Clinical aspects of the functional disorders of the equine and bovine femoro-patellar articulation with some remarks on its biomechanics

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(Met samenvatting in Nederlands)

PROEFSCHRIFT

TER VERKRIJGING VAN DE GRAAD
VAN DOCTOR IN DE DIERGENEESKUNDE
AAN DE RIJKSUNIVERSITEIT TE UTRECHT,
OP GEZAG VAN DE RECTOR MAGNIFICUS,
PROF. DR. A. C. DE VOOYS,
VOLGENS BESLUIT VAN DE SENAAT
IN HET OPENBAAR TE VERDEDIGEN
OP DONDERDAG 13 JUNI 1968
DES NAMIDDAGS TE 4.15 UUR (PRECIES)
DOOR

SOHAN SINGH RATHOR

GEBOREN OP 14 DECEMBER 1933 TE KISHANGARH (INDIA)

DRUKKERIJ dh HOEIJENBOS

UTRECHT 1968

PROMOTOR:

PROF. DR. S. R. NUMANS

Uit de Kliniek voor Veterinaire Heelkunde
van de Rijksuniversiteit te Utrecht
Nederland

To my Parents

To my Wife

ACKNOWLEDGEMENTS

The author expresses his sincere feelings of gratitude to his promotor Prof. Dr. S. R. Numans, for his guidance and constant encouragement which made it possible to carry out this project; he is also grateful for the kind hospitality extended to him during his stay in the Netherlands.

He is indebted to Prof. Dr. K. M. Dyce and Dr. D. M. Badoux (Anatomy) for their constructive criticism and help in preparing this manuscript and for the facilities provided from the Anatomy department.

The author is very much thankful to the Ministerie van Buitenlandse Zaken, I.T.H., 's-Gravenhage, and Mr. H. F. Juta, his fellowship officer, for providing him the scholarship and permitting to stay and work leading towards an academic promotion in the Netherlands.

Acknowledgements are extended to all the members of the teaching and technical staff of "Veterinaire Heelkunde and Röntgenologie" for their assistance and cooperation in this project.

Thanks are expressed to Mr. W. Stam, UNFI, and the photographic sections of Röntgenology and Anatomy departments, for their help in preparing photographs.

Last but not the least, appreciations are due to Miss. M. Crucq for typing the manuscript.

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CHAPTER 1

INTRODUCTION

Broadly speaking, lameness is an indication of structural or functional disorders in one or more limbs, which may be manifested in progression or while standing. It is caused by trauma, congenital or acquired anomalies, infection, metabolic disorders or by a combination of these. Lameness caused by functional disorders is non-inflammatory and is revealed by changes in the line of flight, the arc of flight of the limb or the combination of both (SMITH & RAKER — 1963). A detailed knowledge of the anatomy and physiology of the limb is essential for the correct diagnosis of lameness and for the establishment of its cause and pathogenesis.

The non-inflammatory functional disorders of the femoro-patellar articulation are the main subjects of this thesis.

Study of the literature concerned with the affections of the femoro-patellar articulation is impeded by a confusion of language and one may note many discrepancies between the nomenclature employed and the clinical and anatomical conceptions. The early knowledge of the functional disorders of the femoro-patellar joint has led to the confusing designation of these conditions. Notwithstanding this confusion from the clinical and anatomical literature it can be observed that functional disturbances of the femoro-patellar articulation have to be divided in to two main groups: those caused by fixation and those caused by luxation of the patella.

Very few publications are available regarding lateral luxation of the patella in horses. Permanent lateral luxation of the patella in ponies is not yet reported in the literature. Patellar luxation and fixation are to be considered as functional disturbances of the femoro-patellar articulation.

Chapter two therefore, contains a description of the topographical and functional anatomy of the stifle joint in general and of the femoro-patellar articulation in particular.

The third chapter is a study of the biomechanics of the equine and bovine stifle joint. It includes a description of the normal movements in this joint together with a discussion of the functions of its ligaments and menisci. The hypomochlions of the medial femoral condyle and their relations to the middle patellar ligament are determined. Here the author would like to emphasize that this chapter is not intended to present a complete biomechanical study of the stifle joint but attempts to outline a possible correlation between mechanical factors and the patellar fixation.

The fourth chapter deals with the clinical aspects of the non-inflammatory functional disorders of the femoro-patellar articulation which are the primary studies of this thesis. A complete list of the various terms used for patellar disorders is given, which reveals a

confusing and misleading situation, particularly where the early work is concerned. The currently followed classification of patellar fixation and luxation is composed. These affections have been divided into two groups those caused by (1) fixation and (2) luxation of the patella. The most important and common affections are individually further described in detail dealing with aetiology, symptoms, treatment and results in horses and cattle. Pathology of the permanent lateral luxation of the patella in ponies was studied and the operative treatment which has been successfully practised is described in detail. The last part of this chapter contains the analysis of patients suffering from patellar fixation and luxation and treated in this clinic of Surgery at UTRECHT, from 1956 to 1965.

In chapters five and six a discussion, conclusion and a summary are given. A bibliography is appended.

CHAPTER 2

ANATOMY

2.1 Introduction

In order to make a correct diagnosis and to achieve the best possible therapeutical results, a thorough knowledge of the structures involved in the malady is essential. Hence the anatomical and the physiological (functional) aspects of the stifle joint are described in this chapter, which is divided for convenience into two parts; the first deals with descriptive and topographical anatomy, the second with functional anatomy.

2.2 Descriptive and topographical anatomy

SISSON & GROSSMAN (1966) classified this joint in the ginglymus class of the diarthroses group. One must appreciate, however that the stifle joint is not a typical example of the ginglymus class, since true ginglymus joints perform only flexion and extension movements whereas the stifle joint shows rotatory movements also. The stifle consists of two separate joints:

I. Articulus femoro-patellaris and
II. Articulus femoro-tibialis.

2.2.1 *Articulus femoro-patellaris (Horse)*

This joint is formed by the articular surfaces of the patella and the femoral trochlea. The synovial layer of the articular capsule is loose and thin and is attached around the articular margin of the patella and to the femur at a varying distance from the articular surface: the membrane pouches upwards under the M. quadriceps femoris. It is in contact with the femoro-tibial joint capsule and the cavity, which is extensive, often communicates with the medial compartment of the femoro-tibial joint. The articular surface of the femoral trochlea is obliquely placed and is bounded by lateral and medial ridges which are separated by a wide and deep groove. The medial ridge is large, broad and rounded at its proximal part over which the patellar fibrocartilage glides. The lateral ridge is small and does not extend as high as the medial ridge. The patella glides in the femoral trochlea and on its medial border it carries a fibrocartilage which is adapted to the medial ridge; this cartilage is sometimes regarded as part of the medial patellar ligament (SISSON & GROSSMAN — 1966).

The patella is generally regarded as a sesamoid bone developed in the terminal tendon of the M.quadriceps femoris, although HAXTON (1944), for reasons which have failed to receive support, claimed it as a skeletal bone. The patella is connected to the femur by medial

and lateral femoro-patellar ligaments and to the tibia by three straight patellar ligaments. The former are thin fibrous bands which originate from the patellar margins and are inserted upon the medial and lateral femoral epicondyles respectively. Neither is clearly distinct and each blends with the fibrous layer of the joint capsule.

2.2.2 *Articulus femoro-tibialis*

This is formed between the condyles of the femur, the articular surface of the tibia and the menisci. The condyles of the femur are slightly oblique and each has an articular surface of spiral outline; the outline of the lateral condyle is more strongly curved. The tibial condyles are separated from each other by the intercondylar spine (eminentia intercondylica). The saddle-shaped surface of the tibial condyles are not well adapted to the femoral condyles and are in contact with only a small part of them in any position of the joint.

Two menisci which are intercalated between femur and tibia produce greater congruity of the articular surfaces. They are crescentic fibrocartilaginous plates whose proximal surfaces are concave and adapted to the condyles of the femur: distally they are flat and fit the tibial condyles. The synovial membrane is attached to the femur about fifteen millimeters from the articular margin, but joins the tibia close to the articular margin. It is stronger posteriorly and thinner anteriorly and forms lateral and medial sacs. The medial sac, more rarely the lateral one, communicates with the femoro-patellar joint cavity.

There are two collateral ligaments — medial and lateral. Both ligaments are situated somewhat posteriorly and arise from the respective epicondyles of the femur. The lateral ligament inserts on the head of the fibula and on the side of the lateral tibial condyle, the medial ligament on the side of the corresponding tibial condyle.

The cruciate ligaments, anterior and posterior (SISSON & GROSSMAN — 1966), (lateral and medial decussate ligaments, NICKEL et al. — 1961) are two strong cord-like structures which cross each other in "X" fashion. Each ligament is twisted about its long axis. The anterior cruciate ligament originates from the medial side of the lateral femoral condyle and inserts on the lateral wall of the intercondyloid fossa of the tibia. The posterior cruciate ligament takes origin from the lateral side of the medial femoral condyle and attaches posteriorly to the tibial intercondyloid fossa. The straight patellar ligaments (Fig. 1) are three, strong, fibrous bands which may be regarded as the continuation of the tendon of the M. quadriceps femoris in which the patella develops. The middle patellar ligament is thick and extends from the dorsal surface of the patella to the tibial tuberosity. The lateral patellar ligament is flat. It originates from the dorso-lateral aspect of the patella and is inserted laterally on the tibial tuberosity. SISSON & GROSSMAN (1966) stated that the medial patellar ligament is distinctly weaker than the other two

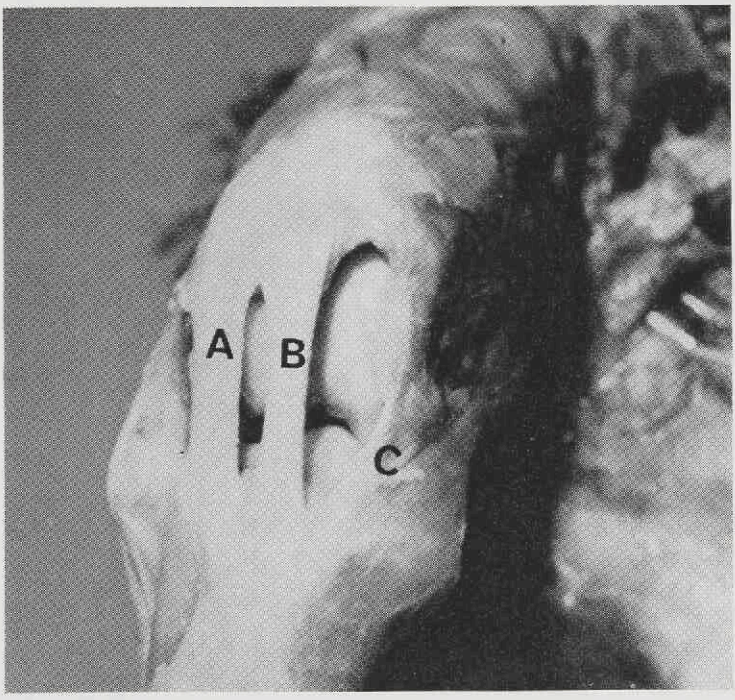


Fig. 1. Right stifle joint of a pony foal, showing three patellar ligaments:
A. Lateral patellar ligament
B. Middle patellar ligament
C. Medial patellar ligament.

and is widely separated from the middle patellar ligament at both ends. In my opinion, however, this ligament is strengthened by an accessory fibrocartilage. It is rounded and more regularly shaped than the lateral ligament which fuses with the tendon of the biceps femoris muscle.

The stifle joint is innervated by the articular branches of the femoral, tibial and peroneal nerves.

2.2.3 *Differential points in cattle*

The apex of the patella is more pointed than in the horse. The communication between the femoro-patellar and femoro-tibial joint cavity is more extensive. The lateral patellar ligament is completely blended with the tendon of the biceps femoris muscle.

2.2.4

In the living animal, when the stifle joint is examined by

palpation, the patella along with its three straight ligaments and the tibial tuberosity can be identified. The patellar ligaments are palpable towards their insertion to the tibial tuberosity. It is not possible to feel the collateral ligaments. The medial femoral trochlear ridge is also palpable in the extended joint when the patella has been pulled to the upper articular margin of the trochlea.

2.3 Functional anatomy

A short survey of the most important features of the functional anatomy of the equine and bovine stifle joint may elucidate some aspects of the pathology. The subject is considered under two heads:

I. Functions of the joint in the standing position and
II. Functions of the joint during progression.

2.3.1 *Function of the joint in the standing position*

The stifle joint plays an important role in the maintenance of normal posture. GRAY (1944) regarded each limb as a telescopic structure capable of exerting a longtitudinal axial thrust. Each limb consists of a series of articulated rods whose joints possess little or no natural rigidity. This arrangement of the skeleton is inherently unstable and the structure wouldimmediately collapse under the load of the body weight. Its ability to resist flexion depends upon the activity of the associated muscles. Internal stability of the limb is secured by the continuous exercise of muscular effort to maintain the position.

In the horse the muscles can be relieved from their task, to a considerable extent, by a special arrangement of ligaments which allows fixation of the stifle joint. This provides a patellar locking mechanism which enables the stifle joint to be rigidly fixed so that it will not yield even when the muscles which normally prevent flexion are relaxed. This arrangement indirectly fixes the hock joint for the two articulations are joined in front and behind the tibia by the tendinous and (relatively inelastic) cords of the M. peroneus tertius and M. flexor digitalis superficialis which link the movements of the hock with those of the stifle. A change at one joint is necessarily accompanied by a corresponding change at the other. The posterior angle between the femur and the tibia and the anterior angle between the tibia and the tarso-metatarsal axis are both approximately 150° when the animal stands normally. The patellar locking mechanism is not called into play when the body weight is symmetrically distributed on the right and left limbs; in these circumstances the patella on each side is located in the trochlear groove where it is held by the tension exerted by M. quadriceps femoris.

At times, and generally when the animal is fully at ease, a greater part of its weight will be transfered to one hind limb and it is then that the stifle and hock joints are fixed. This is achieved by hooking

the patella over the prominent upper extremity of the medial trochlear ridge. The patella is brought into this position by the contraction of the quadriceps muscle and when lodged in place the patellar fibrocartilage and the medial angle of the bone rest upon the projecting medial trochlear ridge while the medial and middle straight patellar ligaments pass one to each side of this. The quadriceps is now relaxed but the patella is securely fixed and the body weight is unable to flex the joint. The tendinous bands that join the femur to the hock region transmit the effect to the lower joint. The distal part of the limb is fixed by the stay apparatus of the fetlock, which needs no further consideration here.

2.3.2 *Functions of the joint during progression*

The following account of the function of the stifle joint during consecutive phases of the normal walking gait is based upon the description by NICKEL et al. (1961) (Fig. 2). They divided the stride into four phases:

Thrust phase;
Raise or lift of the hind limb;
Swinging and
Supporting phase.

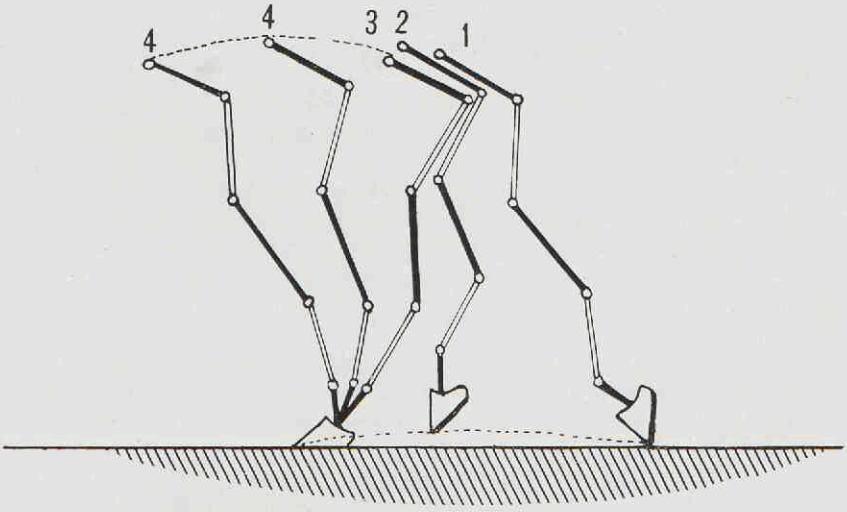


Fig. 2. Phases of the normal walking gait of the horse:
1. Raise or lift of the hind limb
2. Swinging phase
3. Supporting phase
4. Thrust phase. (After Nickel et al.)

During the *thrust phase*, the stifle joint is pulled backwards and simultaneously straightened by the hamstring muscles (Mm. biceps femoris, semitendineus and semimembranaceus) and since accessory tendons from these muscles run to the tuber calcis they also help to extend the hock joint. During the *lift phase* the foot loses its contact with the ground and at this stage the flexor muscles bend the stifle joint and bring the limb into the *swinging phase* in which the stifle joint and the limb as a whole moves forward in a sagittal plane. At the end of this phase all the joints of the limb are again extended as the leg prepares itself for the *supporting phase,* in which the M. quadriceps femoris plays the most important role in extending the stifle joint just as it does in maintaining the normal posture when the animal is at rest.

Although rotational and translatory movements are found in the stifle joint yet its principal movements are extension and flexion.

2.3.2.1 *Extension*

Extension of the stifle joint is performed by a powerful group of muscles which are situated on the dorso-lateral aspect of the thigh. The muscles which are mainly concerned are: M. tensor fasciae latae originates from the tuber coxae and inserts by means of a thick fascial sheet on the patella, the lateral patellar ligament and the tibial crest. It flexes the hip and extends the stifle joint.

M. biceps femoris originates from the dorsal and lateral sacro-iliac ligaments, the gluteal and coccygeal fascia and the tuber ischii: it divides before insertion and attaches to the femur (near the tibial tuberosity), the anterior surface of the patella, the lateral patellar ligament, the tibial crest and finally to the tuber calcis and the crural fascia. Contraction of the part which inserts on the patella and the tibial crest extends the stifle joint when the foot is in contact with the ground (closed chain positon) but flexes the joint when the lower part of the limb is free to move backwards, as happens during the swinging phase of progression (open chain position). The action of the biceps femoris is applied to the hock directly by means of the accessory tendon, indirectly by means of the linkage of the stifle and hock joints.

M. quadriceps femoris is a large mass situated in front of the femur. It has four heads. M. rectus femoris originates from the shaft of the ilium and inserts on the upper two-third of the patella. M. vastus lateralis lies on the lateral side of the femur between the trochanter major and patella: it originates from the trochanter major and the lateral border of the femur and inserts on the patella. M. vastus medialis is situated on the dorso-medial side of the femur: it originates from the distal third of the neck of the femur and inserts on the patella and its fibrocartilage, continuing on to the medial patellar ligament. M. vastus intermedius is covered by the preceding three heads of the quadriceps and lies close to the femur: it originates from

the anterior surface of the femur and the tendinous covering of the vastus medialis and inserts on the patellar base and the uppermost border of the femoro-patellar joint capsule. All four heads collectively extend the stifle joint whereas M. rectus femoris has a secondary action in flexing the hip and M. vastus intermedius during extension maintains tension in the femoro-patellar capsule.

2.3.2.2 *Flexion*

There are no muscles which function purely as flexors of the stifle joint, although the popliteus approaches this most closely. There are however a number of muscles, normally considered as acting primarily on other articulations, which have an important effect upon the stifle joint. Of the hamstring muscles the biceps and the semitendineus can flex the stifle joint although this action is confined to a part of the biceps femoris during the swinging phase. The gastrocnemius is more often regarded as an extensor of the hock, but its potential role in stifle flexion must not be overlooked. The superficial digital flexor is largely tendinous and may transmit hock flexion to the higher joint through a purely mechanical effect in conjunction with the activity of other muscles at the stifle joint. The digital extensor and the tibialis anterior muscles flex the hock and because of the conjunction of movements at the two joints must be considered as flexors of the stifle also. These muscles are not much related to the clinical conditions hence their description and attachments are omitted in this work.

CHAPTER 3

BIOMECHANICS

3.1 Introduction

In the preceding chapter the stifle joint was described as it appears in the dissection room and a general account was given of the participation of this joint in the movements of the hind limb during normal walking. In this section it is proposed to consider the manner of action of the joint in somewhat greater detail since it is clear that a knowledge of the normal behaviour of the components of the joint is a prerequisite for any informed discussion of the abnormalities that are encountered in practice.

Articular biomechanics is a highly specialised subject and the precise evaluation of the movements requires a metrical technique and a mathematical analysis that are beyond the scope of this work. But the general principles can be sufficiently appreciated at an elementary level.

The stifle joint may be regarded as an example of a hinge joint or ginglymus, a class of articulation in which the movements are theoretically confined to swinging (extension and flexion) in the one plane. *) This implies that one (male) surface is shaped like a portion of a cylinder and that the other (female) surface is of the corresponding hollow form. In fact no joint attains this ideal condition and it is usual for the male surface to resemble part of a truncated cone: thus its backward and forward movements over its partner involve a spin or rotation about its longitudinal axis. This spin is an inevitable accompaniment of flexion and extension and is known as conjunct rotation (MacCONAILL — 1966).

3.2 Spin or Rotation

Swinging movements take place between the femur, the menisci and the tibia; spin involves the movement of the femur and the menisci upon a fixed tibia. During extension and flexion of the stifle joint the movements of the femur are not confined to a sagittal plane. BARNETT (1954) pointed out that in man the spin movement is brought about by the fact that the disto-proximal axes of the femoral condyles are not parallel; this mechanism further prevents damage to the articular surfaces when the movement of the joint comes to

*) The femur and tibia in fact articulate by means of paired articular condyles and the category "condylar joint" is, in the more recent literature often applied to this type of articulation. The movements of the two surfaces are inseparably associated and as the advantages of the more complicated classification are rather esoteric the familiar designation is retained here.

a sudden stop, which he compared with a wooden box having two tapes of different lengths (Fig. 3).

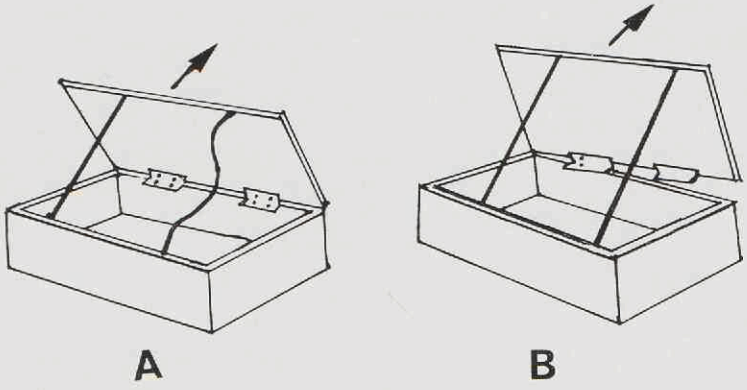


Fig. 3. Wooden box having two tapes of different lengths
A. Further opening of the lid is checked by one of the tapes.
B. After removing three screws the lid further opens till the second tape also checks the movement of the lid. Here the lid has rotated on the remaining screw. (After Barnett et al.)

It is also clear that the profile of each condyle is not circular but spiral and alterations of the radii of curvature in different positions of the joint further complicate the movements. It is obvious upon inspection that there is a small but constant difference between the radii of medial and lateral femoral condyles. This implies that during extension the femoral condyles roll forward upon the table provided by the tibia carrying the menisci with them; as the femur approaches the position of extreme extension it undergoes inward rotation, limited in amount but detectable by the eye; the medial and lateral collateral ligaments become taut in sequence and prevent damage to the joint (GRANT — 1938). It follows that the collateral ligaments have a braking influence on the movements since they cause a closer packing of the bony components of the joint. This effect of the spin movement is therefore additional to the checking activities of the cruciate ligaments. To summarise, extension movement is arrested by tautening of the medial and lateral collateral ligaments in sequence as the spin occurs in the joint and by the anterior cruciate ligament which becomes taut as the extension approaches; the initial stages of flexion movement is followed by relaxation in reverse sequence of the collateral ligaments; the posterior cruciate ligament becomes taut as flexion progresses.

An even more striking peculiarity of the stifle articulation is the very marked incongruence of the femoral and tibial surfaces. This incongruence is reduced by the interposition of the menisci, semilunar fibrocartilages which augment the weight bearing area of the female

surface in all positions of the joint. Their role is obscure for while they improve congruence it is not clear why the tibial and femoral surfaces should be so ill-adapted in the first place. The menisci are attached to the tibia by a series of ligaments which control their excursions during normal movement: the lateral meniscus is attached to the femur by a posterior ligament and follows the movements of this bone more closely. Synovial fluid provides lubrication and facilitates the movements within the joint.

Extension of the stifle is effectuated by contraction of the quadriceps femoris muscle whose pull is transmitted by the patella which rides up in the femoral trochlea. Because of the shape of the bony surfaces make a conjunct rotation inescapable, there is no need to invoke the contraction of rotatory muscles to explain the simultaneous spin, although confirmation of this assumption must await electromyographic studies.

Since the quadriceps muscle is most concerned with the excursions of the patella, it was thought advisable to determine whether the position of the joint affected the mechanical efficiency of the muscle. This led to the determination of the hypomochlions (instantaneous axis of rotation for the swinging movement) in normal standing position of the joint and to the determination of the perpendicular distances between the centre of rotation and the line of action of the muscle.

3.3 Determination of Hypomochlions of the medial femoral condyle

Geometrically it is the momentary centre of rotation of any curved segment of the articular surface of a joint in the sagittal plane of symmetry and it is defined as the point of intersection of the joint axis and the sagittal plane of symmetry. The location of the hypomochlions of the medial femoral condyle was determined in ten adult cows, five horses and five ponies. Their stifle joints were radiographed in a latero-medial direction: the radiographs included the distal extremity of the femur, the patella and the proximal extremity of the tibia. From each radiograph, a diagram was drawn on a transparent plastic cover and copied on the paper. The articular circumference of the medial femoral condyle was then divided into eight equal segments in cows and horses and into six segments in ponies. The selected landmarks were connected by straight lines (chords) and the middle perpendicular was drawn on each chord. The perpendiculars of two adjacent chords were extended to intersection. This procedure was followed for each pair of chords and thus four points of intersection were obtained in cattle and horses and three in ponies. These points are the representative momentary hypomochlions of the joint (Fig. 4).

Since these points do not coincide it is apparent that there is a combination of spin and translatory movements during swing of the stifle joint.

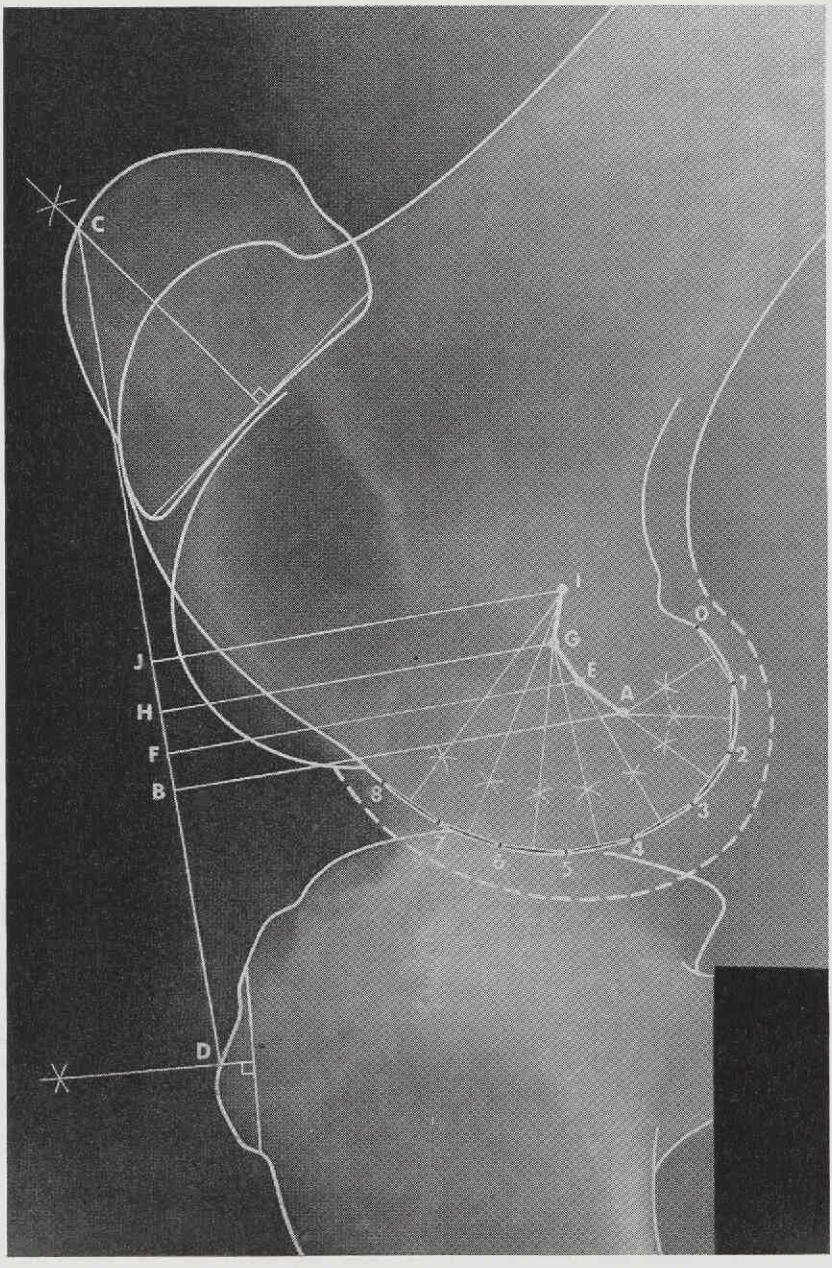


Fig. 4. For details see the text 3.3 and 3.4.

3.4 Topographical relation between the centres of rotation and the middle patellar ligament

The relation between the position of the middle patellar ligament and that of the hypomochlion plays an important role in the patellar movements. If the distance between the patellar ligament and the hypomochlion should change during movements in the joint, this would influence the moment of the extensor muscles about the centre of rotation. To obtain insight into the locations of the hypomochilons and the middle patellar ligament, the two extremities of the patellar articular surface were joined by a line on the sketch diagram. The middle perpendicular was erected on this line which intersected the upper nonarticular surface of the patella. Similarly, two extreme points of insertion of the middle patellar ligament on the tibial tuberosity were joined by a line. The middle perpendicular which was erected on this line also, when produced intersects the tibial tuberosity. The points of intersection on the patella and on the tibia were joined and this line represents the projection of the middle patellar ligament. The perpendicular distance between the hypomochilons and the projected middle patellar ligament was measured and the results are listed below. (These results apply to the normal standing position).

Horses.

S. No.	AB:CD	EF:CD	GH:CD	IJ:CD	
1.	98:184	89:184	74:184	72:184	1:2.21
2.	92:168	92:168	93:168	83:168	1:1.86
3.	108:199	98:199	93:199	112:199	1:1.93
4.	90:190	109:190	100:190	106:190	1:1.88
5.	92:178	93:178	98:178	88:178	1:1.88
average					1:1.95

Ponies.

S. No.	AB:CD	EF:CD	GH:CD	
1.	53:85	51:85	48:85	1:1.67
2.	56:88	54:88	54:88	1:1.60
3.	57:98	55:98	51:98	1:1.81
4.	66:96	61:96	63:96	1:1.53
5.	65:123	58:123	58:123	1:2.05
average				1:1.73

Cattle.

S. No.	AB:CD	EF:CD	GH:CD	IJ:CD	
1.	94:167	75:167	70:167	68:167	1:2.20
2.	96:178	88:178	86:178	84:178	1:2.01
3.	103:164	98:164	90:164	81:164	1:1.76
4.	95:166	81:166	79:166	79:166	1:1.99
5.	96:152	85:152	83:152	79:152	1:1.77
6.	83:181	80:181	75:181	81:181	1:2.21
7.	88:159	81:159	83:159	71:159	1:1.97
8.	94:169	91:169	86:169	84:169	1:1.90
9.	96:176	99:176	96:176	96:176	1:1.81
10.	98:168	79:168	77:168	85:168	1:1.99
average					1:1.96

For the execution of normal swing movements in the stifle joint it is essential that the patella remains in the trochlea. With reference to Fig. No. 4 it appears that extension (when the patella is placed on the proximal part of the trochlea) results in shifting the middle patellar ligament closer to the femoral trochlea; the position of the hypomochlions A.E.G. moves backward during the rotation of the femur and in flexion the patella slides forward carrying the ligament away from the femoral trochlea but the hypomochlions I.E.G. move forward. *It is found that the topographical relation between the hypomochlions and the middle patellar ligament is not significantly changed. This implies that so far as the influence of the location of the ligaments is concerned there is an invariable tension on the patella and its connected structures and the patella remains in normal articulation during rest and movement.*

3.5 Discussion

It is well known that movements in the stifle joint are not performed in isolation; there is always a combination of two or more movements. It has been observed that a horse resting in the stall will have its joint locked in extension to give rest to the muscles. In this state it is necessary to unlock the joint in order to initiate flexion of the limb: this is done by contracting the extensor muscles first and thereafter flexion may occur in the normal fashion. Swing movements are always combined with spin at the stifle joint. Any defect in this unlocking mechanism of the stifle joint can result in a clinical patellar fixation.

It is an usual circumstance for the patella to rest over the trochlea and lock the stifle joint when a horse is resting in its stall,

but when the structures which unlock the joint are not functioning normally patellar fixation may result. WILLIAMS (1906) was of the opinion that hooking of the patella over the medial trochlear ridge is an anatomical impossibility so long as the joint structures remain intact, but this is not so. From this study and general clinical experience it is evident that biomechanical factors have a great influence upon the development and manifestation of patellar fixation. The patellar mechanism can be influenced by means of orthopaedic measures such as corrective trimming and shoeing.

CHAPTER 4

FUNCTIONAL DISORDERS OF THE FEMORO-PATELLAR ARTICULATION

4.1 Terminology

The normal function of the femoro-patellar joint can be disturbed by fixation and luxation of the patella. The first clinical description of any of these conditions was given by BENARD who in 1828 described patellar lateral luxation in foals. Since then many functional disorders in which the situation and position of the patella is displaced from its normal position have been registered under the terms luxation, or subluxation or, especially more recently, fixation. Theoretically displacement of the patella can occur in dorsal, ventral, lateral and medial directions. WILLIAMS (1906) provided a lucid description of some aspects of patellar dorsal fixation and concluded that there is never a true luxation of the patella. A year later MERILLAT (1907) described dorsal patellar fixation as pseudo-luxation, and claimed that it was probably caused by spasm of one or more muscles of the thigh. In 1912 SEYFFERTH classified patellar disorders in horses as:

I. Stationary dorsal subluxation
II. Habitual dorsal subluxation
III. Stationary lateral subluxation
IV. Habitual lateral subluxation
V. Stationary medial subluxation.

While going through the literature one can distinguish two opinions. One group of authors described and discussed the clinical picture of (dorsal) fixation of the patella under the general heading of luxation, dislocation or displacement. Others prefered to include the term fixation or retention in the title they gave to the condition, emphasizing by their choice of word the belief that the patella was not disarticulated as the word luxation would imply.

(1) *Luxation des rotules*

Benard 1828

Dislocation of the patella

Godwin 1845
Youatt 1848
Gloag 1849
Waters 1854
Saunders 1882
Merillat 1907
Cocharn 1912

Patellar luxation

Williams 1879
McCall 1892
Bauman 1905

Outward dislocation

Steel 1881
Hill 1882

Upward luxation or luxatio patellae dorsalis

Wooldridge 1934
Hartog 1941

Habitual luxation

Schimmel & Van Veen 1909
Berge & Müller 1965

Chronic luxation

Rahimuddin 1944
Pillai 1944
Venkataraman 1947

Intermittent or recurrent luxation

Mitchell 1949
Patra 1954

Chronic subluxation

Gadgil 1963

(2) *Upward fixation*

Williams 1906
O'Connor 1938
Vaughan 1960
Adams 1962
Cresswell & Smythe 1963
Delhanty 1963

Momentary upward fixation

Curtis 1961

Dorsal fixation

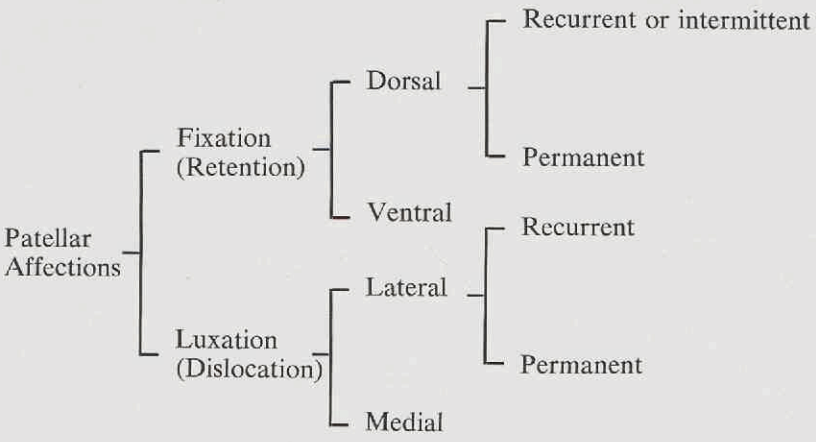
Hoffman 1963
Frank 1964
Hickman 1964

Upward retention

Hickman & Walker 1964

4.1.1

A currently favoured classification of the functional disorders of the patella is as follows:



Conditions listed in this classification are primary functional disturbances: most are idiopathic in nature. It is evident that fixation and luxation of the patella can also be found as secondary affections: the most important are:

a) dorsal fixation of the patella following coxo-femoral dislocation in ponies,
b) patellar luxation due to paralysis of the femoral nerve in calves.

4.2 Dorsal fixation of the patella

4.2.1 Recurrent dorsal fixation

This condition is not apparent in resting animals in which the patella occupies its normal position in relation to the femoral trochlea. It is manifested during progression by an intermittent fixation of the patella through the hooking of the medial patellar ligament over the prominent upper extremity of the trochlear ridge.

4.2.1.1 *Aetiology*

The fixation may be unilateral or bilateral GODWIN (1845). In horses it occurs most frequently in young animals with a faulty conformation of the hind limb FITZWYGRAM (1869), CRESSWELL & SMYTHE (1963), HOFFMAN (1963), and in debilitated animals O'CONNOR (1938), ADAMS (1962) and HICKMAN (1964). In cattle RAHIMUDDIN (1944), PILLAI (1944), VENKATARAMAN (1947), PATRA (1954) and GADGIL (1963) reported it to be a frequent condition affecting young working bullocks. MITCHELL (1949) suggested that this disfuncton of the patella is due to damage to the nerve supplying the quadriceps femoris muscle. Further, HOFFMAN (1962) and CRESSWELL & SMYTHE (1963) pointed out that it may be congenital or hereditary in ponies. It may also be caused by laceration or elongation of the ligamentous structures through trauma GLOAG (1849), MERILLAT (1907) and COCHRAN (1912). It is also caused by the relaxed condition of the patellar ligaments HILL (1882).

4.2.1.2 *Symptoms*

When the animal is first removed from the stable the condition makes itself evident by occasional jerky steps during otherwise normal progression. It frequently disappears as the animal "warms up" with mild exercise. The duration of the warming up process is irregular and it may take some considerable time to get rid of the symptoms. In due course as the condition progresses the symptoms become more frequent and the gait more obviously disturbed. There is a general agreement upon the symptoms that are associated with this condition; the stifle and the hock joints are periodically fixed in extension and this gives the limb an unusual rigidity, while over-flexion of the fetlock causes the toe of the hoof to drag upon the ground during progression (Figs. 5—6).

On clinical examination the patella is some times found to be unusually mobile and in these cases it can readily be carried dorsally by slight manual pressure; if this is done and the animal induced to move, the typical "locked" gait is shown and later, when the patella frees itself, a thudding sensation may be detected. The symptoms may be induced to appear in an exaggerated form by circling the animal

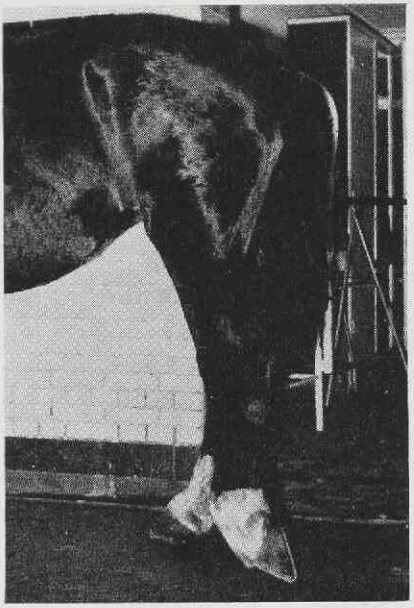


Fig. 5. The left hind limb of a horse affected with permanent dorsal fixation of the patella.

Fig. 6. Cow with permanent dorsal fixation of the patella of the right hind limb. Note typical posture of the affected limb.

with the affected limb on the inner side, while circling in the opposite direction with the affected limb outermost, lessens the symptoms. Certain patients which walk normally may show a mild degree of stiffness of the affected limb when trotting.

4.2.1.3 *Treatment*

Survey of the literature has shown that clinicians have practised different kinds of treatments with varying success. In horses, conservative treatment as rest, massage, fomentation, attention to the diet and mild exercise were advised by YOUATT (1848), WOOLDRIDGE (1934), O'CONNOR (1938) and HOFFMAN (1963). More vigorous measures such as blistering, firing and injection of counter irritants were advocated by GODWIN (1849), WATERS (1854), SAUNDERS (1882), COCHRAN (1912), SHUTTLEWORTH (1935), ADAMS (1962), HICKMAN (1964) and SILBERSIEPE & BERGE (1965). An orthopaedic treatment was introduced by GLOAG (1849) who designed a special shoe, with calkins and a long projecting toe, which was fitted to the affected limb with the object of keeping the stifle joint more flexed. Later NYFFENEGGER (1951) modified this mechanical principle and prepared a shoe with the outside branch higher

and longer than the inside one and shortened the toe as much as possible. When these less drastic methods fail to cure the affection, the last resort of most surgeons is tenotomy of the medial patellar ligament, an operation which results in disappearance of the described syndrome of patellar dorsal fixation.

4.2.1.3.1 *Non-operative*

In general these are based on the following suppositions; first there is slight lengthening or weakening of the straight patellar ligaments caused by overstrain in poor conditioned and young animals which are put to work too early without adequate training (working bullocks and draught horses) and by accidental overextension of the stifle joint; secondly the disturbances of the biomechanics caused by faulty conformation and subsequently abnormal function of the leg result in disturbances of the normal forces in the femoro-patellar articulation. The uncertainities of aetiology and pathogenesis have led to several methods of non-operative treatment, most of which are empirical.

The treatments described below which are based upon anatomical and biomechanical considerations are routinely employed in the Utrecht clinic.

Corrective trimming and shoeing is one of the methods used to prevent the patella from being locked. It provides raised lateral and lowered medial quarters of the hoof, causing correction of the abnormal stresses in the femoro-patellar joint. At times a shoe with calkins is fitted to the affected limb and this results in greater state of flexion of the joint and increased tension in its ligaments.

The second non-operative method assumes that strengthening and shortening of the medial patellar ligament will result from the inflammation and fibrosis that follow injection of counter-irritants in and around it. This treatment can be supported by corrective trimming or shoeing of the hoof. After the injection of counter-irritants the animal is given rest for four to six weeks. Some authorities elsewhere advise increasing amount of exercise from the second day following injection and claim that the animal will be sound by the end of the fourth week.

In the period of two years, nine horses and twentyfive ponies were treated by the methods described above. The horses were divided into two groups: (1) four horses were treated only by corrective trimming and shoeing, (2) in five horses counter irritants were injected in and around the medial patellar ligament and this treatment was supported by corrective trimming.

All the ponies were treated by the injection of counter irritants in addition to corrective trimming of the hoof. They were also divided into two groups: (1) ten animals were given increasing amount of exercise after the third day of injection, (2) fifteen ponies were rested for four to six weeks after the injection.

Results

Among the horses, three out of four in the first group and four out of five cases in the second group recovered from the recurrent dorsal fixation of the patella. Among ponies, seven out of ten in the first group and ten out of fifteen in the second group recovered from the affection.

Tenotomy of the medial patellar ligament was later performed upon two horses and eight ponies which were not cured by the first treatment.

4.2.1.3.2 *Operative*

Consideration of the functional anatomy and biomechanics of the femoro-patellar joint will suggest that tenotomy of the medial patellar ligament will cause a disturbance to the normal conformation and function of the limb. Surgery therefore cannot be accepted as the treatment of first choice in horses, particularly in those patients which one suspects will be put to work at an early date after the operation (race and draught horses and trotters).

In cattle which are mainly used for milk and meat production it is possible to accept more readily those changes in the normal conformation of the joint which are expected to result from the operative treatment. In practice it seems that tentotomy in draught cattle produces no alarming functional disturbances of the femoro-patellar joint and this treatment is recommended in this species.

Technique: Tenotomy can be performed in the standing position in both horses and cattle. The site of the skin incision is indicated by a small depression that may be felt between the middle and medial patellar ligaments above their insertion on the tibial tuberosity. The operational site is shaved and painted with tincture of iodine. Local anaesthetic (2 % xylocaine, 2—5 ml.) is injected subcutaneously over and around the ligament. Sterile surgical gloves are worn and the usual aseptic precautions observed. A small incision is made in the skin between the middle and the medial patellar ligaments, taking care not to penetrate the joint capsule. A tenotom (Fig. 7) is then pushed through the skin incision under the medial patellar ligament

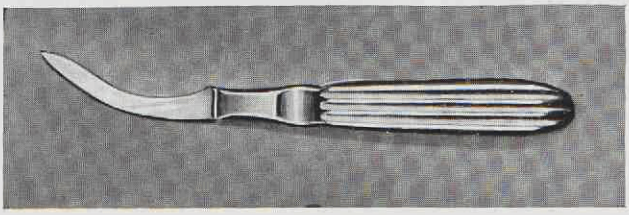


Fig. 7. Tenotom.

and its cutting edge is then directed towards the ligament. The tenotom is now slowly moved while strongly pressed against the ligament which is normally transected in a single movement of the blade. Severance of the ligament is indicated by the development of a deep depression between the cut ends. If the ligament is not completely transected the procedure is repeated. The skin incision is then closed with one or two sutures.

Sometimes the temperament of the animal prevents the performance of this operation in the standing position. In these cases tenotomy is performed after casting. Animals are casted on the affected side and properly secured: the tenotomy is then performed as described above.

Results: During the period of this study twenty cows, two horses and ten ponies were operated upon for tenotomy of the medial patellar ligament. The operation was succesful in every case.

4.2.2 Permanent dorsal fixation of the patella

4.2.2.1 *Symptoms*

This condition though more prevalent in young working cattle is not uncommon in horses and ponies. It is caused by those factors which have been described in the preceding section. When the animal is forced to move, the leg is carried rigidly with the fetlock flexed and the toe dragged on the ground and the weight is supported by the flexed digit. When an attempt is made to back the animal it often refuses to move. Sometimes these symptoms are spontaneously relieved and the animal walks a few steps apparently normally, only to become lame when the patella is again locked. This condition leads to an adaptation of the gait in which the leg is brought forward in abduction in the swinging phase, without flexion of the hock and stifle joints.

4.2.2.2 *Treatment*

Certain early authors FITZWYGRAM (1869), WILLIAMS (1879), STEEL (1881) and HILL (1882) treated this condition in horses by vigorous manipulation: when the patella was unlocked they pulled the limb forward and tied it around the neck with the help of a rope and kept it for 2—3 days in order to prevent the patella from becoming locked again. In a method formerly employed in the UTRECHT clinic, in horses the limb was tied and kept in flexed position for 48 hours after dislodgement of the patella. In cattle and ponies having permanent dorsal fixation of the patella, tenotomy is performed as already described without trying the less drastic methods. Tenotomy was performed successfully in twelve cows, five ponies and two horses suffering from permanent dorsal fixation of the patella. There was no failure.

4.2.3 Dorsal fixation of the patella due to coxo-femoral dislocation in ponies

In the UTRECHT clinic three cases of permanent dorsal fixation of the patella along with the hip dislocation in ponies were encountered during the period of study (1965—68). These ponies were presented in the clinic with the history of stiffness and lameness in one of the hind limbs. The owners had no information about trauma which is possibly the cause of this condition.

4.2.3.1 *Symptoms*

Upon clinical examination it is noticed that the animal walks with marked stiffness of the affected limb. The limb is unable to flex and is held in abduction. When the animal is forced to move, he does so with great reluctance because of the pain and mechanical impediment. While standing it is noticed that the affected limb is short and supports little of the body weight; in motion it is carried in abduction rather than dragged on the ground as in typical cases of patellar dorsal fixation. When passive flexion of the limb is attempted it is not possible to dislodge the patella from its locked position. Examination by palpation of the hip region reveals the displacement of the femoral head. Movements in the hip joint are extremely painful and the animal even falls on the ground during examination. At this stage a tentative diagnosis of hip dislocation was made. Confirmation of the clinical diagnosis was obtained by radiography.

4.2.3.2 *Prognosis and treatment*

The prognosis is poor in ponies in which patellar dorsal fixation is combined with hip dislocation, mainly on account of the latter condition. In one case the fixation was relieved by performing tenotomy of the medial patellar ligament. After the operation the patella was no longer fixed but the animal was still unable to flex the stifle joint.

Dislocation of the hip is the primary affection in these cases and it is postulated that the patella is caught in dorsal fixation at the time of trauma. Due to the antero-dorsal displacement of the femoral head there is a considerable abduction of the limb and the patella, hooked fast over the trochlear ridge, is unable to dislodge. The normal function of the stifle joint does not return even after tenotomy because dislocation of the femur deprives the rectus femoris muscle of its normal leverage. Hip luxation in these cases results in disturbances of the mechanics of the femoro-patellar joint because of the accompaning dorsal fixation of the patella. Tenotomy of the medial patellar ligament corrects the fixation of the patella but it allows little or no additional movement of the stifle and hock joints because of the muscular derangement.

4.2.4 Discussion

WILLIAMS (1906) pointed out that in this condition there is no true luxation of the patella and no hooking of the medial patellar ligament over the internal ridge of the trochlea as had been described in the literature. He put forward the following argument in support of this; the condition invariably occurs spontaneously in horses standing in the stall where there is no history of violence or trauma. According to him hooking of the medial patellar ligament is an anatomical impossibility as the fatty cushion and the aponeurosis of the stifle joint prevent the patella from being hooked fast. During the initial stages of flexion the tension upon the patella tilts it and tends to cause the patella to slip readily downward over the troclhea. He insisted that hooking of the ligament is impossible as long as the joint structures are intact.

MERILLAT (1907) discussed the clinical aspects of patellar fixation in detail and stated that patellar fixation is more of muscular than an articular defect. In dorsal patellar fixation the patella neither occupies an abnormal position nor is its retention apparatus injured. He pointed out that the condition is prevalent only in long-standing, hard working and more fleshy horses and that it was undoubtedly true that horses which sleep while standing are more susceptible. He was of the opinion that the patella is fixed against the trochlear lip by "muscular cramps", resulting in increased femoro-tibial angulation. He stated that the patella was often seen to be fixed on the flattened upper part of the trochlear surface.

Having regard to the functional anatomy and the biomechanics of the stifle joint, it is also my opinion that there is no true luxation of the patella. During extension the patella glides high over the femoral trochlea and in flexion it slides downwards and forwards. This movement of the patella is mainly controlled by the quadriceps femoris and biceps femoris muscles. It is normal for a horse to lock its stifle joint while resting on one hind limb. At this stage the quadriceps femoris muscle is relaxed removing the tension from the patellar base, which results in a slight rotation of the patellar base and forces the apex to submerge between the trochlear ridges. This results in the patella resting on its apex and the fibrocartilage which is firmly hooked on the upper part of the medial trochlear ridge while maintaining proper tension in the patellar ligaments. At this stage the stifle joint is fixed. The objection raised by WILLIAMS (1906) against the hooking of the medial patellar ligament is not valid. When a horse is moved in a circle with the affected limb inside, or when he is backed out, the symptoms of patellar fixation are more prominent because inward rotation of the femur facilitates the hooking of the medial patellar ligament over the medial trochlear ridge.

In normal progression flexion of the stifle is preceded by extension during the thrust phase. Contraction of the extensor muscles pulls the base of the patella and tilts the bone, lifting the apex from

the trochlear groove and it is this adjustment in patellar position that allows the descent of the bone during flexion. This tilting of the patella may not be effectuated in cases having patellar dorsal fixation, which may be a muscular disfunction resulting from poor condition, over work, congenital or hereditary faulty conformation of the limb, faulty shoeing, nervous disorders and malnutrition.

In horses patellar fixation is noticed when the animal is moved out of the stable in the morning or after a long standing rest.

In cattle patellar fixation is invariably first manifested by spasmodic lifting of the limb which slowly progresses to be of permanent nature. This difference may be due to the musculature, which in horses is more powerful than in cattle. In cattle it is most frequently noticed in working bullocks particularly in the morning after a hard day's work; the animal walks stiffly and the movements of one or both the hind limbs proceed by jerks. In a few days the condition may progress to a permanent fixation of the patella, but when the animal is given a little exercise the symptoms are often temporarily relieved. This suggests that it is a functional derangement which is manifested through the patellar fixation. Treatment in such cases is symptomatic.

Before attempting to correct the patellar fixation one must realise that overstretching of the ligaments allows the patella to remain in the dorsal position. Methods available for the surgical correction of this condition are shortening and strengthening or transection of the medial patellar ligament; the effect in each case is to make locking of the patella by hooking over the medial trochlear ridge impossible. Corrective trimming and shoeing of the affected limb aims towards the correction of the biomechanics of the stifle joint. It provides and additional flexion of the stifle joint which prevents the patella becoming fixed dorsally.

4.2.5 Ventral fixation of the patella

An unusual case of ventral fixation of the patella in a horse was described by LEUTHOLD (1959). The horse was found sweating in the stable with the right stifle joint flexed and held in adduction. Clinically it was diagnosed that the patella had fixed under the condyle which was confirmed by radiographs. Suddenly the horse became normal before any treatment was attempted. The author gave his opinion that while resting on the ground the horse might have been frightened by the traffic and suddenly attempted to rise. It was conjectured that during the process of getting up, the patella got locked under the fossa intercondyloidea femoris and retained in this position by the cramp in the M. quadriceps femoris. In time, with the restoration of normal function to the M. quadriceps femoris, the condition relieved itself spontaneously.

4.3 Lateral luxation or subluxation of the patella

Luxation and subluxation are the first to be described of the mechanical affections of the patella and were first reported by BENARD (1828). Since then many authors have reported these conditions under a confusion of different titles. Theoretically luxation of the patella may occur towards; (1) lateral, (2) medial, (3) dorsal and (4) ventral directions. Patellar luxation is congenital or traumatic in origin and is followed by inflammatory changes due to overstretching or laceration or even rupture of the articular and periarticular structures. In different cases the joint capsule, patellar ligaments, adjacent muscles, nerves and even the femoral trochlea and the patella itself are involved. The congenital form of patellar luxation may be apparent at the time of birth or noticed later during the growth of the animal. Traumatic patellar luxation both in horses and cattle is occasionally described in the literature and a few cases have been encountered in this clinic during the last two years. In a number of calves paralysis of the femoral nerve was first wrongly diagnosed as lateral luxation of the patella this becomes clear within a few days. Although the congenital form of lateral subluxation of the patella has long been known to occur in horses as yet no reports of the condition in ponies are found in the literature. In recent years Shetland ponies in the Netherlands are found to suffer more and more often from congenital lateral luxation of the patella.

4.3.1 Recurrent lateral (sub) luxation of the patella

During movement of the limb the patella moves between its normal articulation over the trochlea and the lateral luxated position, sometimes making clicking sounds in its passage.

4.3.1.1 *Aetiology and incidence*

Lateral luxation of the patella in horses was first reported by BENARD (1828). He described this condition in foals and believed it to be congenital: he recognised two varieties, partial and complete luxation of the patella. In 1935, PFEIFFER gave a detailed account of this condition in cold blooded foals. He was of the opinion that this condition is hereditary. In such cases the patella is movable to the lateral side. The lameness is aggravated when they are put to work. There is no overextension but the leg is slightly flexed at both the stifle and the hock joints during the supporting phase. At times a clicking sound produced by the patellar movements may be heard when the animal walks. The joint cavity is distended and a fluctuating painless swelling (hydropsy) occurs. NYFFENEGGER (1951) reported seven cases of patellar lateral luxation in foals and horses. According to him the patella may become luxated when the horse is in process of rising up from the ground. The stifle and the hock joints are flexed and adducted. KOCH et al. (1957) produced evidence that the patellar luxation in cold blooded horses may be genetic in origin due to a

recessive factor. Among the cases mentioned were two foals from the same sire, one of which had bilateral and the other unilateral patellar luxation. SILBERSIEPE and BERGE (1965) believed it to be of rare occurrence in both horses and cattle.

Since 1965, the author had the opportunity to study the cases of recurrent lateral luxation of the patella in the UTRECHT clinic. All the cases presented during this period were ponies. No patient having recurrent lateral luxation of the patella had a history of trauma and the condition appeared to be congenital in every case. It becomes evident as the animal grows and if not, it may be first noticed when the animal is examined for soundness or when put to work. In these cases the patella is generally found to be placed laterally over the femoral condyle. In advanced stages a gono-trochlitis develops with the features of a degenerative osteo-arthritis. Increasing numbers of such cases are now found in Shetland ponies.

HERMANS (1968) is of the opinion that this condition is hereditary. He bred Shetland ponies having lateral luxation of the patella. Where the sire and dam are both affected the offspring also suffered with patellar luxation; the same sire produced two foals from a normal mare; of these one was normal and the other affected.

4.3.1.2 *Symptoms*

Upon clinical examination it is generally observed that by manipulation the patella can easily be moved sideways and when replaced over the trochlea it spontaneously reluxates laterally as soon as tension is created in the extensor apparatus. During the supporting and thrust phases of the gait the patella remains dislocated laterally. While the limb is in the lift and the swing phases the patella occupies its normal place over the trochlea, but dislocates laterally as soon as the limb prepares itself for the supporting phase: this cycle of patellar movements is repeated at every step. These abnormal movements of the patella result in disturbances of the function and biomechanics of the stifle joint. The animal stands in a normal posture and shows no discomfort. When viewed from behind it is found to have turned-in "cow hocks" and abducted stifle and foot. On examination in trot the lameness of the affected limb is most pronounced; the leg is stiff and not fully extended, the pony goes at times at a "bumping trot" and a clicking sound may be heard as the patella moves to and fro between the trochlea and the place of luxation. Sometimes the degree of patellar displacement is so small that it may not interfere with the movements of the stifle joint and does not produce typical clinical symptoms. The affected stifle joints were radiographed and revealed the lateral displacement of the patella (Fig. 8).

4.3.1.3 *Treatment*

Several authors have tried different kinds of treatments with unsatisfactory results. BENARD (1828) treated this condition by

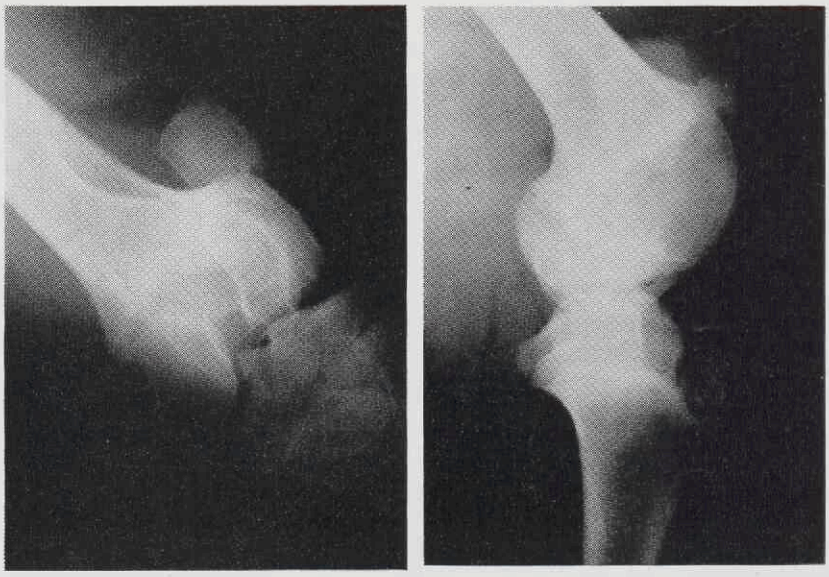


Fig. 8. Postero-anterior and latero-medial radiographs of a stifle joint having recurrent lateral luxation of the patella. There is lateral placement of the patella.

reducing the patella and attempting to retain it in normal articulation by means of a special bandage. Before applying the bandage the joint was rubbed with turpentine oil to produce hyperaemia. The bandage was kept in place for fifteen days. SEYFFERTH (1912) and PFEIFFER (1935) pointed out that treatment of lateral patellar luxation is of little value once gono-trochlitis has developed; blistering, firing and rest may be tried. SILBERSIEPE & BERGE (1965) also suggested blistering the stifle and giving rest to the animal, but held out little hope of recovery. Lateral luxation of the patella results in mechanical flexion of the stifle and the hock joints, though the severity of these is much less in the recurrent form than in permanent. It is clear that no good results can be expected from the conservative treatments, particularly when gono-trochlitis has occurred.

In the UTRECHT clinic the solution for lateral luxation of the patella was found through operative treatment. The principle underlying the surgery is removal of the tension exerted by the fascia, muscles and ligaments which tends to pull the patella laterally. The patella is then repositioned over the trochlea and anchored there by reinforcement sutures at the medial side.

The operation is performed under general anaesthesia as is described in the section 4.3.2. The amount of tissue which is cut in order to free the patella from the lateral pull is less in this form than in permanent lateral luxation.

During the period of study eight ponies aged between four and eight months were operated upon for recurrent lateral luxation of the patella: five of these animals had bilateral and three unilateral luxation.

4.3.1.4 *Results*

Evaluation of the results was complicated by breakdown of the surgical wound following early removal of the sutures from three joints. Debridement and resuturing resulted in good healing. Three out of eight ponies had weak and deformed joints after the surgical treatment. Two of them were euthanised and studied postmortem (4.3.4). Five ponies have good functional use of the operated limb. Radiographs were taken to check the placement of the patella which proved to be satisfactory and in normal articulation over the trochlea (Fig. 9). Here it may be emphasized that increasing age and size of the ponies do not favour success: better results are normally obtained where the foals are operated upon within a few days of birth.

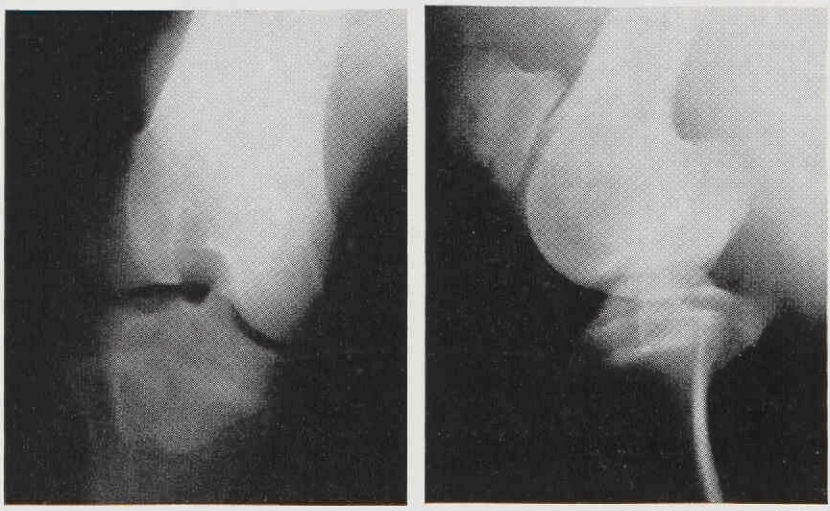


Fig. 9. Stifle joint as in fig. 8 after operation. The patella stays in its normal articulation.

4.3.1.5 *Experimental study*

Ponies with recurrent lateral luxation of the patella are generally operated upon when the condition is first observed by the owner. However, one pony was successfully treated by operation at the age of two years. In adult ponies the muscles are fully developed and this is disadvantageous as it is then more difficult to immobilise the

limb in a plaster cast after the operation. When the mechanism of lateral luxation of the patella is studied it becomes clear that it is the lateral pull of the muscles which luxates the patella. In order to counteract this pull a stainless steel plate was designed (Fig. 10). This plate is fixed to the femur and prevents lateral displacement of the patella. The experimental study was conducted in four ponies having lateral luxation of both patellae.

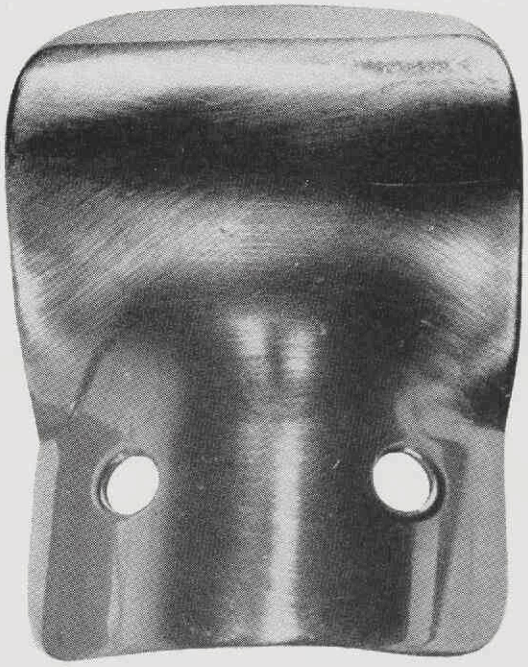


Fig. 10. Stainless steel plate when fixed on the femoral condyle, its flanged part protects the patella from lateral luxation. (magnification 1 × 2.5)

Operation

The operation is performed under general anaesthesia and all those structures which are responsible for the lateral pull upon the patella are severed from their attachments to this bone. The patella is then restored to the normal anatomical position over the trochlea and the limb is passively flexed and extended several times to make sure that the patella is capable of normal excursions over the femoral trochlea. The stainless steel plate is now fixed over the lateral femoral condyle, adjacent to the trochlear ridge, in such a way that its projecting flange will oppose any tendency for the patella to reluxate. Care is taken to avoid injury to the capsule and penetration of the

joint when the screws which retain the plate are put in position. After the plate is secured in position the limb is again manipulated to verify that there is no tendency for the patella to deviate from its correct course and to confirm that the plate offers no obstruction to normal movements. Once satisfied upon these points the operational wound is closed in the usual way (fig. 11).

It is unnecessary to immobilise the limb in a plaster cast. Antibiotics are administered systemically for four to six days. Five stifle joints were operated upon in this fashion, the remaining three being left untreated to provide controls.

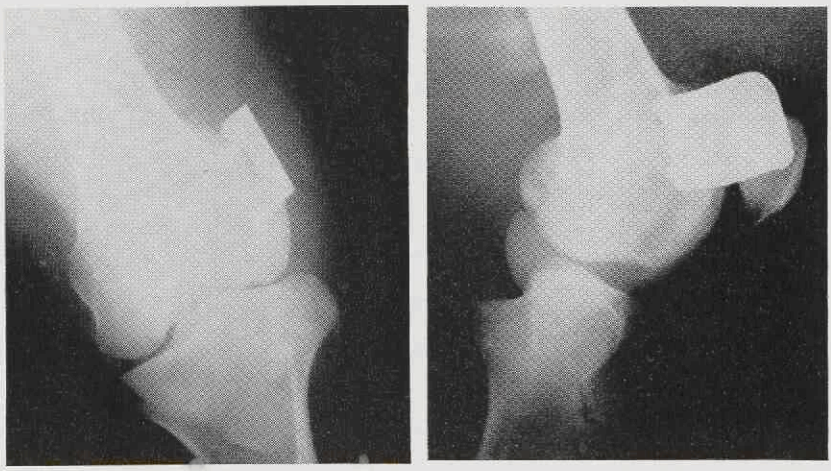


Fig. 11. Postero-Anterior and Latero-Medial radiographs of the stifle joint having recurrent lateral luxation of the patella which was operated for the Stainless Steel plate fixation. (for details see the text).

Observations and conclusion

Four of the five plates were secured by means of stainless steel screws and became detached within a few days when the screws lost their anchorage to the bone. The remaining plate was fixed by means of chromium-cobalt alloy (vitallium) screws and remains firmly in position at the present time, twenty months after operation. Radiological examination of this joint reveals no indications of arthritis or undesirable reactions. The function of the joint appears to be normal and this is in striking contrast to the abnormal movements of its unoperated fellow of the opposite side.

The loosening of the plate following reaction to the stainless steel screws was anticipated as the usual sequel to the employment of non-surgical metals. In the initial stages of this experiment it was believed that fixation of the plates would provide a useful surgical exercise and it was hoped that the screws would not be rejected quite so

swiftly and that these experiments would give preliminary indication of the effectiveness of the device.

As it is, the prospects of the technique must be judged upon the basis of one success. It would obviously be premature to reach firm conclusions upon this slender evidence but the fact remains that normal function is present in this joint twenty months following operation and without obvious tissue reactions: further experiments along these lines are greatly to be desired.

4.3.2 **Permanent lateral luxation of the patella**

In this condition the patella is luxated over the trochlear ridge and rest upon the lateral femoral condyle. It cannot be returned to its normal place of articulation by the movements of the animal nor by manipulation. Admittedly forceful manipulation may temporarily restore it to the trochlea but reluxation occurs spontaneously as soon as the pressure is removed.

4.3.2.1 *Aetiology*

Permanent lateral luxation of the patella in adult horses and cattle is generally acquired and is of traumatic origin, MERILLAT (1907), LACROIX (1930), SHUTTLEWORTH (1935), SINGLETON (1951), GADGIL (1963), SMYTHE (1963) and FRANK (1964). In Shetland ponies however the permanent lateral luxation of the patella is congenital and is probably hereditary; although details of the manner of inheritance are not yet clear the general assumption can hardly be disputed. The condition in ponies is to be differentiated from the common patellar luxation in dogs in which the patella is luxated medially. Patellar luxation in dogs is also hereditary and is most common in the smaller breeds, STADER (1944) and KODITUWAKKU (1962).

4.3.2.2 *Symptoms*

Patellar lateral luxation in foals is apparent at birth and may be noticed by the owner within few hours when the animal first attempts to rise. Patellar luxation in its congenital form was always bilateral in these recorded cases and in such foals both the hind limbs were hyperflexed due to the contraction of the muscles. The extensor muscles which normally extend the limb have their line of force changed by the lateral displacement of the patella and their contraction now results in flexion of the stifle and hock joints. Upon clinical examination of the pony foals it is observed that the fore limbs are normal and are able to support weight but both hind limbs are completely flexed at the stifle and hock joints and are incapable of extension: this posture of the hind limbs is quite unable to support the animal normally and it stands in a characteristic and abnormal posture (Figs. 12—13). These foals quickly tired and they are generally observed in a recumbent position. Palpation of the stifle reveals that the patella has deviated from its normal position and rests over the lateral femoral condyle.

In six out of fifteen cases examined, the patella could be moved but in the remainder it was so firmly fixed in its abnormal position that it could be restored over the trochlea only by the application of a considerable force. The tension upon the patella is such that reluxation occurs spontaneously when the pressure is removed. There is often a considerable distension of the joint capsule and over filling of the joint cavity accompanying the luxation of the patella. In seven

Fig. 12. Pony foal having bilateral permanent lateral luxation of the patella. Standing in a typical abnormal posture.

Fig. 13. Pony foal having bilateral permanent lateral luxation of the patella. Unable to stand and sitting in an abnormal posture.

cases hydropsy of the stifle joint developed and the joint capsule was ruptured by the continuous excessive strain and repeated trauma while attempting to rise. The patella is first held firmly in its abnormal position by the contraction of the muscles and later also by the formation of connective tissues following inflammatory changes in the surrounding structures. Functional movements of the patella are minimal.

For the confirmation of the diagnosis radiographs of the affected stifle joints are taken in postero-anterior and latero-medial directions; these show complete lateral displacement of the patella (Fig. 14).

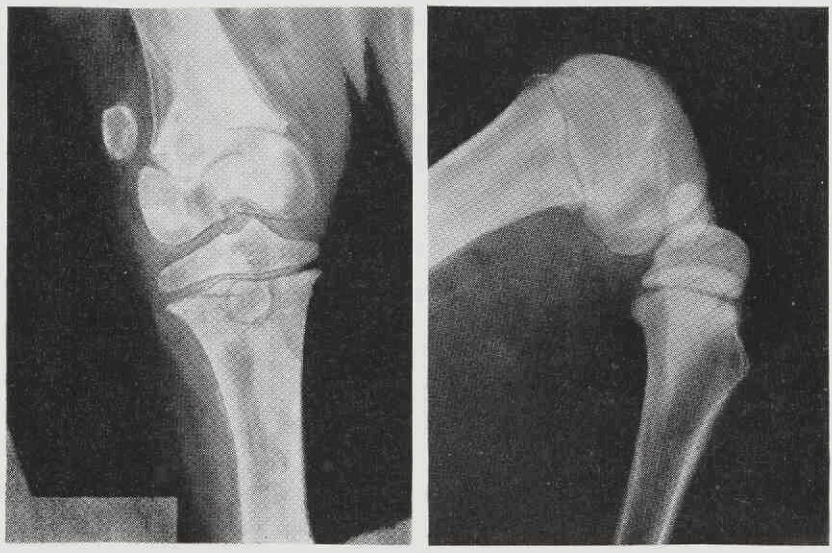


Fig. 14. Postero-anterior and latero-medial radiographs of a pony foal having bilateral permanent lateral luxation of the patella. Note the position of the luxated patella and the acute angulation of the joint.

Permanent lateral luxation of the patella in Shetland ponies is mostly associated with other skeletal deformities. The most common and striking of these is the "prognathia" in which the upper jaw is shorter than the lower (under shot). Second in order of frequency is a distinctive concavity of the fronto-nasal portion of the head which may be due to poor development of the nasal bones. The prognathia generally improves as the animal grows.

4.3.2.3 *Treatment*

In 1907 MERILLAT succesfully treated three cases of traumatic lateral luxation of the patella in horses. He applied a rope around the pastern and tried to pull the affected limb backwards while

manually helping the patella to dislodge from its luxated position. During this procedure which was accompanied by much struggling one animal himself overflexed the limb till the stifle touched the belly when suddenly a thudding noise was heard as the patella returned to position.

The mechanism of permanent lateral luxation of the patella must be studied before attempting any kind of treatment. Though the condition is congenital and hereditary yet it is basically a mechanical affection in which the patella is lying at an abnormal place. In view of the above considerations and the pathology of the patellar luxation, the affected Shetland pony foals were treated by the following surgical operation. It is purely a surgical affection and there is no rational basis for non-operative methods of treatment.

Anaesthesia

Theopentone sodium is injected intravenously to induce anaesthesia which is maintained with Halothane inhalation through the semiclosed circuit.

Operation

The site of operation, anterior and lateral to the stifle joint, is clipped and shaved from the upper thigh to the middle of the tibia. The operational site is thoroughly cleaned with spirit and painted with tincture of iodine to disinfect it. After completing the preparations for aseptical surgical procedure the actual operation is performed in the following way. The operational site is covered by a sterile shroud having 20—25 cm long opening in its centre. A skin incision is made lateral to the joint extending from lower third of the femur to the proximal extremity of the tibia. This exposes the fascia of the M. fasciae latae which is also incised longitudinally exposing the Mm. biceps femoris and vastus lateralis. The cranial part of the biceps femoris is isolated and its tendinous insertion to the lateral border of the patella is severed.

Part of the attachment of vastus lateralis muscle to the dorsal aspect of the patella is also destroyed. Experience has shown that the complete division of this muscle is unnecessary and is to be avoided. Following section of these two muscular attachments attempts are made to place the patella in normal articulation and the limb which has till now been flexed is extended. At this stage it is usually possible to reduce the luxation without much difficulty. Luxation however often recurs when the limb is passively flexed. If this happens it is clear that a more complete division of the lateral patellar connections is necessary and the extent of the additional surgery is determined by palpation while an assistant manipulates the limb through a normal range of movements. The structures which continue to exert a lateral tension upon the patella are cut one by one until patella is enabled to follow its normal course. The amount of tissue that must be

sectioned depends upon the severity of adhesions and no two cases are similar. It is necessary to repair tears in the joint capsule before the superficial structures are sutured as the capsule may be damaged by self inflicted trauma or by the manipulation of the patella during correction. Preoperative rupture of the capsule leads to an oedematous condition of the surrounding structures which complicates the surgical procedure. As a precaution against reluxation of the patella four to six sutures of No. 2 chromic catgut are placed in the patellar fascia medial to the bone and sufficient tension is applied to hold the patella in place without causing it to be drawn medially. These sutures should not be anchored in the muscular mass in order to avoid interference with the muscular activity. Excessive strain upon the sutures is liable to result in poor functional use of the joint. It has been found that mattress sutures are better than ordinary interrupted ones for this purpose. Broad spectrum antibiotics are put in the operational field. A piece of "spongostan" is placed in the depression created by cutting the biceps femoris and vastus lateralis attachments over the patella. This material is later absorbed and the depression filled by the growth of fibrous tissue. The cut ends of the biceps femoris and the vastus lateralis are not joined. The fascia of the M. fasciae latae is sutured with catgut while keeping the limb in extension. Finally the skin incision is closed with perlon. The operated limb is kept in the normal extended position by the application of a plaster cast.

Post-operative care

After operation the foal, along with the mare, is kept in a well padded box. Antibiotics are injected intramuscularly for five to six days. The plaster cast is removed after an interval of seven to ten days. Skin sutures are normally removed after ten days but their removal is delayed if the healing of the wound is retarded.

4.3.2.4 *Results*

Fifteen pony foals having bilateral permanent lateral luxation of the patella were operated upon. Four foals died after the operation due to a systemic infection (navel ill). Eleven foals were successfully treated, nine have a very good functional use of both hind limbs without any sign of patellar luxation (Fig. 15). In two animals the results were unsatisfactory and the functions of the limb were restricted because of atrophy of the quadriceps femoris muscle: there is however no patellar luxation. Radiographs confirmed the clinical observations and show that the patella remains in its normal articulation over the trochlea (Fig. 16).

The five cases which are described below were examined sometime after the operation. The rest were sound and were sold. Their status was confirmed with their present owners.

Fig. 15. Same pony as in fig. 13 three weeks after the operation.

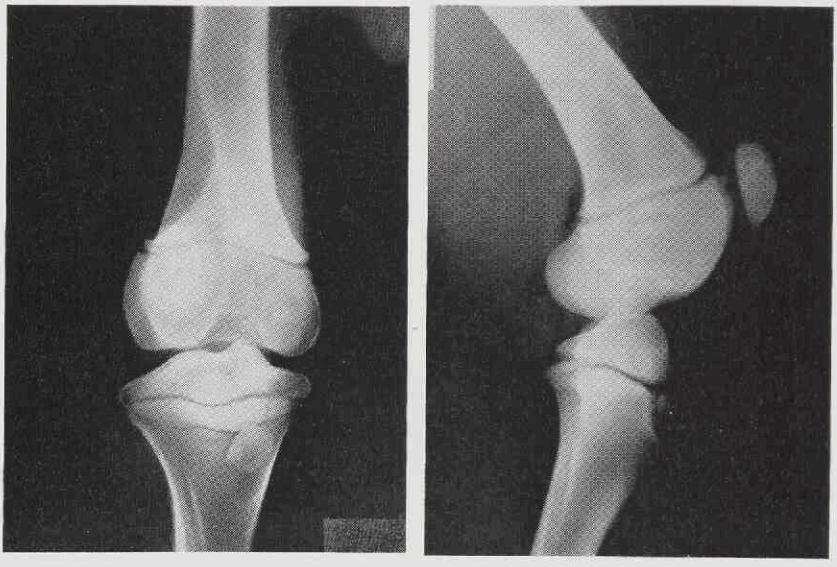


Fig. 16. Postero-anterior and latero-medial radiographs of the stifle joint of the pony foals after operation. Note the normal position of the patella and the angulation of the joint.

Serial No. 1. *Breed:* Shetland pony. *Heelkunde No.* 64-07-257.
Age: 14 days. *Diagnosis:* Bilateral permanent lateral luxation.

Operation was performed as described in the text and antibiotics were injected for seven days.

Examination after two years.

In the left stifle joint the patella was in its normal articulation but the joint was considerably weak. The left limb had an elongated hoof which was a congenital defect and the animal was still lame after the correction of the hoof. The right stifle joint was normal, the patella was over the trochlea and the gait was normal.

Serial No. 2. *Breed:* Shetland Pony. *Heelkunde No.* 65-04-398.
Age: 3 days. *Diagnosis:* Bilateral permanent lateral luxation.

Operation was performed as described in the text except that the joint got opened while replacing the patella.

Examination after sixteen months.

The patella of the left stifle joint was still lateral to the trochlea and could be moved sideways. General development of the thigh muscles was poor and a defect could be felt lateral to the joint. Patella in the right stifle joint was over the trochlea and was unable to move sideways. General development of the animal was satisfactory.

Serial No. 3. *Breed:* Shetland Pony. *Heelkunde No.* 65-05-308.
Age: 5 days. *Diagnosis:* Bilateral permanent lateral luxation.

Operation was performed as described in the text.

Examination after sixteen months.

The left patella was placed more medially and could be moved sideways and the left joint was overfilled and the animal was lame on this limb. In the right stifle joint the patella was over the trochlea but was movable to sideways. The general development of the animal was good.

Serial No. 4. *Breed:* Shetland Pony. *Heelkunde No.* 65-09-132.
Age: 6 weeks. *Diagnosis:* Bilateral permanent lateral luxation.

Operation was performed as described in the text.

Examination after thirteen months

One patella was firmly placed over the troclhea and there was a mild hydropsical condition of this joint. The other stifle joint was

similar to the left one though it was not hydropsical. The general development of the pony was very good and the animal went sound. There was no detectable defect in either joints.

Serial No. 5. *Breed:* Shetland Pony. *Heelkunde No* 66-05-160. *Age:* 2 days. *Diagnosis:* Bilateral permanent lateral luxation.

Operation was performed as described in the text. Animal suffered with pneumonia and thrombophlebitis, hence antibiotics were continued for a longer period.

Examination after seven months

The patella in each joint was in its normal place but the animal was lame on both sides. The right stifle turned inward and the hock outward. Both the limbs were weak and defective. Later the animal was sacrificed. On autopsy it was found that there was excessive formation of the fibrous tissues and the femoro-patellar joint anchylosed.

4.3.3 Medial luxation of the patella

It is well known that this condition is common in dogs but almost unknown in horses and cattle. In this clinic a case of medial patellar luxation was recorded in a horse in 1958 (58-02-151): no treatment was attempted and the animal was slaughtered.

One of the experimental ponies in which a stainless steel plate was fixed to correct recurrent lateral luxation of the patella was found on the third day following operation to be unable to bear weight. The stifle joint was swollen and very painful. On palpation it was found that the patella had dislocated medially, a diagnosis which was later confirmed by radiographs. No attempts were made to reduce the patella and the pony was euthanised.

4.3.4 Pathology of the stifle joint having patellar luxation

PFEIFFEFR (1935) gave an detailed account of the pathology of the stifle joint in animals having patellar luxation. In most cases there was gono-trochlitis of the femoro-patellar articulation. The common changes in the joint are: longitudinal erosions of the articular cartilage, poor development of the lateral trochlear ridge, flattening of the groove, a red thickened and folded synovial capsule and joint mice in the joint. The joint capsule is over distended and hydropsical.

Ten stifle joints of Shetland ponies having lateral patellar luxation were dissected in order to study the pathological changes. These foals either died or been euthanised due to poor prognosis because of systemic or local infection. In the permanent form of patellar luxation the flexed stifle joint could not be extended even by manual force. The patella was found to be resting upon the lateral femoral

condyle. The femoro-patellar joint capsule was distended laterally and overfilled. In six joints the capsule had been ruptured due to recurrent trauma, producing an oedematous condition of the adjacent tissues. Inflammatory changes were found in and around the joint resulting in the formation of connective tissue around the patella. Both the femoro-patellar ligaments were indistinct. M. vastus lateralis and the cranial part of the M. biceps femoris were found to be pulling the patella laterally which could be confirmed by assesing the effects of

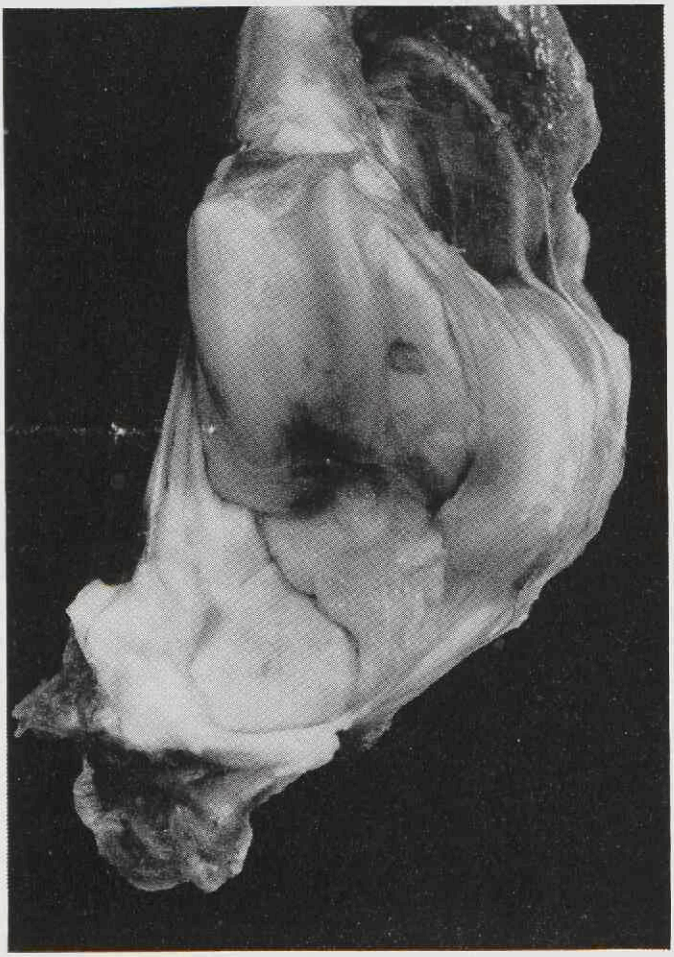


Fig. 17. Degenerative osteo-arthritis of the stifle joint in a chronic cases of recurrent lateral luxation of the patella. There are erosions of the articular cartilages of the patella and the trochlea and over the luxated position of the patella.

removing their attachments to the patella. The middle and lateral ligaments were normal but relaxed whereas the medial patellar ligament was pulled laterally. The trochlear ridge was poorly developed and the trochlear groove represented only by a flat surface in the young foals. In two ponies having recurrent lateral luxation of the patella gono-trochlitis developed. On autopsy it was seen that the articular cartilage of the patella and the lateral trochlear ridge were eroded. In adult ponies with recurrent lateral luxation the lateral ridge of the trochlea was smooth and ill defined because of constant side-ways movements of the patella. The synovial membrane was thick and degenerative arthritic changes were present (Fig. 17).

4.3.5 Discussion

In horses and cattle patellar luxation is commonly to the lateral side whereas in dogs it is to the medial. Lateral luxation of the patella is common in ponies, particularly in heavybuilt animals with short bones: the same is true for dogs. This conformation of the body is one of the factors predisposing to patellar luxation which may be attributed to the muscular force exerted upon the patella. In horses and cattle the well developed medial trochlear ridge and three straight patellar ligaments, along with the direction of the muscular force on the patella, do not allow it to luxate medially. In adult horses permanent lateral luxation of the patella is rare and of traumatic origin: manual replacement of the patella in these cases though difficult will result in cure but if delayed gono-trochlitis and permanent lameness develop and due to the irreparable injury to the ligaments the animal becomes unfit for hard or fast work.

In the congenital form encountered in ponies the lateral pull of the muscles over the patella does not permit it to be replaced manually. The patella can be replaced over the trochlea only if these structures are cut to free the patella. It demonstrates that the lateral pull of the muscles on the patella plays a great role in patellar luxation. It is essential to hold it over the trochlea otherwise it reluxates. As the extensor muscles are unable to exert their force the flexor muscles will flex the joint hence it is essential to immobilise the limb to prevent these muscles flexing the stifle and hock joints: but if prolonged, immobilisation may produce muscular atrophy.

4.3.6 Patellar disfunction due to the paralysis of the femoral nerve

Anatomy. The femoral nerve is derived from the fourth and fifth lumbar nerves and descends between the sartorius and ilio-psoas muscles SISSON & GROSSMAN (1966). It detaches the saphenous nerve and then divides into several terminal branches which innervate the quadriceps femoris muscle.

Aetiology and symptoms. Femoral or crural paralysis in adult horses is often associated with haemoglobinuria. It may also be caused

by pressure exerted by abscesses, tumours and aneurism of the external iliac artery. Overextension combined with abduction of the hind leg may also stretch the nerve which sometimes results in rupture of the nerve particularly during parturition. Young calves with femoral paralysis often have a history of difficult parturition. In the very animals differentiation between femoral paralysis and lateral luxation of the patella may be difficult. The diagnosis of nerve paralysis presents no problems if there has been sufficient atrophy of the quadriceps muscle. Horses with crural paralysis are unable to extend the stifle joint. The affected quarter is lowered because these joints are flexed. In long standing cases the quadriceps femoris muscle is atrophied and appears as a thick cord-like structure. The patella may be moved sideways with a gentle force; the patellar ligaments lack the tension necessary to keep the joint in normal state of angulation. The stifle joint is unable to bear weight and flexes as soon as the animal tries to put weight upon it.

Treatment and prognosis. The treatment and prognosis depend upon the causation of the condition. When there is no informative history general measures may be taken to stimulate the affected limb. Adult horses are regularly exercised on a level ground and this is sometimes of benefit. This may be due to the fact that some abductor and adductor muscles take over the function of the extension. Calves born with femoral paralysis later developed in a normal manner except for the atrophy of the affected muscles: and they can stand and walk but with slackness of the affected limb.

Necropsy findings. A week old calf which clinically exhibited the symptoms of lateral patellar luxation but had femoral nerve paralysis was euthanised and dissected to study the pathological anatomy of the femoral nerve. On dissection it was found that the femoral nerve was ruptured at the point of its separation from the obturator nerve. Blood vessels around the nerve were also traumatised which resulted in haemorrhage around the site of rupture.

4.4 Analysis of cases of patellar luxation and fixation in horses, cattle and ponies treated in Heelkunde from 1956 to 1965

Table No. 1

Affected limb	horses	cattle	ponies
Left limb	31	31	13
Right limb	24	60	11
Both limbs	37	51	61
Total number of cases	92	142	85

Table No. 2

Animals	Dorsal fixation Recurrent / Permanent	Lateral luxation Recurrent / Permanent	Total
Horses	68	10	78
Cattle	136	6	142
Ponies	46 18	9 12	85
Horses	14 unknown		

Table No. 3

Animals	1956	'57	'58	'59	'60	'61	'62	'63	'64	'65	Total
Horses	7	8	9	9	13	4	12	12	12	6	92
Cattle	33	30	17	26	13	1	1	7	5	9	142
Ponies	2	3	6	6	6	14	6	11	25	6	85

Table No. 4
Showing treatment and results in cattle.

Treatment	No. of cases	Result
Tenotomy of the medial patellar ligament.	148	good

Table No. 5
Showing treatments and results in horses

Treatment	No. of cases	Results
Tenotomy of the medial patellar ligament	20	good
Injection of Equasin and hoof correction	30	20 good 5 poor
Special shoeing or only hoof correction	4	5 unknown good
No treatment was done	22	unknown
Total	76	

Table No. 6

Animals	Winter	Spring	Summer	Autum	Total
Horses	25	13	20	34	92
Cattle	37	37	28	40	142
Ponies	24	20	18	23	85

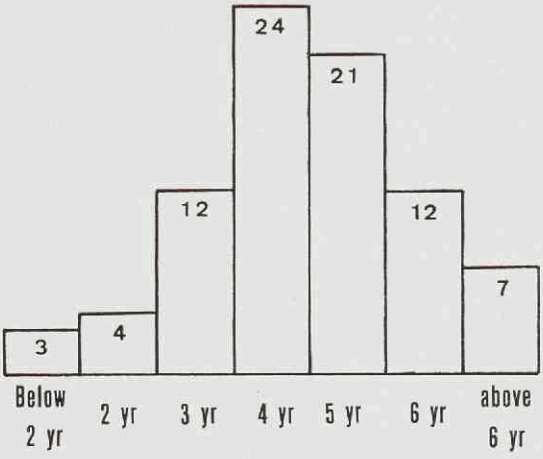
Table No. 7
Showing treatment and results in ponies.

Treatment	No. of cases	Result
Tenotomy of the medial patellar ligament	16	good
Injection of Equasin and hoof correction	40	19 good 4 poor 17 unknown
Only hoof correction or special shoeing	3	2 good 1 poor
Operation for lateral patellar luxation	7	2 died 5 good
No treatment done	7	unknown
Total	73	

Table no. 8
Breed of ponies affected with patellar luxation and fixation.

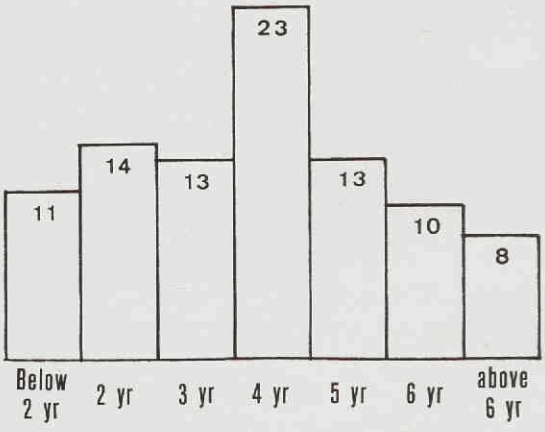
Breed	No. of cases
Shetland	71
New Forest	10
Welsh	10
Others	5
	96

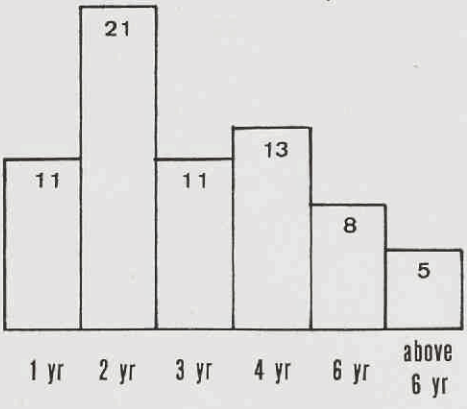
NUMBER OF CASES AND AGE DISTRIBUTION



COWS

HORSES





PONIES

CHAPTER 5

GENERAL DISCUSSION

It is not the convention of medical science to discuss a pathological condition without first giving it a proper name. In the general sense diagnosis is the art or science of distinguishing between one disease and another. Its practice consists in the recognition of the one symptoms which may be supplemented by findings of the laboratory and by specialised examinations. Analysis of a disease means dividing and subdividing it into its components and later each condition is bounded by its definition through the process of synthesis and by setting limits to it. Early authors concerned with patellar affections often failed to analyse the nature of the conditions they described and were content to apply a title, more or less specific as they pleased. As a result we now find in the literature a great variety of terms for one and the same condition of the femoro-patellar joint. There are no provisions through which these outmoded and sometimes inaccurate names can be deleted.

Although it is difficult to define and classify a disease in absolute terms yet attempts at classification are essential if there is to be a common basis for discussion. A general classification of the patellar functional disorders has been essayed utilising the more appropriate terms employed in recent publications. In the preliminary stages of this investigation it was believed that a sufficient explanation of the origin of most cases of patellar disfunction might be found in the conformation of the articular structures and the biomechanical analysis of the working of patellar mechanism of the normal joint was initiated. This expectation has been realised in part only. The brief and sometimes contradictory accounts of the mechanism which are found in the current literature have been amplified. On the other hand it has become apparent that many cases of patellar disorders are of myogenic origin while of the remainder a part shows such obvious malformation of the bone that no subtle explanation of the disturbances are required. It is clear that individual variations in curvature and dimensions of the joint structures are of such extent that only the analysis or examination of a great wealth of material would provide a sufficient basis for a statistically firm conclusion. The biomechanical part of this thesis is therefore restricted to an exposition of the general principles and the mathematical analysis was not persued.

The categories of patellar affections which are most frequently reported in the literature are dorsal fixation of the patella in horses and cattle, and lateral luxation of the patella in ponies. In the former condition the patella does not deviate from its normal excursion but becomes arrested and held at the limit of its range and thus fixes the limb in extension. In the later condition there is a definite departure of the patella from its normal articulation in the trochlea and the

limb is held in flexion. In both affections the extensor apparatus of the stifle joint is denied normal function. Treatment to correct the patellar fixation is symptomatic as it is based upon correcting the symptoms shown by the animal. The treatments commonly practised have been described in the text. These are simple, rational and designed to correct the fixation in a purely mechanical fashion since in most cases it is difficult to determine the aetiological factors.

There is an allied condition, "permanent lateral luxation of the patella" upon which the literature is silent. This appears to occur only in the Shetland pony breed in which it has become increasingly known to the equine practitioners during the last decade. In adult ponies it is prevalent in a recurrent form: it is difficult to correct this affection of mature animals simply because the muscles which pull the patella laterally are fully developed and have adapted to the abnormal direction of their pull. Shetland pony foals with permanent lateral luxation of the patella respond well to surgery when operated upon within a few days after birth and the results are encouraging. This is due to the fact that the muscles can adapt to alter their line of action after the surgical correction of the luxation: if surgery is not delayed the changes that occur in the affected joint are minimised. It is emphasised that extensive surgery should be avoided and every effort made to minimise tissue damage.

Conclusions

I. Dorsal fixation or retention of the patella is caused by muscular disorder rather than by articular defects. In its chronic stages it produces gono-trochlitis and lameness of the affected limb.

II. In horses non-operative treatment for dorsal fixation of the patella should be attempted before resorting to the operative method. In cattle tenotomy of the medial patellar ligament is recommended as it does not interfere with their normal work.

III. Permanent lateral luxation of the patella in ponies is congenital and probably hereditary: it is apparent at birth. Recurrent lateral luxation of the patella is probably hereditary but is not usually detectable for sometime after birth.

IV. Pony foals suffering from permanent lateral luxation of the patella should be operated upon without delay, as the inevitable repeated trauma results in gono-trochlitis. Contraction of the surrounding muscles and aponeurosis make surgery and subsiquent adaptation more difficult.

CHAPTER 6

SUMMARY

In horses and cattle the conditions known as fixation and luxation of the patella have been considered as functional disorders of the femoro-patellar articulation. In order to amplify the existing meagre accounts of the functional movements in the stifle joint a study has been made of the anatomy of this articulation, and of its biomechanics. The principal movements of the stifle joint are extension and flexion and this swing is combined with a spin, twist or rotation of the femoral condyles upon the tibial plateau. Two menisci which are interposed between the femur and the tibia produce greater congruity and increase the area of the weight bearing surfaces. As the spin occurs in the terminal phase of extension the collateral ligaments become taut in sequence and prevent overextension of the joint, safeguarding the articular structures.

Hypomochlions of the medial femoral condyle were determined. Since these hypomochlions do not coincide this reveals the occurrence of translatory movements in the stifle joint. The geometrical relation between the hypomochlions and the projected middle patellar ligament was also determined in the normal standing position of the animal.

In the fourth chapter the varied and confusing terminology which is still in use in the literature to designate patellar fixation is summarised, and a classification of these affections based upon current practices is recommended.

A condition that is often found in horses and cattle is patellar dorsal fixation, whereas lateral luxation of the patella is common in Shetland ponies. Dorsal fixation of the patella occurs in young, hard-working animals. In horses it occurs spontaneously while they are resting in stable, in cattle it starts with occasional jerky movements of the limb and slowly progresses towards a permanent fixation. The symptoms typical of the recurrent and permanent phases are described in detail. As a general rule tenotomy is performed in cattle suffering from patellar fixation. As horses are required to work at a faster pace less drastic treatments were first tried: these included the corrective trimming of the hoof and the application of a special shoe having calkins or long projecting bars. Injection of counter-irritants in and around the medial patellar ligament, supported by corrective trimming of the hoof was also employed as these non-operative treatments often resulted in success. The cases which did not respond to these measures were later treated surgically by section of the medial patellar ligament.

In adult horses patellar luxation is of traumatic origin. Lateral luxation of the patella in Shetland ponies was found to be congenital. Such pony foals are only able to stand by adapting an abnormal posture with both the hind limbs completely flexed at the stifle and hock joints. Ponies with recurrent lateral luxation of the patella nor-

mally show no alarming symptoms when standing or walking, but examination while trotting may reveal lameness of the affected limb. Both the forms of patellar luxation in ponies are successfully treated by a surgical procedure in which the patella is replaced over the trochlea after relieving the tension which pulls it laterally. A few mattress sutures are placed over and medial to the patella to prevent it from being reluxated. Lateral luxation of the patella exhibits no striking age incidence. It has been observed that dorsal fixation of the patella most commonly affects ponies at the age of two years and horses and cattle at the age of four years.

SAMENVATTING

De functiestoornissen (kreupelheden) voortkomend uit afwijkingen in het femoro patellair gewricht, waaraan bijzondere aandacht wordt besteed zijn: de dorsale fixatie van de knieschijf bij paard en rund en de laterale luxatie van de knieschijf die, in de laatste tien jaar vooral bij de Shetlandpony wordt gezien.

In de literatuur en het veterinaire spraakgebruik worden de begrippen fixatie en luxatie afwisselend en door elkaar gebruikt voor één en dezelfde functiestoornis die veroorzaakt wordt door een vasthaken van het kraakbenige uitsteeksel van de patella op de mediale kam van de trochlea. Deze begripsverwarring is mede aanleiding geweest om behalve de klinische aspecten van de functiestoornissen ook de topographische en functionele anatomie en de biomechanica van het femoro patellair gewricht in het onderzoek te betrekken.

Hoofdstuk twee geeft een overzicht van de topographische en functionele anatomie van het femoro patellair gewricht waarin bijzondere aandacht wordt besteed aan het „vergrendelingsmechanisme" van dit gewricht.

In hoofdstuk drie wordt de biomechanica geïntroduceerd als hulpmiddel voor een beter begrip en inzicht in de wijze van functioneren van het kniegewricht, dat als een scharniergewricht wordt beschreven.

Naast de functies buigen en strekken blijkt in de belastingsphase in het kniegewricht nog een draaiing op te treden van de femur ten opzichte van de tibia. Ook de patella neemt bij het glijden over de trochlea aan deze rotatie deel. Daar de M. quadriceps een belangrijk aandeel heeft in de excursies van de patella werden de draaipunten in de mediale femur condyl bepaald ten opzichte van de "line of action" (middelste rechte knieschijfsband) van deze spier bij normale stand en belasting van het been.

Hoewel in dit onderzoek niet alle mogelijkheden van biomechanische benadering van de functie van het femoro patellair gewricht en het vergrendelingsmechanisme zijn benut mag de conclusie worden getrokken dat het mogelijk moet zijn door wijzigingen in de stand van het achterbeen (orthopaedische maatregelen) invloed uit te oefenen op het patellair mechanisme zowel in positieve als negatieve zin.

Het klinische gedeelte (hoofdstuk vier) begint met een classificatie van de mogelijke functionele afwijkingen van de patella gebaseerd op de topographische en functionele anatomie (hoofdstuk twee), en klinische waarnemingen.

Vervolgens worden aetiologie, symptomatologie en behandeling van de functiestoornissen besproken in volgorde van hun belangrijkheid te beginnen met de dorsale fixatie van de patella.

Bij de habituele vorm van de dorsale fixatie wordt wat paard en pony betreft bijzondere aandacht besteed aan de niet-operatieve be-

handeling in de vorm van orthopaedisch beslag dan wel een besnijden van de hoef waarbij de binnen verzenen laag en het toongedeelte kort gehouden worden; een en ander aangevuld met de injectie van een cicatriserende stof („Equasine") in en rondom de mediale rechte knieschijfsband. Wat de permanente dorsale fixatie betreft wordt een tenotomie van de mediale rechte band volgens de klassieke methode aanbevolen. Bij het rund komt een niet-operatieve behandeling niet in aanmerking.

Van de luxaties van de patella heeft van oudsher de laterale subluxatie (klapmouw) de aandacht getrokken, een afwijking die zonder adequate behandeling steeds tot kreupelheid (stijfheid) tengevolge van een zich ontwikkelende gonotrochleitis zal leiden. Een operatieve behandeling (zie 4.3.1.3) biedt een redelijke kans op herstel indien de operatie binnen enkele weken na de geboorte plaats vindt.

Op oudere leeftijd kan een speciaal daarvoor ontworpen stainless steel plaatje een aanvaardbaar hulpmiddel zijn om het opnieuw afglijden naar lateraal van de patella te voorkomen (4.3.1.5).

De permanente laterale patella luxatie zoals die de laatste tien jaar als congenitale afwijking bij Shetlandpony veulens wordt gezien is tot nu toe niet in literatuur beschreven.

De patella ligt in deze gevallen naast de laterale kam van de trochlea waardoor de spierfunctie zodanig wordt verstoord dat de M. quadriceps en M. biceps femoris als buigers van het kniegewricht gaan functioneren. De veulens worden met sterk gebogen achterbenen geboren en kunnen zich nauwelijks oprichten (fig. 12 en 13). Alleen een operatieve repositie en fixatie van de geluxeerde patella gepaard gaande met een myotomie van belangrijke delen van M. quadriceps en M. biceps femoris geeft een goede kans op een functioneel aanvaardbaar herstel (4.3.2.4).

Met een analyse van de gevallen van patella fixatie en luxatie bij paard (pony) en rund uit de Kliniek voor Heelkunde in de periode 1956—1965 en een algemene discussie wordt het proefschrift afgesloten.

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CURRICULUM VITAE

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STELLINGEN

I

For dorsal fixation of the patella in horses less drastic methods may be tried before resorting to the surgical treatment.

II

Permanent lateral luxation of the patella in ponies can be successfully treated by the surgical procedure.

III

Intra-reticular radiographic technique for foreign body in ruminants is of little value to a surgeon and the patient.

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VI

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VII

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