Review Article

Anatomical and surgical basis for the treatment of paralytic knees

SUMMARY

Knee is the joint of lower limb that reassembles the lower extremity of femur, upper extremity of tibia and the patella. It's a complex joint, at the time movable, lithe, solid and resistant, for

which paralysis cause a grave functional handicap because of its intermediate situation in lower limb.

Paralysis has indeed some consequences on muscular balance and osteo-articular growth, which generate orthopedic deformities,with a wide range of clinical forms. However these deformities

cannot be analyzed individually because, if they have a own anatomopathological reality, this one is often modified by which happens above (hip) or below (foot).

Three main etiologies, poliomyelitis, myelomeningocele and cerebral palsy, summarize well the set of asked problems.

In any case, spasticity, contracture, stiffness, laxity, neurological ,deficit must be assessed thanks to a precise orthopedic check-up.

Three therapeutic means, reeducation, bracing and surgery,combine complementarily to correct deformities and improve function.

Introduction

- The knee joint is a complex joint, which must have both stability and mobility because it is very much in demand in everyday life and in sport.
- Paralytic damage to this joint is a serious handicap because of the strategic position of the knee within the mechanical system of the lower limb
- Three main etiologies, namely poliomyelitis (pure motor paralysis), myelomeningocele (motor and sensory paraplegia) and cerebral palsy (central paralysis), summarise the problems.
- Paralytic knee disease has consequences on muscular balance and osteoarticular growth, which will lead to neuro-orthopaedic deformities in the joints, resulting in a multitude of clinical pictures. A good evaluation of the causes of these deformities (spastic or retracted muscles, joint stiffness), allows the therapeutic choice to be planned.
- Interest: Through a review of the literature, we will expose the different anatomical and surgical principles in the treatment of paralytic knees

II-Paralytic knees

A-General

- Paralytic knees cannot be separated from the neurological context which conditions the patient's lifestyle, nor from the rest of the musculoskeletal system because of its strategic place within the lower limb.

Neuro-orthopaedic deformities, which are the consequence of muscular imbalances, represent the main part of the clinic whatever the aetiology.

The study of these segmental disorders is complex and must be integrated into the overall analysis of the lower limbs and the subject being examined:
- The nature of the peripheral or central paralysis and its translation to the muscle effector.
- Segmental disorders, limitation of joint mobility or growth disorder observed at each joint.
- The above and underlying impact.
- The functional impact on ambulation by analysing the contralateral healthy or paralysed limb

There are several etiologies responsible for knee paralysis, which can be cerebral, spinal, muscular or peripheral nerve related.

Objective:
In the context of our study, we will focus on the three main aetiologies that summarise the problems posed, namely: poliomyelitis, spina bifida and cerebral palsy (CP).

A-Polio knee

1-Generalities

Acute anterior poliomyelitis is an infectious disease that is epidemic and endemic throughout the world. It is caused by an enterovirus, which often progresses through four periods: Incubation period, invasion or pre-paralytic phase, paralytic phase and a recovery phase The most commonly affected muscles in the lower limb are the quadriceps, triceps and leg muscles.
- Muscle recovery depends on 3 elements:
o the number of motor neurons free of the initial damage.
o the number of affected motor neurons that recover and return to normal function
o the number of motor neurons that emit axonal extensions that re-innervate muscle fibres that are no longer re-innervated.

2 Consequences of paralysis.

o The sequelae of poliomyelitis: are due to the destruction of the cells of the anterior horn of the spinal cord and the brain stem. This causes paralysis of the lower motor neuron with flaccidity of the muscles but normal sensitivity. The degree of damage to the spinal cord determines the degree of muscle damage.
o Due to the fantasy of muscle deficits, asymmetrical muscle forces are often exerted on a joint, creating muscle imbalances with retractions of the stronger muscles.
o In addition to these retractile tendencies, the effect of loading creates deformities in the joints with deficient muscles, particularly in the knees, feet and spine.
o All these problems are greater in children where growth spurts can dramatically worsen the orthopaedic condition.

Paralysis tends to affect some muscles rather than others. As a result, contractures may occur, due to the imbalance between the affected and healthy muscles.

Other key causes of contracture include the effects of gravity, the effects of bending in bed and the result of leaning on a weak lower limb.

As a side effect of these causes, there is damage to the joints, bones and peripheral tissue at the level of the initial contractures.

o The joint capsules retract on the flexed side, the epiphysis may become flattened or deformed, intermuscular partitions, nerves and vessels shorten over time.
o At the flexed surfaces, the skin itself may show a retraction phenomenon

3. Poliomyelitis knee deformities
It is the paralysis of the quadriceps that dominates the clinical picture. The paralysis and retractions will combine to cause flexion, recurvatum, varum and valgum deformities.

3.1 The flexed knee
This is the most common deformity(1) :
Onimus found it in half the cases in a series of 600 African children with sequelae of poliomyelitis(71). The retraction of the internal and external hamstrings and sometimes of the twins, is opposed to the paralysis of the quadriceps, but the knee flexum can also be the compensation of a hip flexum or equinus of the foot.

Initially , the flexed knee is tendinous, but it may become progressively bony due to the growth disturbances it causes (2).

In adults, flexion deformity of the knee can sometimes be very serious. This is usually associated with subluxation of the tibia backwards and forwards, and sometimes also with external rotation of the tibial plateau, which will frequently result in a painful stiff knee.

Flexion occurs in two main situations:
- If the subject walks autonomously, with a paralysis of the quadriceps, during the stance phase, the line of gravity passes behind the knee, making it necessary to stabilise the knee with the counterpart hand and flex the trunk
- In more severe flexion, the affected limb cannot support the body weight, and if this is combined with moderate paralysis of the contralateral lower limb, the individual loses the ability to walk. Knee flexion is then an obstacle to the achievement of a large walking apparatus.

In all cases, correction of knee flexion is imperative. (3)
3.2 The recurvatum knee
Knee recurvatum is defined by the degree of knee hyperflexion obtained beyond sagittal femorotibial alignment equal to 180 degrees at baseline. A femorotibial angle found at 190 degrees corresponds to an overall recurvatum of 10 degrees.

It is a deformity combining a posterior capsulo-ligament distension and a bony recurvatum (mixed recurvatum).

This deformity is the consequence of an active quadriceps and hamstring paralysis or, on the contrary, of a paralysed quadriceps and a fixed equinus. Poliomyelitis is the most common cause(4).

The initial paralysis of the quadriceps causes a recurvatum attitude when walking, which tends to increase the pressure on the anterior part of the tibial plateaus due to the excess rolling of the femoral condyles.

This results in damage to the tibial growth plate, a decrease in the tibial slope, and therefore a bony recurvatum. At the same time, posterior capsulo-ligament distension worsens, resulting in an increase in knee recurvatum.

The recurvatum knee can be useful if it allows stabilisation by moving the mechanical axis of the knee forward of the femoral-tibial joint. Indeed, this attitude must be respected, as it is the only way to guarantee knee locking in this type of muscle damage.

When the recurvatum worsens during the passage of the step, we speak of "tilting in recurvatum during monomodal support".

3.3 The valgum knee
It is relatively common (10 to 15 cases). It can be seen in isolation or in association with flexion, recurvatum or external tibial torsion.

The valgus knee may be static or dynamic in origin, it may be directly related to paralytic changes in the knee or secondary to a deformity of the hip or foot.

The dynamic valgum knee by paralysis of the internal flexors with a preponderance of the biceps muscle is not frequent, in cases of total or subtotal paralysis of the knee, it is generally due to contracture of the tensor of the fascia lata, with the hip going into external rotation and abduction while the knee goes into flexion.

The valgum knee is the consequence, most often of static alterations of the limb.
- The position of a paralyzed hip is often the external rotation which not only leads to its intrinsic deficit, but also to the need for the patient to ensure a wider polygon of sustentation, and if at the same time there is a paralysis of the knee, the static effort is concentrated on the medial collateral ligament which ends up distending.
- The medial space opens up while the lateral space pinches with an increase in overload, resulting in valgus.
- The valgus knee can be the compensation of a deformity of the hip or the foot. In the first case, it is the consequence of an adducted attitude of the hip. In the second case, it is the result of the patient's effort to compensate for a varus foot. As the support on the outer edge of the foot is unstable, the patient tries to lean on the ground with the sole flat and forces the knee into valgus.
- The valgum knee does not justify surgical treatment in principle, except when it interferes with the fitting of the apparatus.

3.4 The varum knee
It is always observed in association with a flexural deformity. Its origin is most often dynamic, due to the traction exerted by the internal flexors of the knee while the biceps is paralysed. It can also represent the compensation of a valgus of the foot.

B. Spina bifida knee
<u>1. General</u>

Early involvement of the neuraxis leads to malformation of the vertebrae, meninges and spinal cord. This is a defect in the fusion of the vertebral blades on the midline, induced by a defect in the closure of the neural tube. It is a serious condition in terms of vitality (infection, hydrocephalus) There are three anatomical lesions of increasing severity:

- spina bifida occulta .
- meningocele.
- Myelomeningocele, the most severe and frequent, is characterised by protrusion of the medullary tissue and meninges through the skin gap. The underlying motor, sensory and vasomotor deficits are related to the level and extent of the injury.

The lesion level corresponds to the last root responsible for muscular activity. Below the lesion level there is an absence of innervation above the lesion, there is in principle a normal spinal cord
Gait prognosis: depends mainly on the quadriceps (L2-L3-L4), key to standing
Above L3, the quadriceps is paralysed and independent walking without aids is not possible.
Below L5, independent walking is theoretically possible but sometimes difficult due to weakness of the gluteal muscles.

Between L4 and L5, the intermediate stage, the aggravation is even more marked since the quadriceps weakens as it struggles against knee flexion, a consequence of the absence of the gluteus maximus and triceps.

2. Orthopaedic deformity :

They depend on the level of injury and the consequences of the paralysis on the locomotor system Muscle imbalances aggravated by fatigue and retraction, osteoarticular growth disorder. These deformities occur mainly in the sagittal plane (flexion or hyper-extension) and the quadriceps is an important element of the orthopaedic prognosis in this case.

If its value is sufficient, it allows autonomous walking and a good locking of the knee, if on the contrary the quadriceps is weak or limited, it cannot oppose the automatic activity of the hamstrings, to the weight of the body when standing up.

2.1 Bending deformations

They are common. It is possible to observe

- a so-called "batrachian" deformity: this is an external rotation flexion of both hips and flexion of the knees secondary to spina bifida at the thoracolumbar level which, in addition to the flaccid paralysis, can generate reflex activities often involving the external rotators of the hip and the hamstring muscles.
- Valgus external rotation: The weakness of the gluteal muscles, more or less associated with that of the quadriceps, leads to a flexion attitude which begins as soon as the child starts to walk. This flexion deformity of the knee invariably leads to a valgus deviation.
- Patients with weakness in the hip adductors and plantar flexors of the ankle aggravate this external valgus deviation when walking.

External rotation is the consequence of a lesion which is located in particular at the L4 level. When it is bilateral, it leads to a so-called mirror deviation: valgus flexion on one side and varus flexion on the other. (5,6,7,8)

2.2 Stiffness in extension

They are less frequent than bending deformations.

It may be a genu recurvatum or, more often, a stiff knee in hyperextension
The genu recurvatum is never considerable, whereas the irreducible extension can be very troublesome for sitting and walking for example.

Knee extension stiffness is frequently associated with other homolateral deformities such as flexion and external rotation, dislocation or subluxation of the hip, equine varus of the foot and internal rotation of the leg. It is mainly L3, L4 paralysis with fixed knee extension.

It may be due to fibrosis of the quadriceps or bony deformities such as fracture of the distal end of the femur consolidated in a vicious position (9,8).

<u>2.3 Valgus deformity</u>
It can be observed in isolation or in association with external rotation of the tibia after retraction of the tensor fascia lata. It occurs especially in the case of injury at L1, L2 level. If this deformity hinders the fitting of the apparatus, it may justify surgical correction.

C-KNEE OF THE CEREBRAL PALSY(CPMS)

1. General

Cerebral palsy (CP) is the consequence of a brain injury of variable location and size, occurring in the ante-natal, neonatal or immediate post-natal period, resulting in motor, sensory and sensory signs that may be associated with varying degrees of impairment of intelligence and possibly comitiveness. (10)

The brain injury results in variable neurological forms that greatly influence the existence of orthopaedic disorders:

● Spasticity it is especially in this most frequent form that orthopaedic problems will arise This term covers polymorphous entities: Isolated exaggeration of the stretch reflex, postural, resting hypertonia, abnormal reactions, a combination of reflexes and pathological reactions, excessive resistance to stretching of both active (contractile) and passive (viscous retraction) origin.

For the orthopaedic surgeon, spasticity is the opposite of athetosis in that excessive contractions do not cause abnormal movements at rest;

✓The diplegic form: is a particular form where the spasticity mainly affects the lower limbs with flexion-adduction attitude of the hips, flexum of the knees and variable deformity of the feet (equinus valgus or talus), associated with internal rotation of both lower limbs.

✓The quadriplegic form:The pathophysiology of the deformities is under the double dependence of the brain lesion and the bone growth. Spasticity progressively leads to growth disorders of the muscles, which become short, and to osteoarticular deformities. (11,12,13)

2. Deformations of the IMOC

<u>2.1 Genu flexum</u>

Knee flexion is very common. The spastic state leads to a disturbance of the motor pattern with an imbalance between agonist and antagonist muscles, which is reflected in the knees by the hyperactivity of the hamstrings and the weakness of the quadriceps which struggles to maintain joint balance.

The genu flexum may also be secondary to hip flexion (insufficient gluteus maximus, hyperactivity or shortness of the rectus anterior or femoral anteversion) or to a foot deformity (equinus or talus).

If the flexion is moderate because it is compensated by good hip extensors and ankle flexors, it is compatible with independent walking. It can thus be hoped that it will not worsen, because the spasticity of the hamstrings is no longer too great and is easily compensated for by the strength of the quadriceps.

On the other hand, if the flexion is no longer compensated, it worsens because the spasticity is greater, the hamstrings are shorter, which results in an ascension of the patella alta and stretching of the patellar tendon, leading to a decrease in the efficiency of the quadriceps (12,14).

2.2 Genu recurvatum

They are exceptional because in the spastic patient the muscle imbalance is mainly in the sagittal plane with a predominance of the hamstrings. They may be secondary to abnormalities in other joints including excessive femoral anteversion and valgus instability of the astragalo-calcaneal joint.

V-OTHER ETIOLOGIES OF PARALYTIC KNEE

There are other causes of knee paralysis. These include

- Cerebral and spinal cord injuries with multiple aetiologies: traumatic, infectious, vascular tumour, degenerative, malformative.

- Myopathies: (9) of varying severity, they are currently classified into 4 types:

  o Muscular dystrophies are degenerations of the muscle fibre. They are both the oldest and the most common. Examples are Duchenne's dystrophy and Becker's dystrophy.

  o Myotonic syndromes, congenital myopathies and metabolic myopathies

Currently, the treatment of these diseases can only be palliative.

Orthopaedic deformities are the consequence of muscle weakness and the possible retractions that accompany it. Retractions can lead to various deformations of the knee, almost always in flexion.

- Arthrogryposis (15) is a non-hereditary condition, present from birth. It causes limb malposition, predominantly in the extremities and often symmetrical.

The topography of the disease is variable, with localization in the lower limbs in 45% of cases. The lack of mobility is due to muscular insufficiency through atrophy or fibrosis, which is accompanied by secondary retraction of the capsules and periarticular ligaments.

The knees are usually fixed in flexion with a shortness of skin in the popliteal fossa.

The quadriceps is weak or sometimes even totally inactive. Sometimes the knees are fixed in full extension or even in recurvatum. The quadriceps muscle, which is often strong in this case, causes a permanent flexion of the hip at birth.

The hamstring muscles are difficult to assess until some range of motion in knee flexion is regained.

- Isolated crural paralysis (12) may be seen in the setting of direct shock or knife trauma, hip and abdominal surgery, abscess or haematoma of the psoas.

Its injury at the pelvic level leads to paralysis of the quadriceps and psoas (motor slowing down of the crural arch-muscle).

The sensory deficit affects the anterior aspect of the thigh and sometimes the inner edge of the leg
III-Principle of surgical treatment of paralytic knees

1-Orthopaedic stretching procedures

Different types of musculo-tendinous lengthening gestures can be proposed, the choice of which takes into account three elements:

a) The importance of the elongation sought

b) the functional or non-functional purpose

c) the existence of antagonists, their muscle strength, their mode of expression

1.1. Simple tenotomy

It consists of a pure section of the tendon which can, in certain cases, be carried out under local anaesthetic when it is isolated. It allows an elongation which has no limit in the correction of the deformity, but it makes the muscle lose its functional possibilities. It can only be proposed if the antagonists are absent.

1.2 Tendon lengthening

- intramuscular lengthening

It consists of performing a tendon tenotomy at the emergence of the tendon within the muscle fibres or myo-tendon junction, thus the elasticity of the muscle fibres allows for an elongation evaluated on average aat around 15 mm. This procedure preserves all the functional capacities of the muscles, without the phenomenon of sideration, with the possibility of immediate active rehabilitation.

- Intra-tendon lengthening It is based on the principle of Z-shaped tenotomies, either percutaneous or open, allowing the desired lengthening. Tenotomy-suture is preferred when the status of the antagonists remains uncertain to avoid any risk of hypercorrection.

1.3 Muscle disinsertion

The principle is to uninsert all the muscular insertions en bloc and to ensure a mobilisation of the musculo-tendinous body while remaining pedicle on the vascular-nervous bundle. The degree of lengthening depends on the possibilities of mobilising the vascular-nervous bundle.

2-Tendon transfers

Their purpose is to compensate for absent antagonists. There are two types of transfers: active tendon transfers and passive tendon transfers (or tenodeses)

2-1 active tendon transfers

Treatment consists of transferring the distal insertion of a muscle to enable it to perform the desired movement. These transfers can only be performed if the muscles have a strength rating of at least 4.

Unlike tendon transfers in peripheral paralysis, tendon transfers in central injury are performed on muscles with impaired control. It is important that the analytical or synkinetic contraction occurs during the movement being sought.

2.2 passive tendon transfers

They are based on the realization of a proximal fixation of a tendon to ensure a positional balance of the joint. The proximal tenodesis can be either osseous or ligamentary.

3 - osteoarticular gestures

Several types of intervention can be carried out.

a. Arthrolysis

The aim is to free the joint by cutting through the capsular, ligamentary and sometimes muscular formations. They are quite rare in deformities of neurological origin which are by nature extra-articular.

In all cases, arthrolysis must respect the lateral ligaments or the central pivot, in knee arthrolysis, to avoid joint instability.

b. Arthrodesis According to some authors, they have no indication in the proximal joints: hip, knee. For others, however (2), arthrodesis can be proposed as a first-line treatment in a regulated surgery, to treat a paralytic knee.

There are 2 types of arthrodesis:

- extra-articular arthrodesis, which has become rare, in which the joint is fused without approaching it, using a bone graft.

- Intra-articular arthrodesis, the most frequently practised, in which the joint is approached openly for the bone elements in direct contact so that they join together like fragments of a fractured bone.

4-Osteotomies

It is defined by the resection of a bony wedge. In paralytic knees, the osteotomy can be low femoral or high tibial.

Generally, it is performed at the level of the deformity itself. If the deformity does not dictate the location, it is performed at the metaphyseal level.

5-The arthroplasties

They are part of the orthopaedic possibilities for the treatment of spasticity within the framework of vicious circles associating joint arthrosis and an increase in spastic hypertonia. Associated musculotendinous or neurotomy procedures should exceptionally be performed at the same time.

III. Anatomical and surgical basis of the paralytic knee

A. GOALS OF PARALYTIC KNEE SURGERY

The treatment of paralytic knees is based on the action of the agonists by restoring sufficient length to the musculo-tendinous complex, and at the same time on the antagonists by strengthening them or by carrying out a tendon transfer depending on whether they are present, but insufficient or absent. This rebalancing is sometimes accompanied by articular gestures which must allow mobility and/or articular stability

IV-MUSCULO-TENDON SURGERY

1. Lengthening surgery

1.1 Hamstring tenotomy

The treatment of knee flexion depends on its extent, with prevention being the best Therapeutic. If it is moderate (below 30°), it can be corrected by re-education and orthopaedic means, posture or standing braces.

Above 30°, it may require a hamstring release.

- Technique: The patient is positioned prone.

A tenotomy of the semitendinosus and rectus internus is performed, combined with a lengthening of the semimembranosus and, outside, a lengthening of the biceps. The type of lengthening,

intramuscular or Z-shaped, depends on the amount of lengthening required. A lengthening is commonly performed when the muscle strength of the hamstrings is at least 3.

Tenotomy is performed in case of weakness.

Sometimes an additional procedure is performed on twins. This depends on whether they are retracted or not.

The evaluation will be possible after having extended the hamstrings, at the maximum extension of the knee, to appreciate the tenodesis effect of the twins with the appearance of an equinus. In this case, a proximal disinsertion of the twins will be performed.

When full knee extension is not achieved, a posterior capsulotomy is performed. The incision of the capsule is made from the posterior margin of the medial collateral ligament to the posterior margin of the lateral collateral ligament.

In the most severe cases, a section of the posterior cruciate ligament is associated.

Postoperative immobilisation is essential to maintain the result obtained. It is performed with a plaster cast or a Zimmer splint in case of moderate flessum.

However, disunion or skin ulceration may occur. In the case of significant deformity (28), immobilisation is performed with an external femorotibial fixator.

This technique seems to be superior to successive casts, as it allows for easily achieved postures, limits skin risks and facilitates rehabilitation

1.2 Re-energising the extender(5,7)

Re-tensioning of the extensor apparatus may be warranted if there is hyper elongation of the patellar tendon and a patella alta. It consists of tenotomy-resection of the rectus abdominis at the level of the anterior inferior iliac spine and plication of the patellar tendon, or distal transfer of the anterior tibial tuberosity.

- Technique: The patella is lowered so that its lower pole is level with the joint space, with knee extension. In close to or mature skeletal patients, distal transfer to the anterior tibial tuberosity with screw fixation of a bone block containing the patellar tendon is performed. In skeletally immature patients, the insertion of the patellar tendon at the inferior pole of the patella is cut and the tendon shortened (approximately 2cm).

The distal tip of the patella is excised; the tendon is then reconnected to the patella. A Steinman pin is placed transversely through the patella and embedded in a cast.

In all cases, it is imperative to correctly evaluate the tone of the quadriceps in order to avoid hypercorrection in and extension the functional repercussions that this entails.

2. Tendon transfers

There are some basic common principles for successful tendon transfer:

- Each muscle to be transferred must be strong enough to do the work of the paralysed muscle properly.

- A weak muscle always becomes weaker after transfer. From a practical point of view, the transferred muscle must have a muscle strength of at least 4.

- The path of the transferred muscle must be as direct as possible and as close as possible to the ideal path of the replaced muscle, which sometimes comes up against anatomical obstacles such as the aponeuroses to be resected or bony projections to be circumvented.

- The route must also allow for sliding and therefore use the subcutaneous fatty tissue or even the sheath of the replaced muscle. The innervation and vascularisation of the transferred muscle must not be compromised during the tendon transfer.

Transplant harvesting should at best remove a bony or cartilaginous film that will allow for a more solid anchorage after transfer. (16,17)

2.1 Hamstring transfer

Transferring the hamstrings to the patella can (only partially) supplement the strength of the deficient quadriceps, provided that both the biceps and the semitendinosus are transferred for greater strength and better balance (preventing the risk of patellar decentration). The result is better if the quadriceps is not totally paralysed and if the gluteals and triceps provide effective additional stabilisation. (55,85)

In the case of a complete quadriceps deficit, to avoid a recurrence of flessum, the medial rectus can also be transferred. The transfer does not allow the quadriceps to actively lock the knee, but rebalances the flexor/extensor tension.

In case of hip extensor deficits, the rectus femoris, semitendinosus and biceps can be transferred to the femoral condyles (Eggers' procedure).

Patella transfer technique:

The tendons are detached from their insertions and the musclebodies of the biceps and semitendinosus are released as high as possible. The medial rectus is sometimes used to reinforce the transfer. From a transverse incision at the upper edge of the patella, a transverse breach is made in the bone substance, through which the tendon(s) are passed and sutured to the quadriceps expansions. If they are not long enough to pass through the patella, they are sutured to the periosteum of the upper segments of the lateral edges of the patella. A pelvic-pedicle immobilisation is then applied for six weeks with the knee in 5-10° flexion and the ankle in neutral dorsiflexion. (1)

Transfer technique on the condyles (16):

The insertions of the hamstring tendons and the tendon origins of the gastrocnemius are exposed through a horizontal incision in the popliteal fossa. The semitendinosus and biceps tendons are detached from their insertions, the short portion of the biceps is resected from the tendon.

An intramuscular or Z-shaped lengthening is performed on the semitendinosus, depending on the degree of muscle tension. Eggers' operation (16) consists of a total distal transfer of the hamstrings without leaving any muscle flexing the knee. In order to prevent recurvatum (the main complication of the operation), some authors prefer to transfer only the semitendinosus and biceps, leaving the semimembranosus to act as a knee flexor.

The latter is suitably elongated to prevent flexion and thereby reduce the popliteal angle. In Eggers' original approach, fixation of the tendons to the posterior surface of the condyles is technically difficult due to the deep plane location and the presence of popliteal vessels and arterial anastomoses of the knee. The tendons are therefore indirectly fixed to the condyles by suturing them to the tendon origins of the gastrocnemius muscles.

2.2 Tendon transfer of the tensor fascia lata

The tensor fascia lata has the advantage of having fibres whose direction and length are similar to those of the quadriceps, apart from the fact that these two muscles are synergistic

In addition, distal disinsertion of the tensor fascia lata reduces the hip flexion often present and removes the flexor and valgator effect of this muscle on the knee.

Technique described by Riska (12): Through an external longitudinal incision from the inferior edge of the trochanter and folding towards the anterior aspect of the knee, a 4 cm wide strip is cut and folded around a hinge provided by the anterior edge of the iliotibial band; keeping a fixed point on the patella, a longitudinal suture is made to the medial rectus tendon.

Riska proposes another formula for using the iliotibial band, which he detaches completely from its tibial insertion and, after having detached it very high, sutures it to the patella after creating a bone tunnel through which he passes the terminal tabs.

After the operation, immobilisation is carried out with a plaster splint for one month, with knee extension and slight hip flexion. But already under immobilisation, static contraction exercises of the tensor fascia lata are performed 3 or 4 times a day. (10)

2.3 Anterior rectus tendon transfer (5,7,10)

Walking in permanent flexion (or squatting) remains one of the most difficult situations to treat in the cerebral palsy patient. The transfer of the anterior rectus is proposed by some authors as a palliative treatment for the hyperactivity of the hamstrings due to spasticity. The aim is to reduce the flexion forces during the stance phase, and thus strengthen the movements in the sagittal plane during the swing phase.

Potential sites for transfer are the medial rectus, couturier, semitendinosus and iliotibial band.

Technique: An oblique incision is made, approximately one finger's width apart, starting above the patella and extending upwards and medially for a distance of approximately 7 cm. The aponeurosis is incised and the rectus is identified. The muscle is detached from its quadricipital insertion, as low as possible, and freed as high as possible from its attachments to the vastus medialis and vastus lateralis. The tendons of the vastus medialis and the vastus lateralis are joined by a continuous suture to create an intact quadricipital tendon. The medial intermuscular septum and all its sheaths are exposed and opened as far up and down as possible.

If the suture is to be used, it is mobilised anteriorly, a forceps slid posteriorly draws in the rectus tendon, which is wrapped around the suture and then sutured to itself. One or two sutures are then made across the anastomosis to hold the tendon in place.

Tension the muscle and prevent any upward slippage of the rectus abdominis on the seamstress.

In the case of transfer to the medial rectus, after opening the medial intermuscular septum, the muscle is mobilised forward by flexing the knee and its intramuscular tendon is isolated. An intramuscular tenotomy of the medial rectus is performed, then the distal end of the anterior rectus is sutured to its stump by a Pulvertaft-type anastomosis.

Immobilisation is not immediate, but rehabilitation should be started as soon as possible to avoid adhesions

3.1 Correction of knee flexion

Knee flexion is a considerable functional handicap for people with severe paralysis of the lower limbs. In all cases, its correction is imperative.

The extension of the knee will thus lead to an automatic stabilisation of the joint during the stance phase by resorting to postural locking even in the absence of the quadriceps;

The body's axis of gravity will shift in front of the knee, making walking possible without the need for external stabilisation.

- Supra-condylar femoral extension osteotomy (8,10,12)

In cases where the flexion is less than 30 degrees, the supra-condylar femoral extension osteotomy represents a simple and effective surgical technique, on the other hand, when the flexion is greater than 30 degrees, it requires firstly a release of the soft parts (lengthening of the hamstrings), then a slow and progressive correction thanks to the installation of an Ilizarov apparatus which allows, on the one hand, to control the tension of the posterior vascular-nervous elements and, on the other hand, to carry out a supra-condylar osteotomy in order to gain the last degrees of residual flexum.

Technique: the fascia lata is incised, the most distal fibres of the vastus lateralis are reclined and access is gained to the supra-condylar region, which is uncovered subperiosteally; the dissection must remain extra-articular. The site of the osteotomy is identified and must be located in the metaphyseal area. Correction is made by wedge-shaped resection with an anterior base, or even by trapezoidal resection if there is concern that the extension may put abnormal tension on the vascular pedicle.

A preoperative tracing can be used to calculate the exact anterior corner to be removed. A posterior hinge must be left, which is an important guarantee of the stability of the osteotomy.

After resection of the anterior corner, a diaphyseal-metaphyseal impaction is performed in order to put the knee in extension. A few degrees of recurvatum are tolerable but should not exceed 5°. It is then desirable to resect a small wedge, even if it means making a secondary adjustment in the case of an insufficient correction.

Anterior staple or screw plate fixation can then be performed, with the knee held in correction, and is completed with a crural pedal cast in knee extension for a period of 4 weeks.

- Trepano-osteoclasia

It is a simpler technique and easier to perform than osteotomy. It was first proposed by Brandes in 1932 for the correction of spinal deformities; its indication was extended to deformities of other pathologies such as poliomyelitis.

It consists of performing a manual osteoclasty after having weakened the chosen area and then correcting it with a series of perforations

Technical :

A series of divergent fan-shaped perforations are made percutaneously on each side of the metaphysis using a straight perforator with a square cross-section, arranged in a plane perpendicular to the axis of the bone so as to break the trabeculae.

Outside of this area, it is advisable to insert the perforator just in front of the Maissiat's band so as not to run the risk of damaging the external popliteal sciatic nerve. Once the bone is sufficiently weakened, a simple manual osteoclasty can be used to correct it. The perforations must be made in sufficient number so that the osteoclasty can be performed with the least possible force. a

If the procedure has been performed correctly, the characteristics of a subperiosteal fracture are reproduced, in green wood, with interlocking fragments.

Trepano-osteoclastic surgery avoids secondary displacement of the fragments, whose stability is ensured thanks to the periosteal sleeve remaining almost intact and to the interlocking of the cancellous tissue for the same reasons;

Consolidation is achieved more quickly than with conventional osteotomies. (12)

3.2 Correction of the recurvatum knee

The recurvatum must sometimes be respected in the case of a major quadriceps deficit; it helps to lock the knee for standing and walking. In this case, the only thing to do is to monitor the deformity and to prescribe a cast with the knee slightly flexed.

But one can also observe an irreducible extension, very awkward for the sitting position and which

Compromises statics. Surgical sanction is the rule by lengthening the quadricipital tendon or mobilising the quadriceps according to the Judet technique. The difficulty is, here again, to maintain the result acquired by regularly mobilising the knees and alternating postures in flexion and extension. Bone interventions are still the most commonly practiced.

- Supra-condylar femoral flexion osteotomy (2,8,13)

Difficult to perform, it aims at correcting the sagittal axis defect, but also very often the additional rotation or valgus anomalies.

This is a posterior subtraction osteotomy. The procedure is performed externally. The principle is the same as that of the flexion correction osteotomy.

After the guide pin has been inserted, the knee is held in hyperextension and the blade is pushed in for 3 cm, with the plate forming an angle with the femoral shaft equal to that at which the recurvatum is to be reduced. The wedge-shaped resection is then performed and the blade-plate is fixed permanently. An anterior hinge is usually maintained to ensure good strength.

This solution seems preferable to the anterior opening, which poses the problem of tensioning the extensor system, which opposes the correction of the recurvatum.

In children, a "chevron" femoral osteotomy technique was described and proposed, associated with plaster cast immobilisation without any added osteosynthesis means. It addresses the need for correction of an inverted tibial slope. The most commonly used method at present is the H Dejour technique.

This is an anterior suprathecal opening osteotomy. The skin incision is anteromedial, along the medial border of the patellar tendon. After subcutaneous detachment and identification of the tendon, a 6 to 8 cm long tibial rod is prepared with corticospongy bone to raise the TTA. The guide wires are then positioned under the control of the image intensifier, directed from front to back, The guide wires are then positioned under the control of the image intensifier, directed from front to back, from bottom to top, 4 cm from the anterior joint space and about 6 mm from the posterior joint space, in the area of insertion of the PCL fibres, above the tibial insertion of the posterior hulls, thus preserving a posterior hinge.

The osteotomy is performed with an oscillating saw, on pins, above the superior fibula-tibial joint.

There is no need to perform a fibular osteotomy. The opening of the tibial osteotomy is achieved by stacking Lambotte blades successively into the bone, one on top of the other, in order to obtain the correct degree of correction desired by the programming. It is considered that 1 mm of opening osteotomy allows to obtain a correction of about 2°.

The osteotomy site is then grafted with corticospongy iliac bone grafts. The means of fixation is the Blount staple. The TTA is reattached with two screws, taking care not to alter the patellar height.

It is therefore necessary to raise the bone rod to the height of the anterior tibial opening. The osteotomy respects a posterior tibial hinge

Post-operative care:

Contraindicate weight-bearing for 2 months. Re-education by gentle and progressive activo-passive mobilisation up to 90° of flexion for 45 days is extended thereafter. A posture splint is maintained for 2 months at 5° of flessum (Zimmer type or bivalve resin)

- Arthrorises (14)

The principle of these procedures is to prevent hyperextension by means of a bone block acting much like the olecranon in the elbow.

The first attempt was made by Wollenberg in 1910 who discovered the anterior aspect of the tibial epiphysis and then carved a prismatic bone block including the TTA with the patellar tendon insertion and extending upwards to the articular surface.

This block of bone was then mobilised upwards until it reached a notch in the groove of the trochlea, which was then fixed to the tibia with ivory nails.

Léo Mayer proposed another variant which consisted of lengthening the quadricipital tendon by a V-shaped section, and joining the patella to the tibial epiphysis by a tibial graft which, inserted into the anterior edge of the articular surface of the tibia, was opposed on the posterior face of the patella which had been previously edged.

3.3 Valgum knee correction

The supra-condylar femoral varus osteotomy, described as the simplest, is used as an example. (8) The patient is positioned in lateral decubitus with pubic and gluteal supports. Provisional haemostasis is ensured by a pneumatic tourniquet located at the root of the thigh.

The skin is incised along a line starting 15 cm above the knee line at the lateral surface of the diaphysis and curving slightly from back to front towards the tibial insertion of the patellar ligament, but not beyond the line.

The fascia lata is divided along the axis of its fibres along the same path, then the fascia of the vastus lateralis is incised at the level of its insertion on the intermuscular septum.

The vastus is then roughened from the lateral aspect of the shaft only. Below, the lateral aspect of the condyle is cleared to the condylar tubercle, whose upper edge is the preferred level of penetration of the plate, if compatible with the correction to be made.

The guide wire (which must be strictly frontal) is inserted until it is supported in the medial cortex.

3.4 Arthrodesis (2,6)

Knee arthrodesis represents a surgical technique that resolves, in a safer way, the problem of knee

stabilisation. However, stabilisation by arthrodesis must take into account the patient's choice, as it is sometimes more incapacitating in functional terms than a device blocked in extension for walking and locked in the sitting position.

The main indication is complete paralysis of the knee muscles with a flailing joint.

It would also be an interesting alternative technique in cases where arthroplasty is formally contraindicated.

Technical :

1. If it is possible to switch easily during the operation from extension to flexion, a pneumatic tourniquet is placed, root of the thigh. Conventional approaches

anterolateral and anteromedial, simple distraction is sufficient to open the joint and place the femoral and tibial ends.

Excision of the meniscus, cruciate ligaments, para-patellar bone tissue and synovium is performed.

The knee is then placed at a right angle and a 1 cm thick resection is made on the femur and tibia so that the knee is slightly flexed. Two Steinman wires are placed perpendicular to the limb axis and parallel to each other on either side of the joint and a compression of about 50kg is applied through a frame.

This set-up is left for 4 weeks and then, after the pins have been removed, is replaced by a plaster cast. The

Management is allowed after the 4 weeks in a cast, and at 8 weeks strength is good enough to allow walking with a bivalve safety splint.

In addition to the external fixator (mentioned above), other techniques for fixation of arthrodeses are also possible to obtain bone fusion: centromedullary nail association nail-fixer, anterior plate.

V. Conclusion

Paralytic knee disease affects muscular balance and osteoarticular growth to the point of sometimes compromising the possibility of standing and walking. The clinical picture is essentially dominated by neuro-orthopaedic deformities, the most frequent of which are flexural deformities.

A complete and precise neuro-orthopaedic examination allows the assessment of segmental disorders which must be integrated into the global analysis of the lower limbs and the subject to be examined. Combined with a good knowledge of the aetiologies, it enables the bases of the orthopaedic treatment to be defined.

Orthopaedic surgical treatment of the consequences of knee paralysis is varied, both in terms of

The diversity of the gestures that one can be brought to carry out (tenotomies, lengthenings, transfers, osteotomies...), that by that of the situations which one takes care. It must essentially meet functional and not morphological criteria.

Rehabilitation and orthopaedic devices are not to be outdone, as they are two complementary aspects of the surgery.

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