the eight dogs. The mean preoperative lameness grade was 3.91±1.14, which progressively decreased to 1.82±1.25 on the 3rd postoperative day, 1.64±1.29 on the 7th postoperative day, 1.55±0.82 on the 15th postoperative day, 1.27±0.47 on the 30th postoperative day, and 1.18±0.40 on the 45th postoperative day. This progressive reduction in mean lameness score indicated steady functional improvement following surgical

intervention. In addition, the gradual narrowing of the standard deviation values during later postoperative intervals reflected reduced variability in lameness severity between cases as healing progressed.

Postoperative skyline radiographic measurements further substantiated the clinical improvement. The mean postoperative sulcus angle was 132.45±7.81° on day 15, 130.27±7.83° on day 30, and 134.82±8.36° on day 45. Similarly, the mean lateral trochlear inclination angle was 22.64±8.84° on day 15, 22.64±7.39° on day 30, and 21.73±7.74° on day 45, while the mean medial trochlear inclination angle was 25.64±6.09° on day 15, 27.45±5.39° on day 30, and 24.27±5.62° on day 45. These findings showed only minor fluctuations between observation periods, while the relatively stable standard deviation values indicated maintenance of trochlear conformation after surgical correction. The relative stability of these mean values suggested that the reconstructed trochlear groove and patellar alignment were largely preserved throughout the postoperative period (Garnoeva, 2023).

Patellar luxation is a common orthopaedic cause of hind limb lameness in dogs, and accurate diagnosis relies on thorough clinical orthopaedic examination together with detailed radiographic assessment (Rezende *et al.,* 2016; Di Dona *et al.,* 2018). Evaluation of tangential radiographic angles was valuable in determining the severity of patellar maltracking, assessing trochlear groove depth and ridge morphology, and guiding both surgical planning and postoperative evaluation (Garnoeva, 2023). Sulcoplasty served as the primary surgical procedure (Rezende *et al.,* 2016; Sapora, 2025), while adjunct techniques such as medial or lateral retinacular release or imbrication, augmentation with PRF, and intra-articular PRP administration contributed to improved patellar stability and functional recovery. In case 7 where severe osteoarthritis was suspected, intra-articular PRP was administered to enhance joint healing and reduce postoperative inflammation, whereas in case 8, PRF was used as a biological glue for the cartilage with PRP administered intraarticularly to support cartilage healing and recovery (Garnoeva, 2023). In severe cases, intraoperative synovial fluid aspirates analysis also aided in assessing joint health status (Di Dona *et al.,* 2018; Garnoeva, 2023). Overall, early diagnosis and case-specific surgical management were effective in restoring patellar alignment, improving gait, correcting posture, and reducing chronic lameness (Rezende *et al.,* 2016; Di Dona *et al.,* 2018).

In conclusion, early recognition and tailored management reduce chronic lameness and significantly improve functional outcomes in dogs affected with patellar luxation; whereas combination of proper surgical procedures restores patellar alignment in higher grades of luxation.

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