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All author's name and affiliations are given below, after references

Advances in the surgical treatment of canine stifle joint affections

Sanjay Kumar Yadav, Mahesh Kumar, Kiranjeet Singh, Aswathy Gopinathan, Uttam Kumar Sahu, Piyush Rajput, Renu Motwani, Ankush Rana, Prarthana R and Seema Kokde

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Abstract
The canine stifle joint, anatomically analogous to the human knee, is frequently afflicted by conditions such as cranial cruciate ligament rupture (CCLR) and patellar luxation (PL), which are leading causes of lameness and degenerative joint disease. While these pathologies are well-characterized individually, their concurrent presentation poses a significant diagnostic and therapeutic challenge, often culminating in end-stage osteoarthritis. This review explores recent advances in the surgical management of these common stifle disorders. For CCLR, evolving techniques include tibial osteotomy procedures like the Tibial Plateau Leveling Osteotomy (TPLO) and Tibial Tuberosity Advancement (TTA), which aim to neutralize cranial tibial thrust and are often considered superior to traditional extracapsular or intra-articular methods. Surgical correction for PL involves a combination of soft tissue reconstruction, trochleoplasty, and tibial tuberosity transposition, with corrective osteotomies reserved for cases with significant bony deformities. In end-stage disease where conservative management fails, salvage procedures are necessary. Stifle joint arthrodesis (SJA) provides a permanent, pain-free fusion at the cost of joint motion. As a limb-sparing alternative that preserves mobility, total knee replacement (TKR) is emerging as a definitive solution. This review synthesizes the indications, techniques, and outcomes for these surgical interventions, highlighting TKR as an advanced, motion-preserving option that effectively alleviates pain and restores function, thereby improving patient welfare and preventing extremity loss.

Keywords: Canine stifle, CCL rupture, patellar luxation, arthrodesis, total knee replacement

Introduction
The stifle joint, a highly intricate and essential articulation in the hind limbs of quadrupeds, is anatomically comparable to the human knee and represents the largest synovial joint in dogs (Bergh and Budsberg, 2005) [7]. It consists of the femur, tibia, patella, and fabellae, forming three main compartments: the femoropatellar joint and the medial and lateral femorotibial joints. Pathological conditions affecting this joint are a major cause of lameness and degenerative joint disease (DJD) in dogs (Singleton, 1969) [59]. Among these, cranial cruciate ligament disease (CCLD) and patellar luxation (PL) are the most common orthopedic disorders, with CCL rupture being the predominant cause of stifle dysfunction (Harari, 1995; Moore and Read, 1996; Vasseur, 2003) [28, 48, 65] and PL primarily affecting small breeds (DeCamp *et al*., 2015) [17]. Although these conditions are well-documented individually (Jerram and Walker, 2003; Di Dona *et al*., 2018) [31, 18], their concurrent occurrence presents notable diagnostic and therapeutic challenges, with breed-specific variations in prevalence. Both disorders often progress to osteoarthritis, characterized by chronic pain, reduced activity, and persistent lameness (Ramirez-Flores *et al*., 2017; Thitiyanaporn *et al*., 2020) [52, 63]. In cases of advanced joint disease where conservative management is ineffective and mobility becomes severely restricted, surgical salvage becomes necessary. Stifle joint arthrodesis (SJA) is a widely accepted salvage procedure for irreparable joint damage resulting from trauma, infection, or unrelenting pain. It achieves permanent, pain-free stabilization of the joint through techniques such as internal plate fixation, external fixation, or intramedullary pinning.

Corresponding Author:
Mahesh Kumar
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

(Conway *et al*., 2004) [13]. Incorporation of autologous cancellous bone grafts enhances arthrodesis by supplying osteogenic cells and growth factors, particularly valuable in situations involving bone loss or infection (Groom *et al*., 2000; Seo *et al*., 2014) [27, 58]. The approach draws from arthrodesis techniques successfully employed in other joints like the elbow and metatarsophalangeal regions (Rochat and Mann, 1998; Elaine *et al*., 2021) [53, 22]. However, SJA eliminates the joint's natural motion permanently. As a motion-preserving alternative, total knee replacement (TKR) has evolved as a sophisticated and effective treatment for end-stage stifle osteoarthritis, paralleling its proven success in human orthopedics (Liebich *et al*., 2007; Thitiyanaporn *et al*., 2020; Memarian *et al*., 2022; Yang *et al*., 2022) [40, 63, 47, 70]. TKR restores mobility, alleviates pain, and avoids the biomechanical and functional limitations associated with limb amputation. This review aims to discuss recent developments in the surgical management of major canine stifle joint disorders, emphasizing advances in both salvage techniques such as arthrodesis and motion-conserving options like total joint replacement.

Anatomy of the Stifle Joint

The stifle joint represents the largest and one of the most intricate synovial joints in the canine skeletal system (Vérez-Fraguela *et al*., 2017) [67]. Functionally, it is a composite joint composed of two principal articulations: The femorotibial joint**,** which unites the femoral and tibial condyles, and the femoropatellar joint**,** which connects the femur with the patella. The stability and functionality of the stifle depend on the coordinated interaction of its bony framework, ligamentous and capsular components, menisci, and surrounding musculotendinous structures (Vérez-Fraguela *et al*., 2017) [67].

- **Osseous Structures:** The stifle joint is primarily formed by the distal femur, proximal tibia, and patella. The distal femur bears two condyles medial and lateral separated anteriorly by the trochlear groove and posteriorly by the intercondylar fossa. The proximal tibia presents corresponding condyles that articulate with those of the femur and are divided by the intercondylar eminence, which fits into the femoral intercondylar fossa. This eminence is composed of the medial and lateral intercondylar tubercles, and it's cranial, central, and caudal intercondylar areas serve as essential anchoring sites for the cruciate ligaments and menisci. The extensor groove, situated on the cranial surface of the tibia, accommodates the tendon of the long digital extensor muscle, while the tibial tuberosity provides insertion for the patellar ligament. On the caudal surface, the popliteal notch marks the passage of the popliteal tendon (Hazıroglu and Ekim, 2010) [29]. The patella, a large sesamoid bone within the tendon of the quadriceps femoris muscle, articulates with the femoral trochlea and enhances the mechanical advantage of the quadriceps during limb extension.
- **Ligamentou Structures:** The ligamentous system of the stifle is fundamental to maintaining joint stability and is classified into central (intra-articular) and peripheral (extra-articular) groups.
- **Central Ligaments:** Enclosed within the joint capsule and situated in the intercondylar fossa, the cranial cruciate ligament (CrCL) and caudal cruciate ligament (CaCL) are the principal stabilizers that prevent forward or backward displacement of the tibia relative to the femur and limit rotational movement.
- **Peripheral Ligaments:** The patellar ligament, a direct continuation of the quadriceps tendon, along with the medial and lateral patellar retinacula, stabilizes the patella during motion. The medial and lateral collateral ligaments maintain mediolateral stability of the stifle, while the oblique popliteal ligament reinforces the posterior portion of the joint capsule (Vérez-Fraguela *et al*., 2017) [67].

Surgical Affections of the Stifle Joint

Disorders affecting the stifle joint are among the leading causes of pelvic limb lameness in dogs. These encompass a broad range of conditions, including developmental anomalies such as patellar luxation and Osteochondritis Dissecans (OCD) of the femoral condyles, as well as traumatic and degenerative diseases like cranial cruciate ligament (CrCL) rupture and degenerative joint disease (DJD). Such conditions are frequently encountered in routine small animal orthopedic practice (Johnson *et al*., 2022) [72].

- **Patellar Luxation in Canines:** Patellar luxation is one of the most prevalent orthopedic disorders in dogs, seen across both small and large breeds, and occasionally reported in cats as well (Linney *et al*., 2011) [41]. Luxation can occur medially, laterally, or bidirectionally, with medial luxation being the most common form, particularly in small-breed dogs, while lateral luxation is less frequent and typically affects large or giant breeds (Di Dona *et al*., 2018) [18].
- **Grading of Patellar Luxation:** The severity of patellar luxation is clinically classified into four grades based on the degree of displacement and reducibility:
  - **Grade I:** The patella can be manually displaced from its groove but returns spontaneously to its normal position once released.
  - **Grade II:** The patella luxates spontaneously during stifle flexion or manipulation and remains displaced until the joint is extended or manually corrected.
  - **Grade III:** The patella remains luxated most of the time but can be manually repositioned, though it tends to luxate again once pressure is removed.
  - **Grade IV:** The patella is permanently displaced and cannot be manually reduced.

Etiology and Pathogenesis

Patellar luxation is primarily a congenital or developmental condition but may also occur secondary to trauma, which causes tearing or stretching of the retinacular structures on either side of the stifle. Iatrogenic luxation can occasionally develop following surgical repair of CrCL rupture or fractures of the distal femur or proximal tibia (Arthurs and Langley-Hobbs, 2006) [4]. The fundamental cause lies in misalignment of the quadriceps mechanism, which includes the quadriceps muscles, patella, trochlear groove, patellar ligament, and tibial tuberosity. Disruption in this alignment alters the direction of muscular pull during growth, resulting in skeletal deformities such as femoral varus, tibial valgus, and tibial torsion. Moreover, reduced contact between the patella and femoral trochlea leads to inadequate development of the trochlear groove a condition known as trochlear hypoplasia (DeCamp *et al*., 2015) [17]. This initiates a self-reinforcing cycle of instability and structural deformity.

Diagnosis

Accurate diagnosis of patellar luxation depends on a comprehensive clinical examination, grading of the luxation, and detection of any concurrent orthopedic abnormalities.

- **Gait Evaluation:** Observation during walking and trotting assists in identifying the pattern and severity of lameness, which may appear intermittently as a characteristic "skipping" motion when the patella luxates.
- **Standing Examination:** While the patient is standing, both hind limbs should be compared for symmetry, and the stifle joint should be evaluated for effusion, which may suggest concurrent CrCL injury.
- **Palpation and Manipulation:** The patella is located by palpating the tibial tuberosity and tracing the patellar ligament proximally. With the dog placed in lateral recumbency and the stifle extended, internal rotation of the tibia tests for medial luxation**,** while external rotation tests for lateral luxation. In Grade I and II cases, the patella can be manually displaced from its groove, whereas in Grade III and IV, attempts are made to reduce the luxation manually (Kowaleski, 2017) [36].
- **Diagnostic Imaging:** Radiography is indispensable for confirming patellar displacement, evaluating secondary degenerative changes, and identifying angular deformities of the femur or tibia.
- **Standard Views:** Routine mediolateral and craniocaudal radiographs of the stifle are the minimum requirement. On the mediolateral view, a displaced patella appears superimposed on the femoral condyles, while the craniocaudal view reveals medial or lateral displacement of the patella and provides information about varus or valgus deformities.
- **Specialized Views:** In severe or complex cases, additional projections are necessary:
- **Skyline (Tangential) View:** Used to assess the depth of the trochlear groove and the prominence of the trochlear ridges.
- **Full-Limb Radiographs:** Imaging the entire femur and tibia assists in preoperative planning, especially when corrective osteotomies are required to address bony deformities (Kowaleski, 2017) [36].
- **Surgical Treatment for Patellar Luxation (PL)**: The management of patellar luxation primarily involves surgical correction aimed at restoring proper alignment and stability of the stifle joint. The choice of surgical technique depends on the severity of luxation and the extent of anatomical deformity present. Commonly employed procedures include soft tissue reconstruction**,** trochlear deepening (sulcoplasty)**,** tibial tuberosity transposition, and corrective osteotomies for addressing angular or torsional deformities of the distal femur or proximal tibia.
- **Soft Tissue Techniques:** These methods such as medial desmotomy, lateral imbrication, antirotational sutures, and release of contracted medial musculature aim to balance the surrounding soft tissues by loosening overly tight structures and tightening lax tissues to realign the patella within the trochlear groove. While effective in mild cases, soft tissue reconstruction alone is usually insufficient to correct patellar luxation completely and is often combined with osseous procedures for lasting stability (Roush, 1993; Di Dona *et al*., 2018) [54, 18].
- **Trochlear Deepening Procedures (Sulcoplasty):** Sulcoplasty techniques modify and deepen the trochlear groove, improving congruence between the patella and femoral trochlea. The goal is to ensure that approximately half of the patella remains above the trochlear ridges when seated (DeCamp *et al*., 2015) [17]. Commonly performed methods include trochlear wedge recession and block recession osteotomies, where an osteochondral autograft triangular or rectangular in cross-section-is removed, the groove deepened, and the graft replaced. Fixation is unnecessary since joint pressure and natural congruency provide sufficient stability (Johnson *et al*., 2001) [33].
- Recent innovations in sulcoplasty have introduced modifications such as the "K-shield wedge recession", which combines a distal wedge with a proximal block (Katayama *et al*., 2016) [34], and the "extended proximal trochleoplasty", designed for bidirectional patellar luxations while preserving periosteal attachments to minimize postoperative bone proliferation (Wangdee *et al*., 2015) [68]. Another alternative, the "ridge stop technique", employs a polyethylene barrier placed along the trochlear ridge to mechanically prevent patellar displacement.
- **Tibial Tuberosity Transposition (TTT):** This technique addresses misalignment of the patellar ligament by repositioning its insertion on the tibial tuberosity. The tibial crest the attachment site of the patellar ligament is osteotomized and transposed either medially or laterally**,** depending on the direction of luxation, and stabilized in its new position to restore alignment of the quadriceps-patella-tibia axis (Singleton, 1969) [59]. A modern adaptation known as the "rapid luxation technique" utilizes a tibial tappet implant to reposition and secure the tuberosity, improving surgical precision and stability.
- **Corrective Osteotomies:** In cases of significant femoral or tibial deformity, corrective osteotomies are performed to realign the quadriceps mechanism and normalize limb biomechanics. Techniques such as closing lateral wedge osteotomy or medial opening wedge osteotomy are applied to correct valgus or varus deformities, respectively, while derotational osteotomies address torsional abnormalities of long bones, particularly the proximal tibia (Petazzoni, 2014; Brower *et al*., 2017) [51, 9]. Preoperative CT imaging is strongly recommended for accurate assessment of angular deviation and pre-surgical planning (Dudley *et al*., 2006) [20].
- **Postoperative Outcomes:** The success of surgical correction largely depends on the initial grade of luxation. Studies have shown that Grade II PL cases generally have excellent outcomes with minimal recurrence. In contrast, Grade III cases demonstrate a reluxation rate of approximately 11%**,** and Grade IV luxations exhibit variable success (64-93%) with a higher incidence of complications requiring secondary procedures such as corrective osteotomies (Wangdee *et al*., 2013; Dunlap *et al*., 2016) [69, 21].
- **Diagnosis of Cranial Cruciate Ligament Rupture (CCLR):** Cranial cruciate ligament rupture in dogs is typically characterized by reluctance to sit on the affected limb (Matis, 2005) [45] and avoidance of stifle flexion or extension. The condition is frequently accompanied by acute joint inflammation and hemarthrosis, leading to sudden lameness that may vary in severity from intermittent to continuous and may be weight-bearing or non-weight-bearing, depending on the extent of injury (Sandman and Harari, 2001) [56]. Additional diagnostic indicators include atrophy of the thigh muscles,

asymmetry of the hind limbs, joint effusion, periarticular swelling, pain during joint manipulation, and cranial displacement of the tibial crest (Paatsama, 1952; Johnson and Johnson, 1993) [50]. The presence of a positive cranial drawer sign and tibial compression test is considered pathognomonic for CCLR (Brunnberg, 1989) [10]. Radiographic evaluation in mediolateral and craniocaudal projections is recommended to confirm the diagnosis and rule out other conditions (Jerram and Walker, 2003) [31]. Common radiographic findings include loss of definition in the infrapatellar fat pad due to soft tissue opacity, caudal displacement of the caudal fat pad, and osteophyte formation. Arthroscopy offers high diagnostic sensitivity, especially for partial ligament tears, and allows for concurrent therapeutic procedures such as partial meniscectomy. In cases of chronic patellar luxation with acute lameness, concurrent CCLR should be considered among differential diagnoses. Although non-invasive imaging modalities like magnetic resonance imaging (MRI) and ultrasonography can aid diagnosis, their accuracy depends heavily on the operator's expertise and access to specialized equipment. Consequently, arthroscopic visualization and palpation remain the most dependable diagnostic methods for suspected CCLR and meniscal injury.

- **Surgical Management of CCLR:** Over time, a wide range of surgical methods has been described for treating CCLR, which can be broadly categorized into three groups (Jerram and Walker, 2003) [31].
- **Intra-articular techniques:** These procedures aim to reconstruct the ruptured ligament using autografts, allografts, or synthetic materials to restore the functional role of the original CCL. Autografts, harvested from the patient's patellar ligament or fascia lata, are commonly employed in the "fascia over the top" technique and its variations (Brunnberg *et al.,* 1992) [11]. Allografts obtained from donor dogs, such as the patellar ligament or fascia lata, can also be used; however, donor availability limits their application. Synthetic substitutes, including materials like Dacron, silk, and ligament augmentation devices, have been designed to emulate ligamentous biomechanics. Modern bioengineering approaches have introduced matrix-based scaffolds seeded with progenitor ligament cells, offering potential for biologically integrated grafts.
- **Extracapsular techniques:** These rely on the formation of periarticular fibrosis to provide long-term joint stabilization after the temporary mechanical support of the extraarticular implants subsides. They are relatively straightforward, rapid to perform, and do not require specialized equipment. Common extracapsular procedures include "capsular fascial imbrication" (Allgoewer *et al.,* 2000) [3], "lateral retinacular imbrication" (DeAngelis and Lau, 1970) [16], and its widely adopted modification, the "fabellotibial suture" technique (Flo, 1975) [25], which employs strong suture material secured with knots or metallic crimp tubes. The "tight rope" procedure represents a modern variant using high-molecular-weight polyethylene polyester to enhance mechanical strength and durability (Cook, 2008) [15].
- **Tibial Osteotomy Techniques:** Tibial osteotomy procedures are currently regarded as the most effective surgical approach for managing cranial cruciate ligament rupture (CCLR), primarily because they slow the progression of postoperative osteoarthritis compared to other repair methods (Lazar *et al.,* 2005) [38]. The central aim of these techniques is to counteract the cranial tibial thrust by altering the geometry of the proximal tibia. The cranial tibial closing wedge osteotomy (CTWO**)** was the first osteotomy procedure developed to neutralize cranial tibial thrust. It achieves this by reducing the tibial plateau angle through the removal of a cranial wedge of bone from the proximal tibia (Slocum and Devine, 1984) [60]. Building upon this concept, Slocum later introduced the tibial plateau leveling osteotomy (TPLO)**,** in which the tibial plateau is rotated to achieve a desired plateau angle (Slocum and Slocum, 1993) [61]. TPLO may also be combined with a cranial closing wedge ostectomy to address cases involving excessive tibial plateau angle, proximal tibial deformities such as varus or valgus angulation, or tibial torsion. The tibial tuberosity advancement (TTA) procedure, introduced by Montavon *et al*. (2002) [73], stabilizes the stifle by advancing the tibial tuberosity to modify the patellar ligament angle, thereby neutralizing the cranial tibial thrust and tibiofemoral shear forces during weight bearing. This is achieved by cutting the tibial tuberosity and inserting a titanium cage to advance it forward, followed by fixation using a Kyon plate on the tibial crest and proximal tibia. Subsequent innovations have simplified the procedure by eliminating the plate, using only the cage for both advancement and stabilization. These include the modified Maquet procedure, TTA Rapid, and TTA-2 techniques (Etchepareborde *et al.,* 2011; Kyon Pharma, 2012; Samoy *et al.,* 2014) [24, 37, 55]. The main benefits of these variants are shorter operative times and reduced amounts of foreign material implanted in the patient (Marques *et al.,* 2017) [44]. The triple tibial osteotomy (TTO) combines principles of TPLO and TTA. It aims to achieve a 90° patellar tendon angle when the stifle is in a weight-bearing position. This is done by removing a small horizontal wedge of bone along a vertical tibial tuberosity osteotomy. The tibial plateau is then leveled, and the resulting horizontal defect is closed, advancing the tibial tuberosity in the process. Both TPLO (Slocum and Slocum, 1993) [61] and TTA (Montavon *et al.,* 2002) [73] have demonstrated consistently good to excellent outcomes (Lazar *et al.,* 2005) [38] and are widely considered superior to extracapsular stabilization techniques for CCLR management (Lazar *et al.,* 2005; Gordon-Evans *et al.,* 2013; Berger *et al.,* 2015) [38, 26, 6]. However, some studies have challenged the extent of this superiority (Conzemius *et al.,* 2005) [14]. Moreover, these osteotomy techniques require specialized instrumentation, advanced surgical expertise, and are associated with higher costs, which may limit their use in routine clinical practice.

Stifle Joint Arthrodesis for Treating Chronic Osteoarthritis

Stifle Joint Arthrodesis (SJA) is considered an effective surgical treatment for managing severe infections, chronic joint instability, or extensive bone loss leading to loss of flexion and extension in the stifle. Various fixation methods external fixation, plate fixation, or intramedullary fixation can be used to achieve joint fusion (Choi *et al.,* 2008) [12]. In cases involving severe cartilage or bone destruction due to inflammation, autologous cancellous bone grafts have recently gained importance for promoting bone healing and regeneration (Seo *et al.,* 2014) [58]. These cancellous grafts are

rich in osteogenic cells and proteins, which aid in repairing septic orthopedic injuries (Groom *et al*., 2000) [27].

Surgical Technique

During SJA, a longitudinal anterior incision (approximately 15 cm) is made over the stifle joint between the femur and tibia. The fascia is dissected medially near the quadriceps femoris muscle, and the articular capsule is incised. The joint is then exposed by rotating the capsule laterally with tissue forceps (Allis 23 cm, KASCO, Islamabad, Pakistan). On exposure, cranial cruciate ligament rupture can be confirmed. Adhesions and fibrous tissues restricting motion are carefully excised. The distal femoral and proximal tibial surfaces are flattened using a bone file, rasp, and rongeur (Professional instruments, Sialkot, Pakistan) to allow intimate plate contact and bone-to-bone interface. Cancellous bone fragments harvested during preparation are preserved in a sterile syringe for later grafting.

To fix the joint at an angle of 120-130°, a K-wire (1.4 mm × 229 mm, General Vet Products, Australia) is inserted from the medial tibial surface toward the femoral condyle at a 45° angle, followed by two guide pins arranged in a cross ("X") pattern for stabilization. The harvested cancellous bone is placed into the joint cavity to promote osseous fusion. The alignment and position of the fixation plate are confirmed intraoperatively with a C-arm fluoroscope (7700 Compact C-Arm, Hi Tech International Group Inc., USA). The plate is secured using 1.5 mm and 2.0 mm screws (Veterinary Instrumentation, Republic of Korea) alternately inserted into the femur and tibia (Lee *et al*., 2023) [39].

Postoperatively, cephalexin (25 mg/kg), tramadol (2 mg/kg), and carprofen (2.2 mg/kg) were administered twice daily for 10 days to control infection and inflammation. Cold compresses and proprioceptive balance exercises (5-10 minutes twice daily) helped minimize pain and muscle atrophy. Light ambulation was encouraged to preserve limb function. The patient was discharged on carprofen 4.4 mg/kg SID for 20 days, showing satisfactory recovery (Lee *et al*., 2023) [39].

Total Knee Replacement in Veterinary Surgery

The knee (stifle) joint endures significant mechanical stress-compression, torsion, and tension-making complete recovery after trauma difficult (Zalavras *et al*., 2014; Yang *et al*., 2022) [71, 70]. Osteoarthritis secondary to cruciate ligament injuries is a major cause of chronic pain, reduced mobility, and lameness in dogs (Vasseur and Bery, 1992; Liebich *et al*., 2007; Thitiyanaporn *et al*., 2020) [66, 40, 63]. In advanced stages, medical management often fails, and while arthrodesis or amputation can reduce pain, they do not restore full function. Consequently, total joint replacement (TJR) particularly total knee replacement (TKR) has emerged as a definitive and reliable surgical option for restoring mobility and preventing limb loss (Liebich *et al*., 2007; Allen, 2012; Memarian *et al*., 2022) [40, 1, 47].

Modern TKR systems use metal-on-polyethylene condylar implants designed to replicate the femorotibial joint with semi-constrained motion. These implants are often cemented to enhance fixation (Liebich *et al*., 2007) [40]. Many veterinary knee prostheses are adapted from human orthopedic designs (Allen *et al*., 2009) [2]. Early research by Ducheyne *et al*. (1977) [19] explored cementless roller implants to study bone response under dynamic loading. Later developments emphasized cementless fixation and condylar prosthesis designs (Turner *et al*., 1989; Liska *et al*., 2007) [64, 43]. Initially, prostheses were made of stainless steel, but their limited strength and corrosion resistance led to the adoption of cobalt-chromium and titanium alloys (Yang *et al*., 2022) [70]. These smooth-surfaced alloys require bone cement for secure attachment. Typically, the femoral condyles and trochlea are crafted from cobalt-chromium, while the tibial component consists of ultra-high molecular weight polyethylene (UHMWPE) either on a metal base or as a monoblock (Liebich *et al*., 2007) [40].

- **Types of Knee Prostheses:** In canine TKR, the femoral component is metallic, while the tibial component is polymeric (Thitiyanaporn *et al*., 2020) [63]. Both cemented and cementless models exist (Allen *et al*., 2012) [1]. Cementless fixation offers benefits such as preservation of bone stock, elimination of cement debris, shorter surgical times, and suitability for minimally invasive surgery (Allen *et al*., 2012; Muir, 2018) [1, 49]. However, it also carries a higher revision rate. Studies show variability in bone in growth patterns with cementless implants, leading many surgeons to prefer cemented fixation for long-term stability. Allen *et al*. (2012) [1] evaluated a bioactive peri-apatite hydroxyapatite coating that enhances early bone integration in cementless tibial components, finding that although initial migration was greater than in cemented designs, clinical performance remained comparable.
- **Indications:** TKR is indicated for patients with severe, chronic joint pain unresponsive to conservative therapy, advanced osteoarthritis (Liebich *et al*., 2007; Liska and Doyle, 2009; Sarıerler *et al*., 2013) [40, 42, 43], irreparable joint fractures, non-union fractures, and irreducible dislocations (Mckee and Arthurs, 2022) [46].
- **Contraindications:** TKR should be avoided in painless joint conditions, neurological disorders, infectious arthritis, or when pain responds to medical management (Mckee and Arthurs, 2022) [46].
- **Implant Size Determination:** Preoperative implant selection is performed using radiographic templating. Caudocranial radiographs assess the tibial component, while mediolateral views are used for the femoral component (Liebich *et al*., 2007) [40]. Templates are aligned with key anatomical landmarks such as the tibial tuberosity for the tibial part-ensuring the prosthesis fits without compromising the collateral ligaments or fibula.

- **Preoperative Evaluation:** Preoperative assessment includes complete blood count, serum biochemistry, and urinalysis, alongside gait analysis, limb measurements, and radiographic evaluation to determine surgical suitability and optimize outcomes (Liebich *et al*., 2007) [40]. These evolving surgical modalities stifle arthrodesis and total knee replacement-represent the two extremes of joint management: one sacrificing motion for stability, the other restoring function through advanced prosthetic integration.
- **Surgical Procedure:** Following standard aseptic and antiseptic preparation, the surgical field is draped and prepared for operation. The stifle joint can be accessed through a craniolateral, medial, or lateral parapatellar incision (Allen *et al*., 2009; Eskelinen *et al*., 2012; Liebich *et al*., 2007) [2, 23, 40]. After incision, the lateral or medial retinaculum and the corresponding fabellopatellar ligament are incised to permit medial or lateral luxation of the patella (Allen *et al*., 2009; Liebich *et al*., 2007) [2, 40]. The infrapatellar fat pad, menisci, and both cruciate ligaments are then excised using sharp dissection or

electrocautery (Allen *et al*., 2009; Thitiyanaporn *et al*., 2020) [2, 63]. The tendon of the long digital extensor is detached from the femoral extensor fossa, and the popliteus tendon insertion on the craniolateral femur may be partially or completely released to allow distal femoral osteotomy.

Specialized surgical instruments and cutting guides are employed for tibial osteotomy and femoral resections, which include distal, cranial, caudal, and trochlear cuts (Allen *et al*., 2009) [2]. The prosthesis implantation sequence may begin with either the tibial or femoral component (Allen *et al*., 2009; Liebich *et al*., 2007) [2, 40]. For tibial preparation, a cutting guide is fixed to the proximal tibia using Kirschner wires, ensuring protection of the collateral ligaments with gauze. The proximal tibia is sectioned using an oscillating saw, and an 8 mm central hole is drilled to accommodate the tibial implant (Thitiyanaporn *et al*., 2020) [63]. The osteotomy surfaces are flushed with saline, dried, and coated with bone cement before positioning the tibial prosthesis.

For the femoral component, the osteotomy guide is secured to the distal femoral condyle using Kirschner wires. Osteotomy is performed under template guidance with an oscillating saw (Thitiyanaporn *et al*., 2020) [63]. Drill holes (3.2-8 mm) are made into the distal femoral surface to enhance cement fixation (Allen *et al*., 2009; Thitiyanaporn *et al*., 2020) [2, 63]. Bone cement is applied, and the femoral prosthesis is embedded and seated firmly (Thitiyanaporn *et al*., 2020) [63]. The joint capsule is then closed using nylon or polydioxanone sutures, followed by routine closure of subcutaneous tissues and skin (Allen *et al*., 2009; Thitiyanaporn *et al*., 2020) [2, 63]. Post-suturing, the range of motion-flexion, extension, rotation, abduction, and adduction-is assessed to ensure joint stability. Postoperatively, patient movement must be restricted to controlled leash walks for six weeks, and slippery floors should be avoided (Eskelinen *et al*., 2012) [23].

- **Postoperative Care:** Radiographs in caudocranial and mediolateral projections should be obtained to verify implant placement. A Robert Jones bandage is applied to the operated limb to reduce swelling and provide support. Postoperative analgesia may include morphine (10 mg IM every 6-12 hours for 48 hours), along with carprofen (2-4 mg/kg orally once daily for five days) and cephalexin (22-30 mg/kg orally twice daily for 7-10 days), (Allen *et al*., 2009) [2].
- **Complications:** Incomplete osteotomy of the tibial plateau may lead to exposure of unprotected bone surfaces, potentially causing intraoperative bleeding, which can be controlled with bone wax. Damage to the medial collateral ligament is a possible risk during tibial osteotomy, while the popliteus tendon is vulnerable during distal femoral cutting (Allen *et al*., 2009) [2]. Polyethylene wear remains the most frequently encountered complication following total knee arthroplasty, with periprosthetic infections also being relatively common (Koh and Zeng, 2017) [35].

Conclusion

With advancements in orthopedic surgical technology, prosthetic applications once limited to the hip joint are now effectively extended to the stifle. Adapting total knee arthroplasty for veterinary patients represents a significant step in restoring mobility and preventing limb loss. This advancement enhances animal welfare and quality of life for patients previously facing limited treatment options. The present review aims to consolidate current insights into total knee arthroplasty, reflecting its growing clinical significance and potential in modern veterinary surgery.

Conflict of Interest
Not available

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Not available

Reference

1. Allen MJ, Leone KA, Dunbar MJ, Race A, Rosenbaum PF, Sacks JM. Tibial component fixation with a peri-apatite coating: Evaluation by radiostereometric analysis in a canine total knee arthroplasty model. J Arthroplasty. 2012;27(6):1138-1148.
2. Allen MJ, Leone KA, Lamonte K, Townsend KL, Mann KA. Cemented total knee replacement in 24 dogs: Surgical technique, clinical results, and complications. Vet Surg. 2009;38(5):555-567.
3. Allgoewer I, Richter A, Gruenig G, Meutstege F, Waibl H, Brunnberg L. Zwei intra-extraartikulaere *Stabilisationsmethoden* zur Therapie der Ruptur des *Ligamentum cruciatum* craniale im Vergleich: Methode (mod.) nach FLO und Methode nach MEUTSTEGE. Kleintierpraxis. 2000;45:95-103.
4. Arthurs GI, Hobbs LSJ. Complications associated with corrective surgery for patellar luxation in 109 dogs. Vet Surg. 2006;35(6):559-566.
5. Au KK, Evans GWJ, Dunning D, O'Dell-Anderson K, Knap K, Griffon D, *et al*. Comparison of short- and long-term function and radiographic osteoarthritis in dogs after postoperative physical rehabilitation and tibial plateau leveling osteotomy or lateral fabellar suture stabilization. Vet Surg. 2010;39(2):173-180.
6. Berger B, Knebel J, Raith SS, Reese S, Lindenberg MA. Long-term outcome after surgical treatment of cranial cruciate ligament rupture in small breed dogs: Comparison of tibial plateau leveling osteotomy and extra-articular stifle stabilization. Tierarztl Prax Ausg K Kleintiere Heimtiere. 2015;43(6):373-80.
7. Bergh MS, Budsberg SC. The coxib NSAIDs: Potential clinical and pharmacologic importance in veterinary medicine. J Vet Intern Med. 2005;19(5):633-643.
8. Berzins A, Sumner DR, Turner TM, Natarajan R. Effects of fixation technique on displacement incompatibilities at the bone-implant interface in cementless total knee replacement in a canine model. J Appl Biomater. 1994;5(4):349-52.
9. Brower BE, Kowaleski MP, Peruski AM, Pozzi A, Dyce J, Johnson KA, *et al*. Distal femoral lateral closing wedge osteotomy as a component of comprehensive treatment of medial patellar luxation and distal femoral varus in dogs. Vet Comp Orthop Traumatol. 2017;30(1):20-27.
10. Brunnberg L. Klinische Untersuchung zur Aetiologie und Pathogenese der Ruptur des Ligamentum cruciatum craniale beim Hund. Kleintierpraxis. 1989;34(3):111-4.
11. Brunnberg L, Rieger I, Hesse EM. Sieben Jahre Erfahrung mit einer modifizierten "Over-the-Top"-Kreuzbandplastik beim Hund. Kleintierpraxis. 1992;37:735-746.
12. Choi NY, In Y, Yang YJ, Kim JI. Arthrodesis of the knee with a Huckstep nail following the treatment failure of an infected total knee arthroplasty. Knee Surg Relat Res. 2008;20(2):175-180.

13. Conway JD, Mont MA, Bezwada HP. Arthrodesis of the knee. J Bone Joint Surg Am. 2004;86(4):835-48.
14. Conzemius MG, Evans RB, Besancon MF, Gordon WJ, Horstman CL, Hoefle WD, *et al*. Effect of surgical technique on limb function after surgery for rupture of the cranial cruciate ligament in dogs. J Am Vet Med Assoc. 2005;226(2):232-6.
15. Cook JL. Multicenter outcomes study for evaluation of tightrope CCL for treatment of cranial cruciate deficiency in dogs: The first 1,000 cases. Proc 37th Annu Conf Vet Orthop Soc; 2008; Breckenridge, CO.
16. DeAngelis M, Lau RE. A lateral retinacular imbrication technique for the surgical correction of anterior cruciate ligament rupture in the dog. J Am Vet Med Assoc. 1970;157(1):79-84.
17. DeCamp CE, Johnson SA, Déjardin LM, Schaefer SL, editors. Brinker, Piermattei and Flo's handbook of small animal orthopedics and fracture repair. 5th ed. St. Louis: Elsevier; 2015.
18. Dona DF, Valle DG, Fatone G. Patellar luxation in dogs. Vet Med Res Rep. 2018;9:23-32.
19. Ducheyne P, De Meester P, Aernoudt E. Influence of a functional dynamic loading on bone ingrowth into surface pores of orthopedic implants. J Biomed Mater Res. 1977;11(6):811-838.
20. Dudley RM, Kowaleski MP, Drost WT, Dyce J. Radiographic and computed tomographic determination of femoral varus and torsion in the dog. Vet Radiol Ultrasound. 2006;47(6):546-552.
21. Dunlap AE, Kim SE, Lewis DD, Christopher SA, Pozzi A. Outcomes and complications following surgical correction of grade IV medial patellar luxation in dogs: 24 cases (2008-2014). J Am Vet Med Assoc. 2016;249(2):208-213.
22. Elaine VD, Aaron R, Stan V, Guillaume R, Albert CL, Brianna M, *et al*. Evaluation of post-operative complications, outcome, and long-term owner satisfaction of elbow arthrodesis in 22 dogs. PLOS One. 2021;16(11):e0260452.
23. Eskelinen EV, Liska WD, Hyytiäinen HK, Hielm-Björkman A. Canine total knee replacement performed due to osteoarthritis subsequent to distal femur fracture osteosynthesis. Vet Comp Orthop Traumatol. 2012;25(5):427-32.
24. Etchepareborde S, Brunel L, Bollen G, Balligand M. Preliminary experience of a modified Maquet technique for repair of cranial cruciate ligament rupture in dogs. Vet Comp Orthop Traumatol. 2011;24(3):223-7.
25. Flo GL. Modification of the lateral retinaculum imbrication technique for stabilizing cruciate ligament injuries. J Am Anim Hosp Assoc. 1975;11:570-6.
26. Evans GWJ, Griffon DJ, Bubb C, Knap KM, Sullivan M, Evans RB. Comparison of lateral fabellar suture and tibial plateau leveling osteotomy techniques for treatment of dogs with cranial cruciate ligament disease. J Am Vet Med Assoc. 2013;243(5):675-80.
27. Groom LJ, Gaughan EM, Lillich JD, Valentino LW. Arthrodesis of the proximal interphalangeal joint affected with septic arthritis in eight horses. Can Vet J. 2000;41(2):117-23.
28. Harari J. Current concepts in the treatment of cranial cruciate ligament injury. Waltham Focus. 1995;5:24-31.
29. Hazıroğlu RM, Ekim O. Apparatus locomotorius. In: Hazıroğlu RM, Çakır A, editors. *Veteriner anatomi* konu anlatımı ve atlas. Ankara: Güneş Tıp Kitabevi; 2010, p. 32-99.
30. Hulse DA. The stifle joint. In: Olmstead ML, Editor. Small animal orthopedics. St. Louis: Mosby; 1995, p. 395-404.
31. Jerram RM, Walker AM. Cranial cruciate ligament injury in the dog: Pathophysiology, diagnosis and treatment. N Z Vet J. 2003;51(4):149-58.
32. Johnson AL, Johnson JM. Cranial cruciate ligament rupture: Pathogenesis, diagnosis, and postoperative rehabilitation. Vet Clin North Am Small Anim Pract. 1993;23(4):717-33.
33. Johnson AL, Probst CW, Decamp CE, Rosenstein DS, Hauptman JG, Weaver BT, *et al*. Comparison of trochlear block recession and trochlear wedge recession for canine patellar luxation using a cadaver model. Vet Surg. 2001;30(2):140-50.
34. Katayama M, Ogaya H, Shunsuke S, Uzuka Y. Kite shield-shaped wedge recession for treatment of medial patellar luxation in seven small-breed dogs. Vet Surg. 2016;45(1):66-70.
35. Koh CK, Zeng I. Periprosthetic joint infection is the main cause of failure for modern knee arthroplasty: Analysis of 11,134 knees. Clin Orthop Relat Res. 2017;475(9):2194-201.
36. Kowaleski MP, Boudrieau RJ, Pozzi A. Stifle joint. In: Johnston SA, Tobias KM, Editors. Veterinary surgery: small animal. 2nd Ed. St. Louis: Elsevier Saunders; 2017, p. 1071-1168.
37. Pharma K. TTA-Tibial tuberosity advancement. Zurich: Kyon Pharma; 2012 [cited 2021 Aug 10]. Available from: https://www.kyon.ch/current-products/tibial-tuberosity-advancement-tta
38. Lazar TP, Berry CR, Haan DEJJ, Peck JN, Correa M. Long-term radiographic comparison of tibial plateau leveling osteotomy versus extracapsular stabilization for cranial cruciate ligament rupture in the dog. Vet Surg. 2005;34(2):133-141.
39. Lee SH, Roh YH, Lee DB, Cho JH, Kim CH. Stifle joint arthrodesis for treating chronic-osteoarthritis-affected dogs. Vet Sci. 2023;10(7):407.
40. Liebich HG, König HE, Maierl J. Hindlimb or pelvic limb (membra pelvina). In: König HE, Liebich HG, editors. Veterinary anatomy of domestic mammals: Textbook and colour atlas. Stuttgart: Schattauer; 2007, p. 215-276.
41. Linney WR, Hammer DL, Shott S. Surgical treatment of medial patellar luxation without femoral trochlear groove deepening procedures in dogs: 91 cases (1998-2009). J Am Vet Med Assoc. 2011;238(9):1168-1172.
42. Liska WD, Doyle ND. Canine total knee replacement: surgical technique and one-year outcome. Vet Surg. 2009;38(5):568-82.
43. Liska WD, Little MDJ, Eskelinen EV, Sidebotham CG, Harrysson OL, Björkman HAK. Custom total knee replacement in a dog with femoral condylar bone loss. Vet Surg. 2007;36(4):293-301.
44. Marques DRC, Ibanez JF, Monteiro JF, Hespanha ACV, Eggert M, Becker A, Freitas IB. A report of the Maquet procedure for the management of cranial cruciate ligament rupture in a dog: A case report. Semina Cienc Agrar. 2017;38(3):321-30.
45. Matis U. Die klinische Untersuchung des Kniegelenks [Clinical examination of the stifle joint]. Tierarztl Prax Ausg K Kleintiere Heimtiere. 2005;33(2):131-7.
46. McKee M, Arthurs G. Considerations around total and

partial joint replacement surgery. Vet Times [Internet]. 2022 [cited 2022 Mar 17]. Available from: https://www.vettimes.co.uk/article/considerations-around-total-and-partial-joint-replacement-surgery/
47. Memarian P, Pishavar E, Zanotti F, Trentini M, Camponogara F, Soliani E, *et al*. Active materials for 3D printing in small animals: Current modalities and future directions for orthopedic applications. Int J Mol Sci. 2022;23(3):1045.
48. Moore KW, Read RA. Rupture of the cranial cruciate ligament in dogs. Part I. Compend Contin Educ Pract Vet. 1996;18(2):223-233.
49. Muir P. Advances in the canine cranial cruciate ligament. Hoboken (NJ): John Wiley & Sons; 2018.
50. Paatsama S. Ligament injuries in the canine stifle joint: A clinical and experimental study [dissertation]. Helsinki: University of Helsinki; 1952.
51. Petazzoni M. Corrective osteotomies in treating patellar luxation in large breed dogs [conference presentation]. Eur Coll Vet Surg Annu Sci Meet, Copenhagen, Denmark; 2014 Jul 3-5.
52. Flores RGI, Caraza AJD, Hernandez QIA, Hulse DA, Beale BS, Mora VJM. Correlation between osteoarthritic changes in the stifle joint in dogs and the results of orthopedic, radiographic, ultrasonographic and arthroscopic examinations. Vet Res Commun. 2017;41(2):129-37.
53. Rochat MC, Mann FA. Metatarsophalangeal arthrodesis in three dogs. J Am Anim Hosp Assoc. 1998;34(2):158-163.
54. Roush JK. Canine patellar luxation. Vet Clin North Am Small Anim Pract. 1993;23(4):855-868.
55. Samoy Y, Verhoeven G, Bosmans T, Vekens VDE, Bakker DE, Verleyen P, *et al*. TTA Rapid: Description of the technique and short-term clinical trial results of the first 50 cases. Vet Surg. 2014;44(4):474-84.
56. Sandman KM, Harari J. Canine cranial cruciate ligament repair techniques is one best? Vet Med. 2001;96(11):868-75.
57. Sarıerler M, Akin İ, Belge A, Kılıç N. Patellar fracture and patellar tendon rupture in a dog. Turk J Vet Anim Sci. 2013;37(1):121-4.
58. Seo JP, Yamaga T, Tsuzuki N, Yamada K, Haneda S, Furuoka H, *et al*. Minimally invasive proximal interphalangeal joint arthrodesis using a locking compression plate and tissue engineering in horses: A pilot study. Can Vet J. 2014;55(11):1050-6.
59. Singleton WB. The surgical correction of stifle deformities in the dog. J Small Anim Pract. 1969;10(2):59-69.
60. Slocum B, Devine T. Trochlear recession for correction of luxating patella in the dog. J Am Vet Med Assoc. 1984;186(4):365-369.
61. Slocum B, Slocum TD. Tibial plateau leveling osteotomy for repair of cranial cruciate ligament rupture in the canine. Vet Clin North Am Small Anim Pract. 1993;23(4):777-795.
62. Sumner DR, Turner TM, Dawson D, Rosenberg AG, Urban RM, Galante JO. Effect of pegs and screws on bone ingrowth in cementless total knee arthroplasty. Clin Orthop Relat Res. 1994;309:150-155.
63. Thitiyanaporn C, Chantarapanich N, Sompaisarnsilp S, Thengchaisri N. Comparison of canine stifle kinematic analysis after two types of total knee arthroplasty: A cadaveric study. Vet World. 2020;13(5):956-962.
64. Turner TM, Urban RM, Sumner DR, Skipor AK, Galante JO. Bone ingrowth into the tibial component of a canine total condylar knee replacement prosthesis. J Orthop Res. 1989;7(6):893-901.
65. Vasseur PB. Stifle joint. In: Slatter D, Editor. Textbook of small animal surgery. 3rd Ed. Philadelphia: W.B. Saunders; 2003, p. 2090-2133.
66. Vasseur PB, Berry CR. Progression of stifle osteoarthrosis following reconstruction of the cranial cruciate ligament in 21 dogs. J Am Anim Hosp Assoc. 1992;28(2):129-36.
67. EZ-Fraguela VJL, Köstlin R, Reviriego RL, Peris SC, Margallo SFM, Gargallo JU. Semiology of the stifle joint: Orthopaedic pathologies of the stifle joint. Zaragoza: Grupo Asís Biomedia SL; 2017, p. 1-18.
68. Wangdee C, Hazewinkel HA, Temwichitr J, Theyse LF. Extended proximal trochleoplasty for the correction of bidirectional patellar luxation in seven Pomeranian dogs. J Small Anim Pract. 2015;56(2):130-3.
69. Wangdee C, Theyse LF, Techakumphu M, Soontornvipart K, Hazewinkel HA. Evaluation of surgical treatment of medial patellar luxation in Pomeranian dogs. Vet Comp Orthop Traumatol. 2013;26(6):435-9.
70. Yang X, Gao F, Sun W, Li Z. Clinical application and biological functionalization of different surface coatings in artificial joint prosthesis: A comprehensive research review. Coatings. 2022;12(2):117.
71. Zalavras CG, Lieberman JR. Osteonecrosis of the femoral head: Evaluation and treatment. J Am Acad Orthop Surg. 2014;22(7):455-64.
72. Johnson MD, Gillick MS, Fox SM. Musculoskeletal disorders and injuries. In: Clinical medicine of the dog and cat. Boca Raton (FL): CRC Press; 2022, p. 603-646.
73. Montavon PM, Damur DM, Tepic S. Advancement of the tibial tuberosity for the treatment of cranial cruciate deficient canine stifle. Zurich: University of Zurich; 2002.

All Author's Name and Details

Sanjay Kumar Yadav
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Mahesh Kumar
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Kiranjeet Singh
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Aswathy Gopinathan
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Uttam Kumar Sahu
Division of Animal Reproduction, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Piyush Rajput
Division of Animal Reproduction, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Renu Motwani
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Ankush Rana
Division of Parasitology, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Prarthana R
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

Seema Kokde
Division of Surgery, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly, Uttar Pradesh, India

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