CVM 6100

Veterinary Gross Anatomy

Twelve Small Animal Clinical Practice Problems

by

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SMALL ANIMAL CLINICAL PRACTICE (SACP) PROBLEMS

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This packet contains twelve SMALL ANIMAL CLINICAL PRACTICE (SACP) problems. Each of the problems is anatomical in nature, practice-related, and based on articles in the veterinary literature.

Each week one or two SACP problems will be pertinent to the ongoing dissection. Weekly problems will illustrate and emphasize the clinical importance of the gross anatomy that you are currently studying in the dissection lab. Read through the information that is presented and the questions posed in each case. Think about the anatomy and try to answer the questions. Refer to your cadaver when considering the anatomical details of the cases. Answers are presented at the end of each problem.

Important anatomical terms are in **bold** (some may not yet have been covered in lab, so you may want to review early cases when you eventually encounter the structures mentioned in those cases). Clinical details are provided to help you understand the case; however, you are not required to know the clinical information. References are provided only for those who want more information (students are **not** expected to read the references as an anatomy assignment).

The cases are offered as independent study material intended to reinforce your anatomical knowledge. As such, the cases are optional material. However, because of the significance of the related anatomy, you can expect that one or two questions on each examination will be based on the anatomical information contained in these problems. In such questions you will only be asked about anatomical structures you have studied in the laboratory. You will never be tested on your understanding of the clinical aspects of these cases in this course.

Problem #1

Tissue masses palpable from the skin surface. There are several different kinds of abnormal (tumorous) masses of tissue origin that can be palpated from the skin surface. Lipomas (abnormal aggregates of normal fat cells) occur frequently. They are well circumscribed, fluctuating masses that occur occasionally in the **dermis**, but more commonly in the **subcutaneous tissue** of dogs and cats, particularly in the thoracic and abdominal regions, and upper hind limbs and forelimbs. Lipomas constitute about 10-20% of connective tissue tumors seen in these species. There is a predilection for lipoma formation in spayed female dogs and cats.

The following cases illustrate the importance of learning to recognize normal anatomical structures palpable from the skin surface, but also being aware of unusual anatomical structures which may appear. Items of importance relative to the latter are: 1) consistency; shape; with or without definite borders; movable or fixed; unilateral, or bilaterally symmetrical; color and size; and 2) location relative to other anatomical structures including vessels and nerves.

Case 1. A 6-year-old spayed domestic shorthair queen was scheduled for minor dental work. When presenting the animal, the owner also casually sought information regarding a marble-sized "lump" on the cranial surface in the middle of the right **antebrachium**. It was a circumscribed, freely movable structure, which the owner noted to have developed gradually over the period of a year. Following palpation of the lump, a sample of tissue was obtained by needle biopsy. Under the microscope the biopsy sample was found to consist primarily of **fat droplets**. The clinician diagnosed the lump as a lipoma, and advised the client that the structure was not life threatening, and could easily be removed for cosmetic reasons. This was done following completion of the dental work. Histopathologic evaluation of the mass indicated that it consisted of normal adipose tissue. There have been no signs of recurrence of the skin lesion over a subsequent two-year period.

Case 2. An 11-year-old 14 kg. spayed mixed-breed bitch was presented with a history of a progressive left **forelimb** lameness. A large 2 cm. firm, circumscribed, non-fluctuating mass was present on the caudolateral aspect of the proximal portion of the forelimb. A smaller mass, diagnosed as a lipoma was removed from the same site four years previously at another clinic. Palpation of the mass elicited no pain. Texture of the mass was consistent with fat tissue. When standing the dog would not bear weight on the limb, but only touch its toes to the ground. A tentative diagnosis of lipoma was made.

Surgical excision was carried out under general anesthesia with the dog in right-lateral recumbency. A skin incision was made revealing a large, off-yellow fatty mass. It appeared as an unencapsulated fatty tumor. Because the mass was deeply attached to the underlying muscle fascia, partial resection of the **triceps muscle** was required. Since finger-like projections were present infiltrating into and around the muscle and adjacent structures, only approximately 90% of abnormal tissue could be excised. Microscopic section of the fatty mass revealed masses of normal appearing fat cells with skeletal muscle cells scattered among them. A diagnosis of infiltrative lipoma was made.

The incision was closed, with drainage provided. The dog was 90-100% weight bearing on the first postoperative day, and when discharged on the 10th day, locomotion was near normal.

Later follow-up examination indicated that the dog was doing well, but that there was local recurrence of the condition.

Questions.

1. If you as a practicing veterinarian made a diagnosis of lipoma on a dog, and the owner requested its removal, what layers of tissue would you expect to encounter in the process of removing the fluctuating mass?

2. Which vascular and nervous structures, if any, should you be aware of in making the incision? (See pp. 152-153 of Miller's Guide).

3. Why would a clinician want to obtain a needle biopsy of tissue following palpation of the lump on the antebrachium of a queen, as in case 1?

Answers and comments.

1. Tissues to be incised to remove the lipoma are the **skin components**, namely, epithelium and underlying dense connective tissue of the dermis (also a lower-most layer of cutaneous trunci or other cutaneous muscle in some areas). Skin is usually freely movable in relation to underlying subcutaneous tissue. (Witness the shaking of the skin over the thorax and abdomen of the horse during fly season.) Lipomas usually lie in the **subcutaneous layer** called **superficial fascia**. It is made up of loose areolar connective tissue which may contain a lot of fat. The lipomas (case 1) usually can be peeled manually from this layer.

Beneath the superficial fascia lies a more dense connective tissue called the **deep fascia**. It is more firmly attached to the connective tissue coverings of muscle (epimysium) and bone (periosteum). These anatomical structures will be dealt with later. The infiltrative type of lipoma (case 2) invades these layers (see below).

Note: The infiltrative lipoma (lipomatosis), is an unusual form of lipoma. It has the cellular appearance of a lipoma but without distinct boundaries. Further, it contains remnants of connective tissue or muscle which become entrapped by invading lipocytes (fat cells). Infiltrative lipomas are said to be located more often in the limb extremities and cervical region.

2. There are only small branches of the vessels and nerves in the lateral areas of the thorax and abdomen where most lipomas occur. One possible exception (depending on the breed of dog) might be the **lateral thoracic artery** (see p. 126, Miller's Guide, 4th ed.). In case 1, the mass was in the middle of the **antebrachium**. Here the position of the **cephalic vein and radial nerve** branches would need to be noted before making an incision.

3. Circumscribed, movable lumps in the subcutis are very often lipomas, but could be a mast cell tumor, which is more serious. The microscopic finding of fat globules in needle biopsy material is a rapid, efficient way to make this determination. The owner can then be given treatment options and prognosis.

References.

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3. Strafus AC, Smith JE, Kennedy GA, et al: Lipomas in dogs. J Am An Hosp Assn. 1973;9:555-561.

4. Frazer KS, Herron AJ, Fee JF, et al: Infiltrative lipoma in a canine stifle joint. J Am An Hosp Assn. 1993;29:81-83.

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Problem # 2

Anatomy of the ventral cervical region of the dog related to surgical removal of herniated intervertebral disc. The cervical disc problem is one of several clinical conditions encountered in the cervical region which require a detailed knowledge of the anatomy of this area. Pillow-shaped **intervertebral discs** between **vertebrae** give flexibility to the vertebral column. As will be seen later, the discs consist of a capsule (annulus fibrosis), and a central pliable material (nucleus pulposus) (see Miller's Guide figures 86,87,88). When the central material hardens, it tends to distend the capsule or herniate (pop out) out of the capsule upward into the **spinal canal,** placing pressure on the **spinal cord**. This causes pain and dysfunction.

Older dogs, particularly Dachshunds, Cocker Spaniels, Pekingese, and Beagles have a hereditary predisposition to disc herniation. It can also result from injury. Generally the affected dog holds its head low and its neck muscles are tense due to pain. Paresis (partial paralysis) of the forelimbs or weakness or paralysis of all four limbs (quadriplegia) may result.

Case. The owner reported that his 6-year-old female Dachshund suffered a violent attack of pain while playing about one month prior to admission to the clinic. After that she had not been able to move as usual. She had manifested tender abdominal muscles and kept her neck arched. Although treated with vitamin B 1, she gradually became worse. When admitted, she was thin and apathetic. She was unwilling to lie down and would stand with her back arched and neck stretched. She moved stiffly and seemed to suffer from pain when touched. There was no clear localization of pain. When lying down she would lie flat on her side. On account of pain, no examination of reflexes could be made.

On radiographic examination calcified **intervertebral discs** were observed between the following cervical vertebra: C2-C3, C3-C4, and C4-C5. The condition grew worse in spite of intensive treatment with vitamin B1, rest, and heat. The bitch began to show poor balance and ataxia. Further, extensor paresis (partial paralysis) of the right front leg was evident. Myelography (visualization of the spinal cord by the injection of radiopaque material into the **subarachnoid space** enclosing the spinal cord) showed that there was a complete block of passage of material caudally in the subarachnoid space at intervertebral disc C2-C3 (between cervical vertebra 2 and cervical vertebra 3). The condition was diagnosed as compression of the cervical spinal cord by protrusion of material from the intervertebral disc located between C2-C3. The owner elected surgery.

Under general anesthesia, the dog was placed in dorsal recumbency with her neck extended over a sandbag. A midline skin incision was made from the level of the **larynx** to the **manubrium**. At the level of C2-C3 there are four structures (from superficial to deep) lying directly ventral to the vertebrae: paired **sternohyoideus muscles**, **trachea and esophagus**, and paired **longus colli muscle**s. These structures are retracted laterally to provide access to the intervertebral disc between C2 and C3. A scalpel blade was used to make an elliptical incision (fenestration) through the annulus fibrosus (capsule of the intervertebral disc). The nucleus pulposus (central contents of the intervertebral disc) was removed to relieve pressure on the spinal cord. After completion of the fenestration procedure the retracted muscle and other structures were replaced to their original sites. The subcutaneous connective tissue and skin were sutured.

The day following surgery the dog appeared relieved of pain. She could move her head and neck. After a week, normal movements of the right limb had returned, and the animal could climb into its cage. After four weeks the dog was completely recovered. Six months later the owner reported that the dog still was in "perfect" condition.

Questions.

1. What dense connective tissue surrounds many cervical structures and has to be bluntly separated in order to retract structures and gain access to the lesion in question?

2. What is the **carotid sheath** and what does it enclose?

3. Describe the anatomy and function of the **longus colli muscle**. Do this with the aid of your cadaver.

Answers and comments.

1. The tissue of surgical concern beneath the skin is the **deep fascia**. It surrounds the **brachiocephalicus m.** laterally, the **sternohyoideus and sternothyroideus mm.** ventrally, and also surrounds the **trachea,** and **esophagus**.

2. The **carotid sheath** is also a deep fascia structure. It covers the **common carotid artery**, **vagosympathetic nerve trunk, internal jugular vein**, and the **tracheal lymphatic trunk.** (Note that the **external jugular vein**, located superficially between the **cleidomastoideus and sternooccipitalis muscles** is covered by **superficial fascia**).

3. The **longus colli muscle** is a bilateral structure located ventral to both thoracic and cervical vertebrae. In the cervical region it consists bilaterally of four separate bundles. The two components of each side form a V-shaped pattern with the base of the V pointing toward the head. Each component arises on the ventral border of the transverse process of the third cervical vertebra and inserts on the ventral spine of the preceding vertebra. The muscle functions in drawing the neck downward.

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3. Cechner PE: Ventral cervical fenestration in the dog: a modified technique. J Am An Hosp Assn. 1980;16:647-650.
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Problem #3

Problems relating to the anatomy of the scapulohumeral (shoulder) joint. The shoulder joint is a vulnerable area in several domestic species, particularly the dog and horse. Arthrotomy (cutting into a joint) of the scapulohumeral joint is a frequent surgical procedure in the dog. Indications include fractures, luxations (dislocations), and chronic osteochondritis (also osteochondrosis) dissecans (OCD). (Dissecans refers to joint articular cartilage separation from the underlying bone.) Surgical approaches vary, depending upon the condition encountered. Thus it is important to be thoroughly familiar with the anatomy of this area. The muscular and skeletal systems will be considered primarily here. Nerves and blood vessels will be emphasized when this area is revisited later.

Case l. A 4 yr.old Irish Setter was presented with a 2 yr. history of lameness. By radiography a tentative diagnosis of chronic osteochondritis dissecans was made. Free bodies were observed in the medial compartment of the joint.

Under general anesthesia and with the dog in dorsal recumbency, the limb was secured close to the body with the **scapulohumeral joint** flexed. An incision was made **craniomedially** from the middle of the scapula to the middle of the humerus (arrow). The **cleidobrachialis muscle** was retracted laterally exposing the aponeurotic attachment of the superficial pectoral muscle on the proximal humerus. The **superficial pectoral muscle** was incised 3-5 mm from its aponeurotic insertion and retracted medially, exposing the **joint capsule**. A 1-2 cm incision of the capsule was made **dorsomedially** between the **deep pectoral and supraspinatus muscles**. The **subscapularis and deep pectoral muscles** were retracted medially and the supraspinatus muscle retracted laterally as the joint was opened. Loose cartilage and free bodies were removed, the joint lavaged and the fibrous joint capsule sutured. The superficial pectoral muscle was restored to its normal anatomic position and sutured. The surgical site was closed in routine manner. Recovery was uneventful.

The free bodies observed radiographically were bony in nature. They probably developed from detached cartilage fragments nourished by synovial fluid. They were too large to pass from the medial to the lateral or caudal portions of the joint cavity, where they would have been accessible only through a lateral surgical approach.

Case 2. A 5 yr.-old Great Dane bitch was presented with a 1 yr. history of progressive non-weight-bearing lameness in the right forelimb which appeared to center on the shoulder joint. Radiographs indicated the presence of free cartilage bodies in the medial aspect of the joint cavity. A diagnosis of chronic osteochondritis dissecans was made.

Under general anesthesia the dog was placed in lateral recumbency with the affected limb up. A skin incision was made commencing at the midpoint of the **caudal aspect** of the **scapula**. It was extended parallel to the **spine of the scapula** along the caudal border of the scapular head of the **deltoid muscle** to the caudal border of the proximal **humerus**. Dissection was continued in a cranial direction between the scapular head of the deltoid muscle and the **lateral head of the triceps brachii muscle** just distal to the **axillary nerve** and **caudal circumflex artery and vein**. The vessels and nerve were reflected dorsally. This exposed the **teres minor and infraspinatus muscles**. Further dissection under the teres minor muscle exposed the caudal joint capsule.

The joint capsule was incised in a cranial to caudal direction, exposing the **humeral head and the glenoid cavity of the scapula**. Adduction of the distal limb with alternating internal and external rotation of the humerus exposed the caudal aspect of the humeral head. A forceps was inserted into the medial joint compartment and several pieces of loose cartilage were removed. The fibrous joint capsule was closed. Superficial fascia of the deltoideus muscle was sutured to the fascia of the triceps brachii muscle. The subcutaneous tissue and skin were closed in routine fashion.

The dog was partially weight bearing the day following surgery. When seen for suture removal two weeks postoperatively it was normal at the walk.

Case 3. A 6-month-old female dog of mixed breed weighing 16 lb. was examined shortly after being hit by a car. It would not bear weight on the forelimb, and there was marked swelling and evidence of pain in the scapulohumeral area. Cranial dislocation of the **head of the humerus** and fracture of the **lesser tubercle of the humerus** were seen on radiographs. The tentative diagnosis was dislocation of the humeral head.

The dog was placed under general anesthesia, and open reduction of the **scapulohumeral joint** carried out. A **craniomedial** incision was made from the **acromion** distal to the mid-humeral area. Tissue overlying the cranial aspect of the **greater tubercle** and proximal end of the **humerus** were incised, and the cranial portion of the **deltoideus muscle** was reflected laterally. The anterior portion of the insertion of the **deep pectoral muscle** was severed to expose the area, and the dislocation was reduced.

To prevent recurrent anterior dislocation of the shoulder joint, it was elected to reposition the tendon of the **biceps brachialis muscle**. For this purpose the **intertubercular ligament** was incised, and the **tendon of the biceps brachii muscle**, which was intact, was exposed. The greater tubercle was cut obliquely in order to maintain the integrity of the humeral head and the insertion of the **infraspinatus and supraspinatus muscles**. The joint was exposed by reflecting the cut tubercle proximally and incising the **joint capsule** approximately 1 cm. medially and laterally from the osteotomy (cutting a bone) site. A narrow osteotome (bone cutter) was used to create a trough in the cut surface of the humerus, and the biceps tendon was placed in this groove. In this position the tendon effectively eliminated any tendency of the humerus to luxate. The greater tubercle was replaced over the tendon and fixed with 2 nails. The fractured **lesser tubercle**, with the insertion of the **tendon of the subscapularis muscle** attached was fixed with a nail. The surgical field was thoroughly flushed with physiological saline and routine closure was carried out.

The scapulohumeral joint was stable and had a full range of motion immediately after closure. The limb was bound in flexion, with the joint at rest, for 9 days. At 14 weeks postoperatively lameness was absent and the dog was normal in every respect.

Questions.

1. What is the extent of movement of the shoulder joint? What type of joint is it?
2. What structures support the shoulder joint?
3. What is the extent of the shoulder joint cavity?

Answers and comments.

1. The shoulder, a **ball-and-socket type joint**, is capable of movement in any direction, but chiefly those of flexion and extension.

2. The shoulder joint is supported by the following:

a. Y-shaped medial and a rectangular-shaped lateral **glenohumeral ligament**, both of which are thickenings of the fibrous layer of the joint capsule. They are said to provide substantial support to the shoulder (See ref. 4). The joint capsule does not provide strong joint support.

b. Surrounding muscles (and their tendons), principally the four "cuff muscles", namely, **teres minor, infraspinatus, supraspinatus, and subscapularis**. Additionally, at least five other muscles provide support, namely, **biceps brachii, long head of the triceps brachii, coracobrachialis, deltoideus**, and to a lesser extent, **teres major** (See ref. 5).

3. The shoulder joint cavity has a lateral, a medial, and a caudal ("cul-de-sac") area; and an approximately 2 cm distal extension around the tendon of origin of the biceps brachii in the **intertubercular groove**.

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Problem #4

Anatomy of the stifle (femorotibial) joint related to tissue replacement of a ruptured cranial cruciate ligament in the dog.

The **cranial cruciate ligament** originates on the caudomedial aspect of the **lateral femoral condyle.** It extends distocranially and inserts cranially on the tibial plateau caudal to the cranial intermeniscal ligament. The cranial cruciate ligament is named for its **tibial** attachment.

Cruciate injuries are the most common lesion diagnosed in the femorotibial joint of the dog, with the cranial cruciate ligament being the most frequently involved. Other examples are luxation and fracture of the patella. The literature records several techniques for replacing ruptured cranial cruciate ligaments using a variety of nearby tissues as well as synthetic materials. Methods which avoid as well as those which invade the joint capsule are used in replacing the damaged cruciate ligaments. It is thus important to be very familiar not only with the anatomy of this joint, but also the structures immediately surrounding it.

One case, and two brief examples are presented. They illustrate use of alterative nearby anatomical replacement tissues for a ruptured cranial cruciate ligament.

Case 1. An 8-year-old Australian Shepherd weighing 26 kg was admitted to the clinic with a history of having tumbled down icy porch steps the previous day. When presented the animal was lame on the left hind limb. Examination under sedation disclosed that there was a 4 mm cranial subluxation of the tibia (cranial drawer sign) when the flexed crus was pulled cranially. Radiographic examination disclosed that there were no fractures. A diagnosis of cranial cruciate ligament rupture was made. The owner requested surgical relief for the patient.

It was decided to use the **popliteal tendon** as a replacement tissue for the cranial cruciate ligament. This is an extra-articular technique, which avoids the placement of foreign or autogenous material in the joint.

The dog was placed in dorsal recumbency, and under general anesthesia an incision was made through the left lateral parapatellar joint capsule. A ruptured cranial cruciate ligament was found, excised, and the incision closed.

The lateral fascia was separated from the joint capsule and retracted to expose the lateral collateral ligament and the caudal part of the **femorotibial joint** capsule. The **common peroneal nerve** was identified in order to protect it during surgery. The **gastrocnemius muscl**e was retracted caudally to expose the musculotendinous junction of the **popliteal muscle**. The tendon of the popliteus muscle was bluntly dissected and isolated from the overlying collateral ligament. The popliteal tendon was then transected so as to include its **sesamoid bone** in the replacement tissue. The popliteal tendon was then freed to its origin on the **femoral condyle**. The proximal part of the cranial tibial muscle was elevated to expose the tibial tuberosity cranial to the tendon of the **long digital extensor muscle**. A suture was placed on the distal part of the popliteal tendon (distal to the sesamoid bone). A tunnel was drilled through the **tibial tuberosity**, and the suture and end of the popliteal tendon pulled through it. The sesamoid bone was also pulled partly into the tunnel. With the tibia in external rotation and the stifle slightly flexed, the suture was secured through a button on the medial side of the tibial tuberosity. The suture was tightened until the drawer motion was completely eliminated. The fascia, subcutaneous tissue and skin were closed in routine fashion.

Postoperatively the limb was placed in a soft, padded bandage for 2 weeks, and the animal's activity restricted for 4 weeks. The owner was instructed to carry the animal up and down stairs. Recovery was uneventful.

Example 1. The use of fascial replacement. The standard lateral parapatellar approach (para- Gk., alongside of or near) to the femorotibial joint was used. A section of **fascia lata** 1-2 cm wide was separated from the cranial edge of the **biceps femoris muscle** and freed proximally from the upper one third of the **quadriceps muscle** to the **femorotibial joint**. The lateral one-third of the **patellar ligament** was included in the graft by dissection from the patella. The graft was dissected free of the joint capsule down to the tibial insertion. This fascial graft was drawn into the joint capsule under the intermeniscal ligament. It was then brought caudally between the femoral condyles, over the top of the lateral condyle, and sutured to the soft tissue of the **lateral femoral condyle**.

Example 2. Use of the long digital extensor tendon for correction of cranial cruciate ligament rupture. The **stifle joint** was exposed through a lateral parapatellar incision. The tendon of the **long digital extensor muscle** was isolated after subperiosteal elevation of the **cranial tibial muscle** from the sulcus muscularis. A trough was cut in the tibial crest, and the long digital extensor tendon was transplanted into it and fixed in place with heavy wire sutures. In this position the tendon functions also as a ligament between the femur and the tibia, and its direction is almost parallel to that of the normal cranial cruciate ligament.

Questions.

1. What is the function of the cranial cruciate ligament?

2. Would the loss of the function of the popliteus muscle severely restrict the use of the leg of a dog?

3. What is the composition of the fascia overlying the stifle joint and how does it relate to the patellar ligament?

4 Would the use of the long digital extensor tendon as a replacement of a ruptured cranial cruciate ligament have any effect on its usual function?

Answers and comments.

1. The cranial cruciate ligament constrains stifle joint movement by preventing: 1) cranial subluxation of the tibia on the femur (cranial drawer sign); 2) hyperextension of the stifle joint; and 3) along with the caudal cruciate ligament, excessive internal rotation of the tibia on the femur.

2. The popliteus muscle will atrophy after the tendon is severed (from lack of use). The popliteus does aid in flexion of the stifle joint, and inward rotation of the leg. Diminution of these functions probably would not be noticed, unless the animal was used in some form of competitive (athletic) activity.

3. The fascia overlying the stifle joint is a part of the aponeurosis of the tensor fascia lata muscle. It is thick (double-layered), and intimately united with the patellar ligament.

4. There is no reported evidence of a loss of limb function that might be attributable to the use of the long digital extensor tendon as a substitute for the cranial cruciate ligament.

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Problem #5

The anatomy of the hip in relation to dysplasia and dislocation. Traumatic dislocation of the hip and hip dysplasia are problems encountered frequently in small animal medicine. Knowledge of the anatomy of the hip region including skeletal and supportive tissues is therefore important.

In **traumatic dislocations** of the **hip joint** there is usually a normal **femoral head** and **acetabulum**. The case presented illustrates the anatomical structures involved in relieving the dislocation and stabilizing the joint.

Case l. A 5 yr-old Pomeranian female was presented with a dislocated right **coxofemoral joint** that occurred as the result of being hit by a car two days previously. Surgical intervention was advised. Under anesthesia and with the dog in lateral recumbency the skin was incised on the craniolateral surface of the thigh, extending from the **greater trochanter** to the middle of the **femur**. The **fascia lata** was sectioned along the cranial border of the **biceps femoris**, and the incision was continued parallel to the **superficial gluteal muscle**. The joint capsule was exposed by blunt dissection. The **femoral artery, vein, and nerve** lying cranial to the joint were identified. The **femoral head** was repositioned and the joint capsule sutured to retain the femoral head in normal position. Ventral to the **acetabulum** the **iliopsoas muscle** was retracted ventrocranially to expose the insertion of the **psoas minor tendon** on the **iliopubic eminence**. Final stabilization of the joint was accomplished by passing two heavy strand suture loops under the **psoas minor tendon** and under the **greater trochanter** to anchor in the **tendon of the gluteus medius muscle**. While rotating the joint inwardly the first loop was tied and the joint tested. (If excess joint laxity is present, correction can be made by tying the second loop). The **fascia lat**a was sutured to the **biceps femoris muscle**, and the subcutaneous fascia and skin were sutured. Lameness disappeared four days following the surgery and recovery was uneventful.

In **hip dysplasia**, the acetabulum is shallow and lacks sufficient dorsal rim to cover the femoral head. When the femur is loaded axially, medially directed muscular forces are unable to prevent dorsal subluxation of the femoral head. The femoral head then protrudes laterally from the acetabulum. This results in variable loss of leg movements due to pain, and usually leads to degenerative arthritis. Hip dysplasia is found commonly in dogs, less so in cats.

Pelvic osteotomy (cutting a bone) in the treatment of canine hip dysplasia was pioneered by one of our graduates (Dr. Bruce Hohn, see ref. 1). Over the years the original approach and those of others have been modified. (See Wallace and Olmstead ref. 4). Generally speaking, the procedure now involves cutting three pelvic bones to create a free acetabular segment which then can be axially rotated and stabilized over the femoral head to increase hip joint stability.

Case 2. The following is a brief summary of the anatomy involved in five canine cases where a triple osteotomy was performed (See ref. 2). It involved cutting and axial rotation of the pelvic bones to produce a freed acetabular segment. The acetabulum then could be repositioned ventrolaterally to afford an increased lateral extension of the acetabular roof.

Under general anesthesia a skin incision was made from the **ilial crest** to the middle of the femur. The **biceps femoris muscle** was retracted caudally. The **tendon of the superficial gluteal muscle** was transected and the muscle reflected dorsally. The **tendon of the internal obturator muscle** was retracted caudally to expose the **gemelli muscles**, which were bluntly separated to expose the **ischium**. The osteotomy was then carried out. (Remember that the **wing of the ilium** is fused to the **sacrum**). The triple pelvic osteotomy involved 1) a cut through the **pubic bone** at a point midway between the **iliopubic eminence** and the **pubic tubercle**; 2) a cut through the **ischium** from the **obturator foramen** to a point medial to the **ischial tuberosity**; and 3) a transverse cut through the **body of the ilium**.

The freed segment of the pelvis, which contains the acetabulum, was then rotated so the dorsal border was shifted approximately 45 degrees laterally. This extended the acetabular roof over the femoral head and thus served to prevent future subluxation. The rotated ilial osteotomy area was stabilized with metallic bendable or prefixed-angle osteotomy plates. The ischial osteotomy was stabilized with wire. The pubic osteotomy was automatically stabilized by the other two. Muscles, fascia, and skin were sutured routinely.

Post operatively a sling was used to prevent weight bearing and to maintain the hip in abduction and internal rotation for 7 to 10 days. Controlled exercise was encouraged 2 weeks following surgery. In 2 to 9 months all five hip joints were stable according to clinical and radiologic evaluation. Each owner was happy with their dog's performance.

Case 3. Pectineus tenectomy (tendon excision) in the cat. An eight-month-old Siamese cat weighing 5.9 kg was presented at the clinic with a history of intermittent bilateral leg lameness for two months prior to admission. There was no other history of illness. The cat had a poor appetite and was reluctant to move about the house. During examination pain was evidenced upon moderate abduction of the **femurs**, extension of the **coxofemoral articulation**, or when moderate digital pressure was applied dorsally to each coxofemoral articulation. No other abnormalities were found on examination of either pelvic limb distal to the coxofemoral articulation. Radiographs of the pelvis revealed the acetabuli to be normal when compared to those of other Siamese cats. However, the left **femoral head** was slightly subluxated from the acetabulum, and showed moderate osseous proliferation on the cranial-dorsal lip. A diagnosis of left hip dysplasia was made. It was decided to attempt to restore joint stability by means of tenectomy of the **pectineus muscle**.

Under general anesthesia a 4 cm incision was made from the proximal caudal femoral artery distal over the pectineus tendon. The **sartorius muscle** and **femoral artery and vein** were retracted cranially. The **pectineus muscle** was isolated by blunt dissection. The tendon was transected between two forceps, thereby removing a 1 cm section. The pectineus muscle was gently pushed further proximally on the leg. The subcutaneous fascia and skin were sutured.

The day following surgery the cat was sent home. On the second day post operatively the owner reported that it was walking and running in the house without signs of lameness, and that its appetite had improved to normal. One year later it was doing well with no signs of discomfort or lameness.

Questions.

1. Where does the **gluteus medius muscle** insert?

2. Which prominent pelvic region nerve might be damaged during the surgical process?

3. On a skeleton, locate the sites listed above (case 2) where the pelvis was cut during surgical repair of the hip. In which direction is the freed segment of the acetabulum rotated?

4. What is the origin and insertion of the pectineus muscle? Why might the pectineus muscle be a primary consideration in treating hip dysplasia in the cat.

Answers and comments.

1. The gluteus medius muscle inserts on the **greater trochanter of the femur**.

2. The **sciatic nerve** especially (See ref. 7), but also the **obturator and caudal gluteal nerves** and pelvic wall blood vessels may be damaged if great care is not taken.

3. The freed segment of the pelvis was rotated so as to shift the dorsal border of the acetabulum laterally.

4. The pectineus muscle originates on the **body of the pubis** from the **iliopubic eminence to the pubic tubercle**. It inserts distally on the **caudomedial surface of the femur**. Resection of its tendon or removal of the pectineus muscle would allow increased abduction of the femur and would be expected to lessen the upward tension on the joint capsule. The muscle is small enough to be expendable as a participant in the adductor function.

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Problem #6

Anatomy of the lumbar region as related to intervertebral disk problems. Herniation of the intervertebral disk into the vertebral canal, with resultant compression of the spinal cord, is very common in dogs. Dachshund, Poodle, and Pekingese breeds, especially, are prone to this condition. Symptoms of intervertebral disk herniation vary from hypersensitivity of the sensory nerve endings of the skin to paralysis caudal to the site of the lesion. Hemilaminectomy (removal of a portion of a vertebral lamina) and disk fenestration (making an opening in the annulus fibrosus of an intervertebral disk) are surgical procedures used to relieve pressure on the spinal cord caused by disk herniation.

Over the years a variety of hemilaminectomy and fenestration approaches have been described to relieve pressure on the spinal cord. Successful surgery requires not only excellent surgical technique, but also an intimate knowledge of the structure of vertebrae, the associated nerves, blood vessels, and surrounding musculature. The following are two generalized case presentations using different published approaches to illustrate the anatomy involved in treating this condition.

Case 1: Anatomy involved in hemilaminectomy. A Dachshund was presented with a history of bilateral caudal limb paralysis which began several days previous. Results of radiological examination indicated that there was a herniation of the **intervertebral disk** between L3 and L4. Surgery was advised. Under general anesthesia the dog positioned in sternal recumbency and support placed under the abdomen to maintain the normal curvature of the thoracolumbar vertebral column. A skin incision was made directly over the **dorsal spinal processes** from T9 to the L7. Following blunt dissection of subcutaneous tissue the **thoracolumbar fascia** was incised close to the dorsal spines to avoid cutting the underlying musculature. Retraction of the muscles to expose the dorsolateral surface of the vertebrae was done in a three-step method to separate tendons of insertion of the **epaxial muscles** from the 1) dorsal spines; 2) **cranial and caudal articular processes**; and 3) the accessory processes. This included removal of the insertions of 1) the **multifidus muscle** (**transversospinalis system**) from the dorsal spines; 2) the **longissimus lumborum muscle** from articular processes; and 3) **iliocostalis lumborum muscle** from the lateral processes. The removal of muscle from the accessory processes was done carefully to avoid damage to the spinal nerves and vessels emerging from the **intervertebral foramina.**

The **caudal articular process** of L3, and enough of the **vertebral lamina** were removed to visualize the herniated **intervertebral disk**. The herniated material was removed from the **vertebral canal** to relieve pressure on the **spinal cord**.

The retracted musculature was replaced in close apposition to the vertebrae. The **thoracolumbar fascia** was pulled over theusculature and sutured to the dorsal midline. Subcutaneous tissue and skin were closed by routine procedures.

Case 2: Anatomy involved in fenestration. A Poodle was presented with a two-day history of acute pain over the lumbar region and refusal to walk. Results of radiological examination indicated that herniation of an **intervertebral disk** between L4 and L5 had occurred. Surgery was advised to relieve the condition.

After induction of general anesthesia the dog was positioned in ventral recumbency, with support under the abdomen to maintain normal curvature of the thoracolumbar vertebral column. A dorsal skin incision was made from the level of T10 and toward the ventral border of the **wing of the ilium**. The **thoracolumbar fascia** was incised paralleling the skin incision. The fat lying on top of the combined **longissimus lumborum and ilocostalis lumborum muscles** was separated longitudinally, bringing into view the slanting fibers of the **iliocostalis muscle.** By palpating deep in the muscles with a forceps, the **transverse vertebral processes** were discerned. A curved forceps was forced through the **iliocostalis muscle** just dorsal to the tip of the **transverse process** and the jaws opened. The index finger was inserted into the opening to elevate the muscle off the transverse process and expand the hole laterally. Care was taken to avoid blood vessels that run just cranial and caudal to the tip of the transverse processes. A retractor was inserted in the hole to retract the musculature dorsally.

The **intervertebral disk,** located immediately cranial to the level of the transverse process, was observed to be covered by loose fascia containing a blood vessel and the spinal nerve. These structures were carefully retracted cranially from the edge of the disk to avoid injury. The lateral surface of the **annulus fibrosus** was identified by visualizing its white fibrous sheath and by testing resiliency with a blunt instrument. The fascia, spinal nerve and blood vessel were held cranially and protected while a window was cut in the white annulus fibrosus, beginning at the point where the transverse process joins the body of the vertebra. A rectangular window was completed and removed. The **nucleus pulposus** was removed by curettage (scooping out). A chiropractic bending of the spine was then used to loosen any disk material not previously removed.

Closure of the incision consisted of replacing the muscles, and suturing the thoracolumbar fascia and skin.

Questions.

1. Why might it be important to determine the number of vertebrae ina given area when preparing for a surgical approach?

2. Name the two parts of a vertebral arch.

3. How are **spinal nerves** related anatomically to intervertebral disks?

3. Which of the three listed lumbar vertebral processes, (cranial articular process; caudal articular process; accessory process) covers the dorsal aspect of the intervertebral foramen?

Answers.

1. The number of vertebrae in dogs is usually quite constant. However, numerical variations do occur in the caudal vertebrae and rarely in the lumbar vertebrae.

2. The walls of the vertebral arch are the pedicles; the roof is the lamina. Note the term laminectomy.

3. A spinal nerve exits from the vertebral canal through an intervertebral foramen that is located immediately dorsal to the intervertebral disk.

4. The accessory vertebral process covers the dorsal aspect of the intervertebral foramen.

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Problem #7

Anatomy of cutaneous vasculature as related to autologus skin grafts. Vascularized skin flaps are used in the cat and dog for repair of major skin defects due to traumatic injury, burns, or tumor removal. These grafts can present challenging reconstruction problems. For example, non-replacement or improper skin replacement in the facial region in the cat can result in loss of eyelid function, and distortion of adjacent structures. Also, sizeable skin wounds become infected and will not heal without a viable skin covering.

Proper healing requires that the replacement skin remain attached to a vascular supply. Thus it is important to understand the distribution of cutaneous blood vessels. Numerous superficial arteries are available for autologous (animal's own) skin grafts (see illustration). Eligible donor skin sites are those where there is sufficient skin slack to allow suturing of the wound produced. This presentation illustrates some appropriate anatomical donor sites and some of the methods used.

An **axial pattern flap** is a pedicle graft whose **pedicle (stalk)** incorporates a direct cutaneous artery and vein. A **conduit flap** is not a true axial pattern type because its main blood supply is cut off and its nutrient supply is based on reverse blood flow from collateral circulation. A vascularized **"free flap"** is one where the vessels of the donor skin flap are anastomosed to those vessels at the recipient wound site.

Case 1. Use of the **axial pattern flap** method (see top figure). A two-year-old male Siamese had a bite wound abscess that resulted in a 4.5 x 5 cm full-thickness defect on the dorsum of the head. In order to select a feasible vascularized donor skin patch, the vascular distribution pattern of the blood supply to the pedicle of the graft to be selected was determined. A caudal auricular skin patch area was identified that extended far enough caudally to include the **caudal auricular artery** and also a **distant cranial branch of the superficial cervical artery.** This caudal auricular vascularized skin patch, 4.5-cm wide x 9 cm long, was excised with blood vessels intact and rotated 180 degrees onto the wound site and into position and sutured to close the defect. The patch healed without complication and hair regrowth was evident 2 months after surgery.

Case 2. Use of the **conduit flap** method. An 8 year-old female domestic short-haired cat was presented with a wound over the **metatarsal bones** that resulted from a fan belt injury. It extended from 2.5 cm distal to the point of the hock to the phalanges.

Surgical repair involved development of a paper template of the wound site. This was used to select a proper-sized, vascularized donor skin flap with a conduit stalk on the medial thigh (see bottom figure). The conduit provided the tissue flap a "lifeline" containing its vascular supply. At the proximal aspect of the flap the **medial saphenous artery and vein** and **medial genicular artery and vein** were ligated, and the **saphenous vein** transected. The **peroneal artery and vein** and the **medial saphenous vein**, located in the conduit part of the flap were left intact as sources of reverse blood circulation. The blood supply to the graft thus depended on reverse and collateral circulation. The skin flap was rotated 180 degrees onto the **metatarsus** and sutured onto the wound site. The edges of the stalk (conduit) part of the graft containing the cranial branch of the **medial saphenous artery and vein**, the **peroneal artery and vein** and the caudal branch of the **saphenous artery and vein** were sutured together. The stalk now formed a tube-like bridging conduit between the donor and graft sites. That is, the conduit tube bridged an area of intact skin between the source of the flap and the site of the graft.

Complete healing was evident after 21 days. Six weeks after the operation, new vascularization of the donated skin was sufficiently established so that the vascular conduit could be excised.

Case 3. Use of vascular anastomosis in the transfer of a vascularized cervical cutaneous **free flap** to the **metacarpus**. A 3-yr-old female mixed-breed dog was presented with a skin defect on the right dorsal metacarpus. It resulted from a large skin slough that occurred following repair of fractured **metacarpal bones**. It was decided that the wound was a poor candidate for conventional reconstructive procedures (skin grafts or pedicle flaps).

Preoperative angiography indicated that there was a blood supply to the antebrachium from the **median, radial, interosseous, and ulnar arteries.** It was concluded that one of these arteries and its **venous partner** could be used to supply a transferred vascularized free skin flap without jeopardizing the blood supply to other parts of the **antebrachium**. A vascularized **superficial cervical skin** pedicle was used as donor tissue. The donor pedicle, including the terminal branches of the s**uperficial cervical artery and vein,** was excised and transferred to the wound site in the antebrachium and sutured in place. With the use of a microscope, microvascular end-to-end anastomosis was performed between the **superficial cervical artery and the ulnar artery, and their respective veins**.

Examination two weeks following surgery indicated that 100% of the skin flap was viable, and that the donor site was healed. The skin sutures were removed. The limb was placed in a splint to immobilize the metacarpal fractures.

Questions.

1. From which parent vessels do the caudal auricular and superficial cervical arteries arise in the cat and dog?

2. Assuming that a replacement skin graft healed properly, what undesirable cosmetic effects would still be present, especially in a facial skin graft? In this respect, what advantage, if any, would a free flap method of replacement provide?

3. Why is necrosis (death) of tissue surrounding the site of the patch removal not likely to be a problem?

Answers.

1. The caudal auricular artery arises from the external carotid artery. The superficial cervical artery arises from the subclavian artery.

2. Since axial pattern flaps used in replacement are rotated often up to 180 degrees, hair growth will be in a different direction to that of the surrounding skin. Also, color patterns may differ between the replacement site and the origin of the cutaneous patch. The use of a free flap replacement might offer the option of matching hair direction and color. Also, note that the nerves to the flap have been severed.

3. After removal of the major blood supply to an area, blood can be supplied by collateral circulation from nearby arteries.

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Problem #8

Acute gastric dilatation (AGD), torsion and volvulus, and splenic torsion in dogs. It is estimated that 40,000-60,000 dogs in the United States are affected with gastric dilatation-volvulus (GDV) each year with a mortality rate of up to 33%. (See Vet Surg 1996;25:127-133). Volvulus (L. to roll) is a twisting of the intestine causing an obstruction. Torsion (L. torsio, to twist) is a twisting or rotation of a part upon its long axis.

Gastric dilatation can lead to torsion (twisting) and eventual volvulus (obstruction). Splenic displacement and torsion can occur in conjunction with these gastric changes, or alone. These conditions, particularly when both spleen and stomach are involved are among the more perplexing disease entities faced by the dog fancier. Gastric distention and its sequelae occur more frequently in the large, deep chested breeds than in others. The cause(s) is/are unknown, but some believe these conditions may be brought on by the ingestion of a large meal with water, followed by post-prandial exercise or excitement. The conditions can be fatal if diagnosis and intervention, usually involving surgery, do not occur promptly.

Involvement of both **stomach** and **spleen** is believed to begin with gastric distention, and lead to torsion where the stomach rotates on its long axis. Further distention results in a twisting, causing both cardiac and pyloric openings to become occluded. This would be the condition of volvulus. Gastric torsion can result in splenic displacement and splenic torsion at its vascular pedicle. Congestive splenomegaly (splenic enlargement) occurs due to occlusion of its venous return. If the gastric distention and partial torsion subside, splenic displacement and torsion may continue and be accentuated by animal movements. (e.g., rolling, retching). Persisting splenic torsion can lead to thrombosis of the splenic vein and splenic infarction (areas of necrosis due to lack of blood supply).

The conditions described briefly above serve to indicate the importance of being well acquainted with structure, position, attachments, and vasculature, as related to stomach and spleen and the surrounding organs, particularly the pancreas.

The following two cases are presented to illustrate the possible sequential relationship of gastric and splenic torsions.

Case 1. A 9 year-old Great Dane was admitted with history of episodes of acute collapse. Physical examination findings included 5% dehydration, weakness, inability to stand, and mild abdominal distention. Abdominal radiography revealed generalized loss of abdominal detail, consistent with free abdominal fluid, cranial displacement of the **stomach**, and a mass with mottled radiolucency in the cranial left quadrant, which was suspected to be the **spleen**.

Surgery revealed mild peritoneal inflammation and a 360 degree splenic torsion, with complete thrombosis of the **splenic veins** and **arteries**. The spleen was removed, the dog recovered without complications and was discharged 6 days after admission. .

The dog was readmitted 55 days later with signs of shock, depression, abdominal distention, and retching. On the basis of radiographic and other findings abdominal gastric dilatation-volvulus (GDV) was diagnosed. At surgery an 180 degree clockwise volvulus and several adhesions associated with the previous splenectomy were noted. Following gastric decompression with an orogastric tube the stomach was returned to its normal position and circumcostal gastropexy (attachment) was performed. The dog was discharged 4 days later. Recovery was uneventful.

Case 2. A 6-year-old male German Shepherd Dog was admitted with a immediate history of acute collapse and lethargy. The dog had vomited 3 to 4 times weekly for the past 2 years. Radiography disclosed splenomegaly, loss of abdominal detail indicating free abdominal fluid and cranial displacement of the stomach. Splenic torsion was suspected.

A 450 degree splenic torsion with complete thrombosis of splenic veins and arteries was found during surgical excision. Other abnormalities were not found. The dog recovered without complications and was discharged 3 days later.

The dog was remitted 17 months later with a history of retching. This history along with mild abdominal distention and a 5% dehydration were consistent with a diagnosis of GDV. Surgery revealed a 90 degree clockwise volvulus. Other abdominal abnormalities were not noticed. A circumcostal gastropexy (attachment of stomach to body wall) was performed. The dog was discharged 5 days later. Recovery was uneventful.

Questions.

1. What attachments do the **stomach** and the **spleen** have?

2. What precautions need to be taken during splenectomy when ligating blood vessels in order to preserve the vascular supply to adjacent organs? Which adjacent organ would be most vulnerable to ablation (removal) of the **splenic artery**?

3. What might an owner do to prevent recurring gastric dilatation and volvulus in a dog predisposed to these conditions?

Answers and comments.

1. The canine stomach is free to rotate around the esophagus (its point of attachment to the diaphragm), even though fixed by several ligaments. The first, the **gastro-phrenic ligament**, attaches the cardia to region of the esophageal hiatus of the diaphragm. This ligament has little effect in preventing the rotation of the stomach on the axis of the esophagus. The second, the **gastro-hepatic ligament** (part of the lesser omentum) connects the lesser curvature and the pylorus to the hilus of the liver. This ligament tends to immobilize the pylorus and the lesser curvature of the stomach, but the rotation of the main body of the stomach around its axis can still occur. A third, the **gastroduodenal ligament** (part of the greater omentum) attaches the pyloric part of the stomach to the duodenum and in no way limits the rotation of the stomach. A fourth, the **gastro-splenic ligament**, a part of the greater omentum, attaches the spleen to the greater curvature of the stomach. This limits the rotation of the stomach only in-so-far as the length of the splenic vessels limits the movement of the spleen. The stomach's only other attachment is the **greater omentum** itself, which is freely movable. Movement of the duodenum is limited by the **transverse mesocolon,** which attaches it to the transverse colon, and the **mesoduodenum** (J. Comp. Path. 1944;54:189-199). Thus, the main influences in preventing undue movement of the stomach are the presence of the other organs in the abdominal cavity, mainly the intestines, and the abdominal walls themselves. (J. Comp. Path. 1944;54:189-199)

2. Branches of the splenic artery provide essentially the sole blood supply to the left lobe of the pancreas. Branches of the splenic artery also supply blood to the left area of the greater curvature of the stomach (via left gastroepiploic artery); however, this areas has a collateral supply.

3. Important measures to prevent the recurrence of gastric dilatation-volvulus and splenic torsion are said to be avoiding large intake of feed and water, and avoiding strenuous exercise or excitement following feeding. Dogs which recover from gastric dilatation have a 69% chance of recurrence and progression to gastric volvulus. (See Vet Surg 1996;25:L127-133). Preventing the recurrence surgically is by means of gastropexy.

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Problem #9.

The anatomy of hepatic portal system anomalies. The frequent occurrence of clinical signs related to abnormal development of the hepatic portal system, and the fact that many cases can be successfully treated, are reasons to become thoroughly familiar with the anatomy of this area.

Portal blood, i.e., blood draining the **intestines, pancreas, stomach, and spleen** normally passes through the **liver** to filter out toxins, hormones, and bacteria from the intestines, as well as orally administered drugs. Hepatic encephalopathy (brain damage) may result when toxic levels of these substances, normally metabolized in the liver, enter the brain via the systemic circulation.

Two principal types of shunt anomalies occur. One is the failure of closure of the **ductus venosus**; the other is shunting of blood from the **portal vein** into a non-hepatic venous channel bypassing the liver **(portosystemic shunt).** University teaching hospital clinical records from 1973-1979 show the following relative frequency of the main shunt types as follows: **patent ductus venosus-4; portocaval-12; portal azygous-2; and other portosystemic vessel** (i.e., smaller vein, e.g., cranial mesenteric) draining into the caudal vena cava)-5. The following are three typical cases summarized from the literature:

Case 1. A 5-month-old, male Domestic Shorthair cat was presented with a 2-1/2 month history of behavioral abnormalities and grand mal seizures. Changes consisted of staring blankly for long periods, biting itself, and pulling its hair out. When admitted the cat was ataxic, with a tendency to fall forward, appearing dazed. A preliminary diagnosis of suspected **hepatic portal anomaly** was given following observation of data from the clinical work up.

A laparotomy was done to access a jejunal vein catheter for mesenteric portography. A prominent **pancreatic-duodenal vein** 7 mm in diameter was identified coursing (shunting) away from the portal vein and liver and through the **diaphragm**. The **portal vein** going into the **liver** was only 3 mm in diameter. Liver biopsy revealed a hypoplastic though functional liver. Hepatic hypertension resulted when the shunt was provisionally test ligated. However the liver became opacified (intrahepatic venous vessels filled) when contrast medium was injected through a major jejunal collecting vein, indicating the presence of an adequate intrahepatic venous system.

A second injection of contrast medium revealed a large second shunt from the central portal vein to the **caudal vena cava**, i.e., a **porto caval shunt**). When this large shunt was partially ligated the portal system did not become overly distended, indicating that hepatic hypertension was transitory (i.e., the liver circulation was adequate). The intestine remained normal in appearance during 10 minutes of observation following ligation of the central portal vein.

The ligature was secured, the laparotomy closed, and post operative medication administered. The cat recovered without complication, was discharged 4 days later, and placed on a commercial diet. Abnormal behavior was not observed prior to discharge. One month later the cat was examined and found to be robust and alert, and normal in all respects 8 months postoperatively.

Case 2. A 4-month-old male Beagle was referred to the clinic with a history and clinical work up including radiology that suggested hepatic encephalopathy caused by a **portosystemic** shunt. The venous phase of cranial mesenteric angiography revealed a single shunt that carried blood from the **cranial mesenteric vein (portpsystemic shunt)** into the caudal vena cava. Contrast medium was not seen to enter the hepatic portal system. The shunt was surgically occluded by ligation which reduced the lumen of the **cranial mesenteric vein** by 80%. Liver biopsy at the time of surgery revealed atrophy of hepatocytes, hypoplastic (under developed) portal vasculature, and fibrosis (replacement of liver cells by connective tissue) around portal areas and central veins. Recovery from anesthesia and surgery was uncomplicated. The dog was placed on commercial feed. Six weeks after surgery angiography revealed the shunt was still present, but greatly reduced. It also showed near normal portal circulation in the liver, a finding not seen in the original angiographic studies. Four months after surgery, biopsy of the liver showed it to have normal histologic appearance. Twelve months after surgery the dog was free of signs of hepatic encephalopathy.

Case 3. A 6-year-old spayed female Minature Schnauzer was admitted for evaluation or progressive lethargy, signs of depression, and anorexia. Malaise, polyuria, and polydypsia (chronic excessive thirst) were observed throughout the dog's life but worsened 3 months earlier when another dog in the household died. Since that time, the dog had been lethargic and anorectic and was encouraged to eat palatable high-protein meals. The dog had a 5 year history of chronic recurrent urinary tract infections. On physical examination, the dog appeared anxious and demented and was head pressing. Palpation of the dog's abdomen revealed flaccid muscles; borders of the **liver** could not be identified. Abdominal radiography revealed a small liver; on abdominal ultrasonography the liver again appeared small, but vascularization seemed normal. A large calculus was identified in the urinary bladder. Differential diagnosis included hepatic encephalopathy caused by liver disease or portosystemic shunt. A liver biopsy specimen revealed reduction in portal venous structures. This finding was indicative of the presence of a portosystemic shunt.

The dog was anesthetized and intraoperative mesenteric portography was performed. Radiographic results revealed **portocaval and portoazygous shunts arising from a common trunk**. These anomalous vessels were completely ligated at the common trunk without substantial increase in portal venous pressure. This indicated that near normal liver circulation was established. A cystotomy was performed to remove the urate calculus. The dog recovered satisfactorily and was discharged 2 days later, with medical treatment continuing at home. A prescription diet was prescribed.

Questions.

1. What is the function of the **ductus venosus** during embryonic and fetal development, and what is the fate of this vessel following birth?

2. What is the embryonic origin of the **portal vein**, and how does this explain the frequency of anomalies in this area?

3. What is the relation between a congenital hypoplastic liver and either a portocaval shunt or a patent ductus venosus?

Answers.

1. The **ductus venosus** is a prenatal venous channel between the **left umbilical vein** and the **caudal vena cava** which permits rapid passage of most of the oxygenated blood from the placenta to the heart without traversing the liver sinusoids. Following birth the ductus venosus closes rapidly (100% by 6 days postpartum in the dog) and becomes a fibrous remnant (**ligamentum venosum**).

2. The development process for abdominal vein formation involves patching together parts of pre-existing embryonic vessesl to create adult veins (**portal vein, caudal vena cava, azygous vein**, etc.). A few faulty anastomoses (connections) among the numerous embryonic venous segments during fetal development can give rise to anomalies such as portosystemic shunts.

3. Development of the richly vascular liver and its parenchyma in the fetus is dependent on sufficient blood flow through the hepatic sinusoids. Either a persisting patent ductus venosus or a portosystemic shunt results in a hypoplastic, dysfunctional liver by depriving the liver of a sufficient volume of blood.

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Problem #10

Anatomical problems in the pelvic cavity related to recurrent urinary bladder infection, incontinence, and abnormal elimination. Abnormal anatomical conditions of organs in the pelvic cavity, such as ectopic (out of place) ureter, and rectovaginal or rectourethral fistula (abnormal passage between two organs) occur in dogs and cats. Many of these can be corrected by surgical intervention. Thus it is important to be familiar with the structure and locations of the contents of the pelvic cavity, including vessels and nerves.

Case 1. Bilateral ectopic ureters with bladder hypoplasia in a bitch. A 14-week-old Cairn Terrier bitch weighing 3 kg was presented with a history of incontinence and perineal scalding (urine-related dermatitis) beginning at 6 weeks of age. Previously a tentative diagnosis of cystitis (bladder inflammation) had been made, and antibiotics given topically and systemically without success. Examination of the patient revealed that the **perineal region** and medial aspects of the thighs were wet with a strong odor of ammonia and urine. The **vulva** was inflamed and its **dorsal commissure** necrotic. Otherwise the animal appeared to be healthy.

Under anesthesia contrast material was infused intravenously and radiographs taken. The left **kidney** was hydronephrotic (contained excess urine), with an enlargement of approximately 40%. The right kidney could not be seen. Both **ureters** were distended. They appeared to bypass the bladder and appeared to "come together in the region of the mid-**pubic symphysis**". A non-distended **urinary bladder** was present. A tentative diagnosis of bilateral ectopic ureters, together with hypoplasia of the bladder and right kidney was made.

Exploratory laparotomy was performed. The bladder was found to be small-sized, otherwise normal. Both ureters were enlarged. The right kidney was atrophic. Other organs appeared normal. The ureters entered the bladder laterally but did not invade the submucosa to terminate in the bladder. Instead, they could be seen along the neck of the bladder and urethra dorso-laterally. They terminated caudally in the **urethra** close to the **vestibule**. No **vesical trigone** was noted. Both ureters were ligated, resected from the urethra, and uretero-vesical anastomoses carried out.

Three days later the bitch was observed to squat and urinate for the first time. By the 6th day postoperatively the vulva appeared normal, and the perineum was dry and no longer foul-smelling. Two weeks postoperatively a further urogram was performed. Radiographs showed that the left kidney was still enlarged, and that the bladder was nearly double the pre-operative size. Three months later the animal was reported to be healthy, but the frequency of urination was greater with smaller volume than that of its littermates.

Case 2. Bilateral ureteral ectopia in a male cat with urinary incontinence. A 2-year-old castrated male American Shorthair cat was referred with a history of urinary incontinence since it was a kitten. Two courses of antibiotic treatment were unsuccessful to relieve the problem. Excretory urography indicated that both **ureters**, which were somewhat dilated, by-passed the **urinary bladder** and appeared to empty into the **urethra**. Both **kidneys** were mildly hydronephrotic.

Exploratory surgery disclosed that the left ureter emptied into the urethra about 2 mm distal to the neck of the urinary bladder; the right ureter emptied into the urethra about 4 cm distal to the

neck of the bladder. Both ureters were ligated and transected at their attachments to the urethra. They were transplanted at an angle into the wall of the bladder on either side near the **trigone**. The ureters were pulled through tunnels, about 15 mm long, made through the muscular layers and submucosa. They were sutured to the urinary bladder mucosa. Analysis of a urine sample taken at surgery revealed a heavy growth of streptococci. Antibiotic treatment was given over a period of 17 days. The cat was continent at 7 days post surgery, and was discharged on the 9th day. At 3 months excretory urography revealed normal kidneys, normal ureteral size, and normal emptying of both ureters into the urinary bladder. When examined 10 months after surgery the cat was clinically normal.

Case 3. A 7-year-old castrated male Miniature Poodle with congenital urethro-perineal fistula, urethral duplication, and urorectal fistula. The dog, which had no history of trauma, had been treated for multiple bouts of cystitis (bladder inflammation) for 6 years. The new owner noticed perineal dermatitis, and at times, urine leaking from the perineal opening below the anus during active micturition. The referring veterinarian had anesthetized the dog and noted that, during manual depression of the **urinary bladder**, urine leaked from the **anus** and also from a perineal ostium (opening).

Catheterization and urethrocystography (radiography of both **urinary bladder** and **urethra**) using contrast material, disclosed a bifurcation of the urethra to form an anomalous urethral opening near the pelvic outlet. The other, more caudal (normal) urethra reflected around the **ischial arch**, where it was dilated, and continued as the **penile urethra**. The anomalous, more cranially located urethra also was dilated for a short distance, and then opened on to the surface of the penis below the ischial arch. Contrast material also was found to exit from the (normal) urethra into the **rectum**.

A caudal ventral midline incision was made into the **peritoneal cavity**. An ischial-pubic osteotomy (bone cutting) was performed. When the penile part of each urethra was catheterized a urethrorectal fistula was found extending intra-pelvically from the normal urethra to the rectum. It was ligated and resected. The urethroperineal fistula was catheterized, dissected back to its attachment to the (normal) urethra, ligated, and resected. Surgical closure of the osteotomy site and skin was performed.

Twenty-four hours after surgery there was normal micturition, though urine also dribbled intermittently from the penis. Incontinence had resolved completely by 48 hours, and the dog was discharged 72 hours after surgery. At 6 months post surgery the urine stream was normal, and the cystitis had disappeared completely.

Case 4. Urethrorectal fistulectomy in a dog, using a perineal approach. A 3-year-old castrated Labrador Retriever was referred with a 2 1/2-year history of recurrent urinary tract infection characterized by hematuria (blood in urine) and pollakiuria (frequent micturition). Various microorganisms had been cultured from its urine over a period of 2 1/2 years. Though several courses of long-term antimicrobial therapy had been administered, when terminated, a variety of microorganisms again could be cultured from its urine. Urethrography revealed a fistula 1 cm in diameter from the mid pelvic dorsal portion of the **urethra** to the ventral portion of the **rectum**.

Using a perineal approach, a right lateral curvilinear incision was made from the base of the tail to just ventral to the level of the **pubis**. The incision was continued through the adipose tissue of the **ischiorectal fossa** so that the **internal pudendal artery, vein, and pudendal nerve** could be isolated. The fistula was located, and gentle blunt dissection was continued ventromedially through the adipose tissue (between the **external anal sphincter, levator ani, and internal obturator muscles**) to free the fistula from the deep perineal fascia. The fistula was ligated flush with the urethra and also at the rectal base of the fistula, and excised. Muscles of the ischiorectal fossa were apposed with sutures and the remainder of the incision closed. With usual postoperative medication the incision healed without complication, and by 15 days post surgery the dog was urinating and defecating normally. By 30 days bacterial culture and urinalysis were normal.

Questions.

1. **Clinical** ectopic ureter in dogs is discovered more frequently in the female than in the male (25:1 ratio). Why? The actual incidence of **anatomic** ectopic ureter in male dogs probably is higher than its clinical incidence. Why?

2. What developmental process does not occur properly to result in a urorectal fistula?

3. Innervation related to micturition and defecation is very important. Which pelvic cavity nervous tissue structures would be especially important to avoid in a pelvic osteotomy or a perineal approach to surgically correct ectopic ureter or urorectal septum disorders?

Answers and comments.

1. Urinary incontinence (dribbling urine) and frequent urination (due to cystitis) are more often diagnosed in the female relative to the male because the much longer urethra in the male would more likely result in urine being refluxed back into the bladder rather than emitted through the tip of the penis. The longer male urethra also makes bladder infection from the outside less apt to occur in the male. Thus the anomalous condition may be present in the male and yet go undiagnosed.

2. Urethrorectal fistula results from a failure of the urorectal septum to grow caudally and fuse with the perineum, thus separating the cloaca into urethrovesical and rectal parts.

3. In female dogs ectopic ureters are reported to terminate in the vagina (70%), urethra (20%), neck of the bladder (8%), or uterus (3%), Thus the hypogastric-, pelvic-, and pudendal nerves, and the pelvic plexus may be subject to trauma during pelvic surgery.

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Problem #11

Anatomy of the canine external and middle ear related to surgical intervention following anomalous development, laceration and infection. Many ear cases presented for surgical treatment are caused by laceration due to car accidents or fighting, with subsequent infection of the external ear canal. Successful surgical treatment of ear conditions and avoidance of nerve damage requires detailed knowledge of this organ and surrounding vascular and nervous elements. (See figures 210B, and 211A, Miller's Guide, 4th ed.). The following cases are presented to illustrate this point.

Case 1. A 6 month-old Boxer was presented the absence of a patent external auditory meatus. There was no history of trauma. On examination a bulging skin area was found at a position normally representing the external opening of the **ear canal** at the horizontal-vertical junction. (See drawing of the normal anatomy.) The site of the bulge suggested that the condition involved either the persistence of a fetal solid epithelial plate (meatal plug) as seen in the human (see Sadler ref.), or the presence of a septum at the horizontal-vertical junction. Since the bulge was fluctuating, a tentative diagnosis of septum between the horizontal and vertical parts of the **external auditory meatus** was made. The owner consented to surgical treatment of the animal.

The skin area was cleansed and prepared for surgery. Traction was placed on the bulged skin area with a toothed forceps. A skin plug approximately 3 mm in thickness was excised. A patent horizontal **external auditory canal** was found surrounded by an apparently normal **annular cartilage**. The canal was filled with ceruminous material, which was removed. The presence and condition of a **tympanic membrane** could not be determined. Following irrigation of the horizontal canal, its mucosa adjacent to the annular cartilage was sutured to the skin of the **auricle** surrounding the excised patch. With postoperative topical medication, the animal made an uneventful recovery. Information concerning the auditory function of the ear was not available.

Case 2. Traumatic separation of the auricular and annular cartilages. The following is a case summary of this condition in 4 dogs in age from 1 to 6 years (two Basset Hounds, one Weimaraner, one Cocker Spaniel, and one Doberman) that had sustained prior (3 to 44 months) traumatic unilateral separation of the otic cartilages when hit by a car. Palpation revealed separation of the horizontal and vertical ear canals. Otoscopic findings included a shallow vertical ear canal and a pseudotympanic membrane across the proximal end of the auricular cartilage. Findings at surgery confirmed the diagnosis of cartilage separation and included an exudate-filled horizontal ear canal and a blind-ending vertical ear canal. Surgical treatment involved isolating the distal end of the **annular cartilage** (horizontal ear canal), opening and evacuating the horizontal ear canal, and following cleansing, suturing the open end of the annular cartilage to the skin. The length of annular cartilage was variable among the dogs, although each dog had sufficient horizontal canal to oppose skin to otic epithelium. The vertical canal was not surgically dissected or manipulated. All dogs had patent ear canals when examined at follow-up examination.

Case 3. Traumatic ear canal separation and para-aural abscesses. A six-year-old male Lhasa apso was presented with a one-year history of intermittent abscess formation and percutaneous drainage immediately ventral to the right horizontal ear canal. The owner reported the dog had received a non-penetrating wound in a dog fight three months prior to the onset of clinical signs. Examination disclosed a mild otitis externa, with a small amount of purulent, ceruminous exudate. The ear canal was occluded at the junction between the vertical and horizontal parts. Radiographs under general anesthesia showed that the right vertical ear canal was filled with air to the level of the
horizontal canal. There was increased opacification of right tympanic bulla (middle ear cavity).

A soft, fluctuating swelling and associated draining fistula were present ventral to the right horizontal ear canal. Sinography (radiography using contrast media) disclosed a communication between the draining fistula and the distal horizontal ear canal, with subsequent flow of contrast media into the tympanic bulla (middle ear). The distal horizontal ear canal filled with contrast medium but ended abruptly and did not communicate with the vertical canal.

Permission was obtained for ablation (surgical removal) of the external ear canal and lateral tympanic bulla. The surgical site was prepared and skin incisions made to avoid the auricular arteries. Upon further dissection the **auricular cartilage** was found to be separated from the **annular cartilage** and the vertical and horizontal canals separated by a thin fibrous tissue wall. Total ablation of the ear canal and a lateral bulla osteotomy with curettage (scraping of the interior of a cavity) were performed. Injury to the adjacent vessels, nerves and salivary gland were avoided by gentle retraction. A continuous closed suction drain was placed in the tympanic bulla and removed two days post operatively. The surgical site was flushed with physiological saline, the deep layers closed, and the skin sutured. Bacterial cultures disclosed the presence of *Staphylococcus intermedius*. A three- week course of antibiotic treatment was prescribed, and the dog discharged three days postoperatively. At 36 weeks postoperatively the dog was healthy with no occurrence of the abscess or draining fistula.

Questions.

1. Beside vessels, what nerves and gland must be avoided during the external and middle ear treatment described above?

2. What nerve innervates the muscles that move the ear? Which nerves are sensory to the ear?

3. What is the advantage of the annular cartilage being separate from the auricular cartilage? Why during accidents or fights does the luxation occur between the annular and auricular cartilages and not within one of the two cartilages?

Answers and comments.

1. Cautious surgical dissection is required to avoid the facial nerve and its branches and the auriculotemporal branch of the trigeminal nerve (CN V). The parotid salivary gland surrounds the ear canal.

2. The facial nerve (CN VIII) innervates the muscles that move the ear. The great auricular nerve (C2 ventral cutaneous nerve) innervates the caudal surface of the pinna while the facial nerve (internal auricular branches) innervates the cranial surface. The vagus nerve (X) supplies the external auditory canal. (Also, the glossopharyngeal n. (IX) supplies the middle ear and the vestibulocochlear n. (VIII) supplies the inner ear.)

3. Separation of the annular and auricular cartilages allows for a wide range of motion in the pinna of the ear. When separation trauma does occur, the cartilages remain intact because presumably they are considerably stronger than the ligamentous connection that binds them together.

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Problem #12

Anatomy of components of the third eyelid related to prolapse. Prolapse of the third eyelid is a condition known as "cherry eye". The largest component of the third eyelid is the superficial gland of the third eyelid at its base. Thus the condition is often called the "prolapse of the **gland** of the third eyelid", a misnomer.

The prolapse condition has been reported in dogs especially, but also cats, for over thirty years. Certain breeds of dogs such as Cocker Spaniel, Boston Terrier, Pekingese, Beagle, Basset Hound, and English Bulldog are said to be predisposed to its development. The cause of prolapse is unclear. One suggestion is hypertrophy of the lymph nodules in the third eyelid; another is a congenital lack of a connective tissue band holding the third eyelid gland in position (Severin, 1976).

Over the years several different means to correct the prolapse have been offered. To understand these, a detailed knowledge of the structure of the third eyelid and structures adjacent to it is necessary. The following are three surgical-anatomical approaches to treat "cherry eye" which serve to illustrate this point.

Case 1. A 3-month-old Cocker Spaniel pup was presented with prolapse of the third eyelid and follicular conjunctivitis (enlarged lymph nodules).

Under general anesthesia an incision was made through the **conjunctiva**, over the prolapsed gland, on the bulbar aspect of the **third eyelid**. A fine toothed forceps was used to grasp the conjunctiva at the **ventral limbus** and rotate the **globe** dorsally. An incision was made down to the epibulbar tissue (tissue covering the globe of the eye). Retraction of the third eyelid away from the globe allowed a deep dissection between the third eyelid and the globe. A suture was placed as deep as possible in the epibulbar fascia beyond the **ventral conjunctival fornix.** This suture was then carried up to the most dorsal aspect of the prolapsed **gland of the third eyelid**. Correct placement of the suture was verified when the suture was tied. Tying the suture retracted the gland into its normal position in the vicinity of the epibulbar fascia, The tied suture was buried beneath the conjunctiva, the folds of which were placed over the cut suture ends. Antibiotic treatment was initiated.

Three weeks later the left third eyelid prolapsed and similar procedure was performed on this eye. There was no evidence of prolapse in either eye three weeks later. Slight conjunctivitis was present. Two years later there was no recurrence of prolapse in either eye.

Case 2. A year-old Basset Hound was presented with a prolapse of the third eyelid in the left eye. It was decided to reposition the **nictitans gland (gland of the third eyelid)** to its normal position with a modified technique. The purpose was to avoid transsecting the excretory ducts of the gland which exit through the bulbar aspect of the third eyelid

Under general anesthesia and the animal in right lateral recumbency the nictating membrane was extended with fine tooth forceps to allow a ventral incision. A suture was placed through the **periosteum** of the **orbital rim**. It was then passed through the incision dorsally to the highest plateau of the prolapsed gland, exiting on the dorsal bulbar face. The suture was looped back through the gland and brought out ventrally through the conjunctival incision. By gentle traction on the suture, the gland was retracted toward the orbital rim to its normal position. The incision was sutured.

Topical and systemic antibiotic treatment for 5 days was prescribed. The authors have used this modified technique on 8 dogs with excellent cosmetic results.

Case 3. A 4-year-old Burmese cat was presented with a red mass protruding from the bulbar (caudal) surface of the left third eyelid. (Two years earlier a similar mass, which included all components of the third eyelid, had been removed from the cat's eye. Despite conservative treatment and **parotid duct** transposition as an alternative source of fluid, keratoconjunctivitis (KCS, dry eye) developed soon afterwards.)

When presneted, epiphora (overflow of tears; watery eye) was evident in the left eye, and a small adherent white opacity of the **cornea** was observed adjacent to the mass. When the protruding tissue was gently grasped with the forceps, the proximal part of the cartilage could be seen folded upward and forward within the **third eyelid** (See illustration).

The patient was placed under general anesthesia in lateral recumbency. Following lateral canthotomy (slitting of the canthus) a conjunctival incision was made posterior to the 3rd eyelid near the limbus. The proximal (basal) portion of the cartilage with the gland was located and exteriorized. A small longitudinal incision was made through the gland to expose the cartilage. The cartilage was captured with a suture, and an incision made along the medial wall of the **orbit** to the origin of the **ventral oblique muscle**. The suture was passed through the incision as near bone as possible. Since the folded cartilage was not flexible, the **bulbar conjunctiva** of the 3rd eyelid was incised over the fold in the cartilage. An incision was made through the cartilage at the fold to facilitate straightening it. The third eyelid was then retracted to a position near the ventral oblique muscle and fixed with the suture to bring it into its normal position. All conjunctival incisions were closed.

Five months after surgery the third eye lid appeared normal. The patient appeared comfortable even though the 3rd eyelid was immobilized.

Questions.

1. Beneath which surface (rostral or caudal) of the third eyelid do the lymph nodules lie?

2. Where is the gland of the third eyelid located? What is considered to be the usual cause for prolapse of the third eyelid?

3. What are some nearby structures to which a prolapsed gland of the third eyelid (actually the entire third eyelid itself) can be anchored in restoring a prolapse?

Answers.

1. The lymphoreticular tissue (aggregated lymph nodules; tonsil of the third eyelid) is located on the caudal side.

2. The gland is located ventrally, surrounding the base of the cartilage of the third eyelid. Enlargement of the lymph nodules of the third eyelid and/or lack of attachment at its base is usually considered to be the cause of prolapse of the third eyelid.

3. Case reports reveal that the gland of the third eyelid has been sutured to the epibulbar fascia (orbital periosteum), ventral equatorial sclera, and fascia associated with the ventral oblique muscle.

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Note: The attached figures may be helpful in understanding your dissection of the eye.