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Patellar Luxation in Dogs and Cats: Management and Prevention*

KEY FACTS

- Cranialization of the tibial tuberosity with reduction of retropatellar pressure should reduce pain caused by chondromalacia on the articular surface of the patella.
- Corrective limb realignment procedures should be reserved for treating patellar luxation in large-breed dogs.
- The tarsus should not be covered during surgery to allow full range of motion of the hindlimb during the procedure.

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ABSTRACT: Patellar luxation in dogs with clinical signs of lameness is managed by surgical correction. Treatment consists of a combination of bone reconstruction and soft tissue correction techniques. Bone reconstruction procedures include mainly trochleoplasty and transposition of the tibial tuberosity. Release and imbrication of the joint capsule and fascia, antirotational suture or posterolateral capsulorrhaphy, and transposition of the quadriceps muscle are the main soft tissue reconstruction procedures. The prognosis for animals that receive surgical correction is considered good. Animals with patellar luxation must be excluded from breeding to prevent this condition in future generations.

Patellar luxation can be either medial or lateral and is one of the most common orthopedic diseases of the hindlimb in dogs. The disease is most often congenital and is associated with varying degrees of skeletal deformity in the femur and tibia. An abnormal conformation of the hip joint or pelvis has been suggested as the origin of the disease. Deformities in the distal femur and tibia are thought to be caused by the bowstring effect of atrophic quadriceps muscles and are reversible with early surgical transposition of the tibial tuberosity. The condition is less common in cats. Patellar luxations can be classified into four grades of severity. Diagnosis is based mainly on palpation of the affected stifle and patella. This article reviews the different surgical techniques used to manage patellar luxation and discusses the progress made in preventing the disease.

*A companion article entitled "Patellar Luxation in Dogs and Cats: Pathogenesis and Diagnosis" appeared in the March 2002 (Vol. 24, No. 3) issue of *Compendium*.
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TREATMENT PROCEDURES

Successful treatment of patellar luxation involves selecting the proper combination of surgical techniques to realign the structures participating in the extensor mechanism of the stifle, thereby reestablishing normal joint function. These techniques can be divided into two classes: bone and soft tissue reconstruction. The most important bone reconstruction techniques are trochleoplasty (deepening of an abnormally shallow femoral trochlea) and transposition of the tibial tuberosity. Soft tissue reconstruction techniques include release of retinacular tissues (e.g., desmotomy, capsulectomy), retinaculum and fascia overlap or imbrication, antirotational sutures, and quadriceps release. It should be emphasized that skeletal deformity (e.g., deviation of the tibial tuberosity, shallow femoral trochlea) should be corrected by bone reconstruction techniques. Bone structures are the primary restraining structures of the patella; therefore, attempts to overcome these abnormalities with soft tissue procedures alone will not be successful in the long term. The most frequent cause of treatment failure is neglecting to transpose the tibial tuberosity, and surgeons should be aggressive when selecting surgical techniques for the treatment of patellar luxation.[1]

Bone Reconstruction

Trochleoplasty

Several techniques for trochleoplasty have been described. Trochlear sulcoplasty involves removal of articular cartilage and subchondral bone to create a deeper sulcus.[1] The defect heals with a combination of fibrous scar tissue and fibrocartilage,[2] and the procedure results in good function in small dogs and cats.[1] Other trochleoplasty techniques have been developed to maintain an articular surface of normal hyaline cartilage. In dogs younger than 5 months of age, articular cartilage can be elevated with a periosteal elevator. Trochlear chondroplasty involves elevation of a cartilage flap and removal of the subchondral bone beneath it. Once the sulcus is deep enough, the cartilage flap is pressed back into place.[1,2] In animals older than 5 months of age, cartilage becomes thinner and more adherent to subchondral bone; therefore, elevation of the cartilage is no longer possible. In wedge recession trochleoplasty, a V-shaped wedge that includes the sulcus is removed from the trochlea using a saw. The defect is then widened on the side of the luxation by removing an additional slice of bone. The wedge is finally replaced but lies deeper than it did originally, thus creating a deeper sulcus[3–5]; the supratrochlear entrance to the sulcus can be widened using a bone file. Recently, a technique involving removal of a rectangular block of subchondral bone rather than a V-shaped wedge was described.[6] This technique, known as block recession trochleoplasty, was found in cadavers to increase the depth of the proximal aspect of the sulcus, increase the patellar articular contact with the recessed proximal trochlea, recess a larger percentage of trochlear surface area, and result in greater resistance to patellar luxation with the stifle in an extended position when compared with wedge recession trochleoplasty.[7]

Transposition of the Tibial Tuberosity

The objective of transposition of the tibial tuberosity is to realign the extensor mechanism in the stifle and reposition the patella within the trochlear groove. The technique involves osteotomy of the insertion of the patellar ligament 3 to 4 mm proximal to the ligament using an osteotome, transposition of the bone fragment (laterally in the case of medial patellar luxation and medially in the case of lateral patellar luxation), and fixation using Kirschner wires inserted in a slightly proximal direction.[1,2] There is some disagreement among authors regarding whether the fragment should remain attached distally and which technique should be used for fixation; some authors advocate creating a notch in the bone to aid in fixating the fragment.[1]

More recently, the notion of cranialization was introduced in conjunction with transposition of the tibial tuberosity.[8] This modified technique was based on the observation that with removal of only a small portion of bone at the insertion of the patellar ligament, transposition of the fragment would result in a more caudal position of the insertion of the patellar ligament

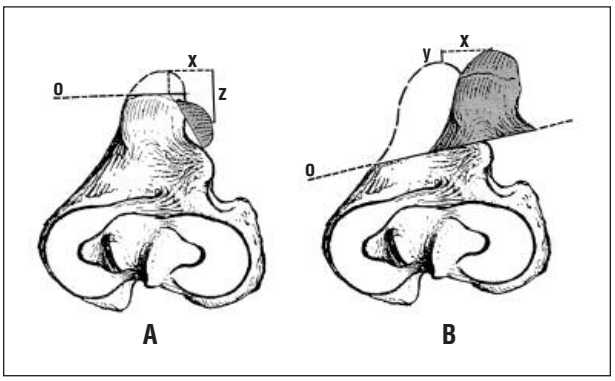

Figure 1—(**A**) Transposition of only the most cranial portion of the tibial tuberosity results in twisting of the patellar ligament as well as caudalization *(z)* of its insertion. (**B**) A more caudal osteotomy *(o)* of the tibial tuberosity allows transposition and cranialization *(y)* without modifying the orientation of the insertion of the patellar ligament. (*x* = lateralization of the tibial tuberosity)

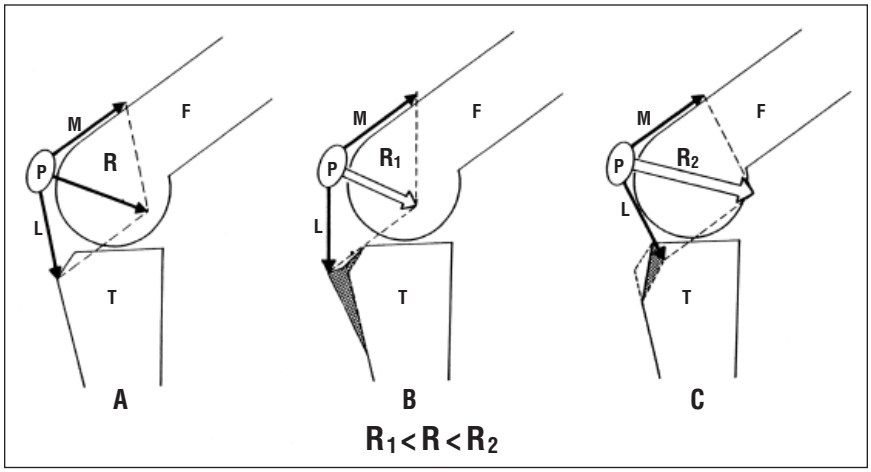

Figure 2—Schematic representation of the stifle joint. The retropatellar pressure *(R, R_1, R_2)* is the result of the traction forces of the patellar ligament *(L)* and the quadriceps muscle *(M)*. Cranialization of the tibial tuberosity (**B**) causes a decrease in retropatellar pressure and caudalization (**C**) causes an increase in retropatellar pressure, compared with the preoperative situation (**A**). (*F* = femur, *P* = patella, *T* = tibia)

(Figure 1A). Caudalization of the insertion of the patellar ligament causes an increase in retropatellar pressure (Figure 2), which is thought to be detrimental, particularly in patients with retropatellar cartilage injury or chondromalacia. Fixation of the insertion of the patellar ligament to the side of the tibia (Figure 1A) causes a rotation of the bone fragment compared with its original position. In human medicine, this condition, known as Wyberg's syndrome, results in partial contact of the patella with the sulcus. Although no evidence suggests that this condition is of clinical significance in dogs, it seems possible that this modification of the ligament's orientation could cause a detrimental change in the biomechanics of the patella. Therefore, a technique was developed to transpose the tibial tuberosity, thereby relocating the insertion of the patellar ligament in a more cranial position (Figure 1B), with the aim of decreasing the pressure of the patella on the femoral trochlea and reducing postoperative pain in patients with chondromalacia. The modification involves a more caudal osteotomy of the tibial tuberosity along an oblique plane, avoiding damage to the medial meniscus and to the tendon of origin of the long digital extensor muscle (Figure 3A). This caudal osteotomy results in a much larger surface of bone, allowing transposition of the fragment by several millimeters without twisting the ligament or increasing retropatellar pressure. Following lateral arthrotomy, the tibial tuberosity is dissected by elevating the origin of the cranial tibial muscle. The retropatellar fat pad is carefully dissected and the medial retinaculum and fascia incised in order to pass a small hobby saw behind the patellar ligament for the osteotomy. The extensor groove is carefully palpated and the cranial edge of the medial meniscus visualized before starting the osteotomy. The osteotomy is extended distally beyond the distal end of the insertion of the patellar ligament (Figure 3B). After transposition, the fragment is fixed using a tension band wiring technique (Figure 4).

A retrospective study of 20 cases in which the cranialization technique was used reported good results (63% of animals were no longer lame at an average 15-month follow-up) and a low rate of complications (one case of implant failure due to inadequate surgical technique).[9] There is, however, no comparative clinical or experimental (analytical in vivo or in vitro) data to confirm the superiority of cranialization over the more traditional transposition of the tibial tuberosity.

Other Techniques

Osteotomy of the femur and tibia has been described for the correction of severe axial or rotational deformity resulting from medial or lateral patellar luxation.[1,2,10,11] In view of the complex sequence of processes leading to

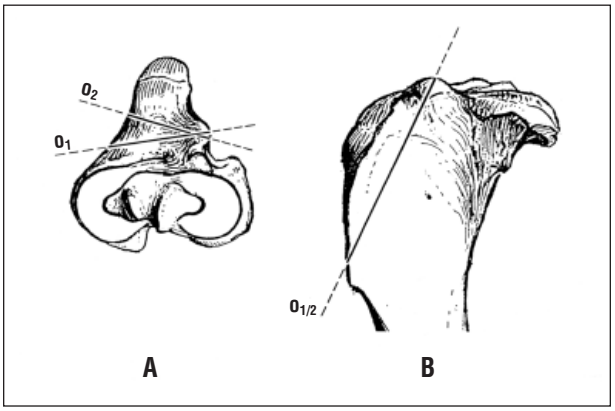

Figure 3—Proximodistal (**A**) and lateromedial (**B**) views of the proximal portion of the tibia indicate the position of the osteotomies for cranialization of the tibial tuberosity. Care should be taken not to damage the cranial border of the medial meniscus or the tendon of origin of the long digital extensor muscle in the extensor groove (sulcus muscularis). (O_1 = plane of osteotomy for a medial patellar luxation, O_2 = plane of osteotomy for a lateral patellar luxation)

Figure 4—Postoperative mediolateral radiographic view of the stifle showing fixation of the tibial tuberosity using tension band wiring after transposition and cranialization.

these deformities, it appears, however, that such osteotomies cannot be recommended for routine management of patellar luxation and should be reserved for very severe cases or large dogs with this condition.

A technique involving removal of the entire patella has been described[1] but should be used only as a salvage procedure on rare occasions when patellar erosion is severe and other procedures have failed.

Soft Tissue Reconstruction

Tension in soft tissues on the side of the patellar luxation can be relieved by performing a release incision into the fascia and, if necessary, into the joint capsule. This technique is often used in conjunction with other soft tissue reconstructive procedures. If such an incision is performed as part of the surgical approach to the stifle joint, the incision is left open to prevent excessive tension of the tissues. If this occurs, the synovial membrane (and not the fibrous capsule) may be sutured to prevent synovial fluid leakage.[1]

On the opposite side of the patellar luxation, different techniques may be used to increase tension in the soft tissue. The joint capsule may be imbricated by removal of an elliptical piece of the capsule and suture of the edges. The lateral and medial fascia (lateral side in patients with medial patellar luxation and medial side in patients with lateral patellar luxation) may be imbricated using a similar technique or by suturing the retinacular incision using an overlapping suture pattern (i.e., the fascia is sutured over the patella and patellar ligament).

In small dogs with medial patellar luxation in which inward rotation of the tibia is very marked or there is concurrent rupture of the cranial cruciate ligament, a posterolateral capsulorrhaphy can be performed. Alternatively, an antirotational suture may be placed around the lateral fabella and through a hole in the tibial tuberosity or through the cerclage wire used to fix the transposed tibial tuberosity. The suture is then passed under the patellar ligament and tied in a figure-of-eight pattern, preventing inward rotation of the tibia and thereby improving alignment of the extensor mechanism in the stifle. The suture also serves as an extracapsular fixation for the unstable stifle joint if the cruciate ligament is ruptured.

Finally, in patients with severe patellar luxation, the quadriceps muscle can be so misaligned that it has to be dissected free from its insertion on the patella on the luxated side to release the displacing tension on the patella.[1,2,12] Transposition of a portion of the stifle extensor muscles proximally at their origin has also been suggested for the treatment of medial patellar luxation. The origin of the rectus femoris muscle may be transposed laterally in patients with bow-legged conformation.[13] The muscle is detached from its attachment on the pelvis, passed through a tunnel in the vastus lateralis muscle, and reattached to the cervical tubercle of the greater trochanter. Alternatively, a transposition of the cranial head of the sartorius muscle has been described.[14]

SELECTION OF THE TREATMENT PLAN

Surgical treatment is recommended in all symptomatic animals as well as in those that are young (1 to 3 months[15]) if it is thought that postponing surgery may aggravate skeletal deformities associated with patellar luxation. The surgical procedure selected for the treatment of patellar luxation depends on the degree of luxation, the animal's age, and physical evaluation of the patella (both preoperative and intraoperative). Patients should be draped for the procedure in such a way as to enable full range of motion in both the stifle and hock. The surgical area

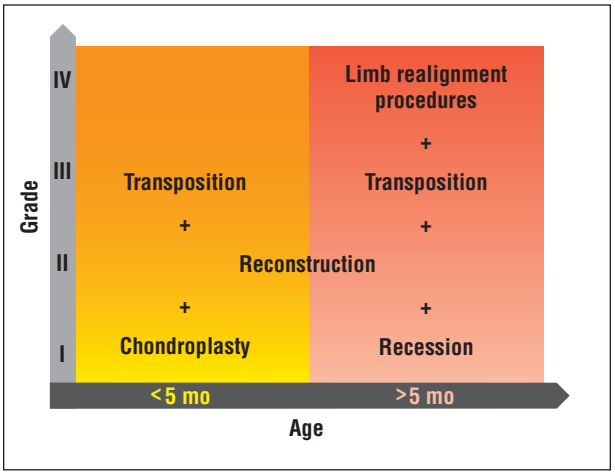

Figure 5—The surgical techniques most likely to be adequate for treatment of patellar luxation as a function of both the patient's age and the degree of luxation.

should be clipped distally to the tarsus, and the sterile tape covering the distal portion of the limb should not cover the tarsus. After transposition of the tibial tuberosity and before joint capsule closure, the limb should be manipulated extensively several times through the whole range of motion (including the hip joint) with both internal and external rotation. The transposition is considered adequate if the patella cannot be displaced by manipulation of the limb alone. Spontaneous luxation of the patella during limb manipulation usually requires further transposition of the tibial tuberosity, but additional soft tissue procedures may also be helpful. Surgical treatment should be initiated early in young animals because an early realignment of the extensor mechanism of the stifle can prevent further skeletal deformities, and surgery should be considered in these patients even if the degree of luxation is low (Figure 5).

Immobilization of the limb is not necessary after surgery. Early active use of the limb is encouraged, but exercise should be limited for the first 3 to 4 weeks. Active physiotherapy in the form of swimming or active flexion–extension is recommended if the dog does not start to bear weight on the limb within 3 weeks after surgery.

PROGNOSIS

Many authors have reported good results following surgical treatment of patellar luxation in dogs[9,16–19] and cats.[20,21] The prognosis can generally be considered good for luxations up to and including grade 3, and treatment outcome for these patients is successful in over 90% of cases.[17] Recurrence of grade 1 patellar luxation is seen in approximately half the patients[16] but does not usually require additional surgery. The size of the dog does not seem to affect prognosis, and good results have also been reported in large-breed dogs.[18] There are little data concerning the prognosis for patients with grade 4 luxations. In these patients, prognosis varies according to the individual patient and with the degree of skeletal deformity. In our experience, these patients may require several surgeries before a satisfactory result is achieved.

Osteoarthritis of the stifle joint progresses significantly after surgery.[9,19] However, in one study no difference was seen in the progression of osteoarthritis between surgically treated and nontreated joints.[19] The severity of osteoarthritis was not associated with the degree of patellar luxation but was positively correlated to the patient's age at surgery.[19] The prognosis for patients with patellar luxation and cranial cruciate ligament rupture is similar to that for patients with cruciate ligament rupture alone and is, therefore, influenced by the degree of osteoarthritis (present before the initiation of treatment) and by the patient's weight.

PREVENTION

Although not as much is known about the hereditary components of patellar luxation as is for other skeletal diseases (e.g., hip dysplasia), there is general acceptance and evidence[22] that patellar luxation is inherited; it is also agreed that affected animals should be excluded from breeding. Kennel and breeding clubs in many countries require that certain breeds receive a preliminary examination for patellar luxation before they can be registered for breeding. Attempts to use radiography or magnetic resonance imaging to objectively separate affected from nonaffected animals have failed to identify parameters that can be consistently associated with patellar luxation.[23,24] Excluding an animal from breeding because of patellar luxation, therefore, must be based on physical examination only. The most commonly used descriptions of the different grades of patellar luxation,[25,26] however, leave considerable room for variation depending on the examiner because the animal's position during the examination and the exact limit between grades are poorly defined. This has led to the definition of a standardized diagnostic procedure for the preliminary examination of patellar luxation (see the box on p. 297).[27] The animals are examined first standing (palpation of the patellae for spontaneous luxations), then in dorsal recumbency to compare the degree of rotational instability in the tibia in both limbs, and finally in lateral recumbency. Light pressure is exerted on the patella and attempts are made to luxate the patella both medially and laterally while combining flexion and

Standard Diagnostic Procedure for the Preliminary Examination of Patellar Luxation[27]

Before examination of the patella is started, the owner should be asked about any history of lameness and the animal's gait briefly examined.

Standing Animal
The standing animal is placed on a table. The examiner stands behind the animal and palpates both patellae simultaneously. This examination enables the classification into lateral versus medial luxation and into grade 2 or better versus grade 3 or worse. If after repeated examination the patella was at least once found to be in a spontaneously luxated position, then the luxation is classified as grade 3. Pain at pressure on the patella indicates retropatellar chondromalacia.

Dorsal Recumbency
The animal is placed on its back on the table, its stifles and hocks are held at a 90° angle, and the tibiae are rotated inward and outward. Any instability or difference between the left and right sides is noted.

Lateral Recumbency
The animal is held in lateral recumbency, allowing the upper hindlimb to be manipulated in full range of motion. With slight pressure, attempts are made to luxate the patella in both directions, rotating the tibia inward and outward and extending and flexing the hip joint. Medial luxation is easiest to cause by extending the hip joint and rotating the tibia inward, whereas lateral luxation is obtained by flexing the hip and rotating the tibia outward. The pressure used to luxate the patella should not be such that it causes any pain. The patella is said to be riding if it cannot be completely luxated. Grade 4 luxations can be challenging to diagnose, particularly if the patella is hypoplastic. By following the patellar ligament proximally, the patella can be palpated in its luxated location.

extension in the hip joint with inward and outward rotation of the tibia. In addition, the following points are clearly defined: 1) the patella must be entirely out of the trochlear groove to be considered luxated; 2) if the patella is found at least once to be spontaneously luxated while the dog is standing, then the luxation is considered grade 3 or worse; and 3) the worst finding is the one that is retained for the final assessment. (That is, even if the patella is stable in most positions but can be luxated by holding the limb in one particular position [e.g., hip in extension and inward rotation], the dog is considered to have a patellar luxation. The result of the worst limb will determine whether the dog should be excluded from breeding.) Therefore, the grading classification of patellar luxation originally described by Putnam[25] was adapted based on these principles (see the box on the *right*).

Classification of Patellar Luxation[27]

Grade 0: The patella cannot be completely luxated, regardless of the limb's position.

Grade 1: The patella can be completely luxated, but when pressure is released without manipulation of the limb the patella regains its original position.

Grade 2: The patella can be completely luxated, but manipulation of the hindlimb causes the patella to regain its original position.

Grade 3: The patella is found (at least once) spontaneously luxated with the animal in a standing position, or it is permanently luxated but can be repositioned manually or by manipulating the limb.

Grade 4: The patella is permanently luxated and cannot be repositioned.

In an effort to increase the efficiency of the breeding selection in miniature breeds based on the preliminary examination for patellar luxation, courses were organized in Switzerland to inform practicing veterinarians about the standardized diagnostic method.[28] These courses involved theoretical information about diagnostic technique and practical exercises using dogs with different degrees of patellar luxation. The findings of nearly 300 veterinarians were compared with reference results (examination by faculty members of the University Veterinary Teaching Hospital, Zurich, Switzerland).[29] When considering the decision to exclude animals with grade 2 patellar luxation or higher from breeding, the participants made the correct decision with 90% accuracy. It can, therefore, be concluded that the implementation of a standardized diagnostic method for the preliminary examination of patellar luxation can lead to a high degree of consistency between examiners, despite the subjectivity of a clinical examination.[29]

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ARTICLE #2 CE TEST

The article you have read qualifies for 1.5 contact hours of Continuing Education Credit from the Auburn University College of Veterinary Medicine. *Choose the best answer* to each of the following questions; then mark your answers on the postage-paid envelope inserted in *Compendium.*

1. In patients with patellar luxation, the most frequent cause for failure of treatment is
   a. omission of soft tissue reconstruction techniques.
   b. wedge loosening in wedge recession trochleoplasty.
   c. failure to transpose the tibial tuberosity.
   d. implant failure after fixation of the tibial tuberosity.
   e. none of the above

2. Elevation of a cartilage flap from the femoral trochlea and removal of subchondral bone is termed
   a. trochlear chondroplasty.
   b. subchondral trochleoplasty.
   c. trochlear sulcoplasty.
   d. recession trochleoplasty.
   e. subchondral sulcoplasty.

3. Wedge recession trochleoplasty
   a. is recommended only in dogs younger than 5 months of age.
   b. involves the removal of a rectangular wedge of bone.
   c. results in a deeper sulcus by removal of a thin slice of bone.
   d. is not recommended because of the risk of loosening of the wedge.
   e. requires the use of an oscillating saw.

4. Cranialization of the tibial tuberosity
   a. leads to increased instability of the patella and, therefore, should be avoided.
   b. reduces retropatellar pressure and pain caused by chondromalacia.
   c. is detrimental to surgical patients because of retropatellar chondromalacia.
   d. is obtained by removing only a small portion of bone at the insertion of the patellar ligament.
   e. involves an oblique osteotomy of the most cranial portion of the tibial tuberosity.

5. Transposition and cranialization of the tibial tuberosity for the treatment of medial patellar luxation involves an oblique osteotomy of the tibial tuberosity. Which important anatomic structures are most at risk of being damaged during the procedure?
   a. medial meniscus and the tendon of the long digital extensor muscle
   b. lateral meniscus and the tendon of the long digital extensor muscle
   c. medial meniscus and the tendon of the popliteus muscle
   d. medial meniscus and the cranial cruciate ligament
   e. tendon of the long digital extensor muscle and the fibular nerve

6. Soft tissue reconstruction techniques
   a. are most often used alone to treat patellar luxation.
   b. include imbrication of the joint capsule and fascia on the side of the luxation.
   c. include transposition of the origin of the rectus femoris muscle for the treatment of lateral patellar luxation.
   d. include a medial capsulorrhaphy in dogs with concurrent cranial cruciate ligament rupture.
   e. include not suturing the joint capsule and fascia on the side of the luxation after arthrotomy.

7. Surgical treatment of patellar luxation should be considered only
   a. in mature patients.
   b. in symptomatic and young animals.
   c. if the luxation is grade 3 or worse.
   d. if there are no signs of osteoarthrosis.
   e. in patients with nonpermanent patellar luxation.

8. Osteoarthritis of the stifle joint
   a. is worse in patients with a higher grade of patellar luxation.
   b. ceases to progress after surgical treatment of the luxation.
   c. is why dogs with grade 3 or 4 patellar luxation have a bad prognosis.
   d. is usually worse in older patients with patellar luxation.
   e. all of the above

9. Medial patellar luxation is easiest to produce with
   a. internal rotation of the tibia and extension of the stifle and hip joints.
   b. internal rotation of the tibia and flexion of the stifle and hip joints.
   c. internal rotation of the tibia, extension of the stifle joint, and flexion of the hip joint.
   d. external rotation of the tibia, extension of the stifle joint, and flexion of the hip joint.
   e. none of the above

10. Selection of healthy breeding animals based on a clinical examination
    a. can be improved by standardizing the evaluation procedure and educating veterinarians on how to use it.
    b. is impossible because of the subjectivity of such an examination.
    c. is inefficient, and selection should be based on radiographic findings.
    d. is recommended and should exclude all animals with grade 3 or 4 patellar luxation.
    e. none of the above