Knee Stiffness in Children

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Contents

Abstract

Persistent stiffness of the knee in childhood in flexion or extension which is unresponsive to conservative management and requires surgical treatment is rare. The causes may be congenital, in particular related to arthrogryposis multiplex congenital (AMC), traumatic, following prolonged splintage after fracture, in association with burns, or iatrogenic following surgery such as leg lengthening. Intramuscular injections in early infancy into the quadriceps muscles have been recognised as a specific cause of stiffness of the knee in extension. Infection, severe spasticity associated with cerebral palsy or head injury, poliomyelitis, myelomeningocele, juvenile chronic arthritis and haemophilia are other possible causes.

Surgical intervention is indicated only when conservative treatment has failed or may cause further damage. The standard soft tissue procedure for the knee which is stiff in extension is quadricepsplasty. For fixed flexion contracture, posterior soft tissue release, which may have to be very extensive, is indicated. Bony procedures such as supracondylar osteotomy and the management of the stiff knee in cerebral palsy are described elsewhere in this book.

Keywords

Aetiology • Children • Extension and flexion stiffness • Knees • Non-operative treatment • Stiffness • Surgical Techniques

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Introduction

Aetiology

Stiffness of the knee in childhood in either flexion or extension may be congenital or acquired.

Congenital Causes

Some degree of fixed flexion in the knee is normal in the newborn child and the knee may not extend fully up until the age of 1 year. When the child starts to walk (so-called toddler's gait), he or she still walks with a somewhat flexed knee and a characteristic relatively short stride length. The normal pattern of adult gait does not develop until the age of 4 or 5 years [16].

Fixed extension or hyper-extension may be associated with genu recurvatum, congenital subluxation or dislocation of the knee.

Rigid flexion or extension of the knees is common in arthrogryposis multiplex congenital (AMC), otherwise called multiple congenital contracture syndrome (MCC). This is a descriptive term and there are at least 150 causes for a child to be born with rigid flexion or extension deformities of the joints [5].

Acquired Causes

Trauma

Acquired stiffness of the knee may be due to trauma with damage to the muscles controlling the knee, particularly the hamstrings or quadriceps muscles. Alternatively, it may be due to damage to the joint surfaces of the knee by injury or disease. Prolonged splintage after fracture or in association with burns may give rise to significant stiffness. Iatrogenic trauma following surgery such as leg-lengthening can lead to serious knee stiffness with sometimes subluxation or even dislocation of the joint [7]. Damage to the joint cartilage has been reported in dogs during experimental lengthening [15].

Intramuscular injections in early infancy into the quadriceps muscle may cause a particular form of quadriceps contracture [12]. This is less common now that most drugs are administered intravenously, but can still be encountered and may require surgical release [8].

Infection

Infection within the knee joint, or spreading from the adjacent tibia or femur into the knee joint, can cause severe stiffness due to inflammation, adhesions, fibrosis and damage to the joint surfaces and to the growth plates around the joints.

Juvenile Chronic Arthritis

Juvenile chronic arthritis is a potent cause of knee stiffness. Flexion deformity appears early in the disease when the synovium becomes inflamed in association with an effusion and pain. This is exacerbated by hamstring spasm and weakness and wasting of the quadriceps muscles. Flexion is the main problem, but loss of extension can also occur due to fibrosis and contracture of the lateral expansions of the quadriceps. Later on in the disease, cartilage erosion and joint deformation may also occur. An excellent description of this process is given by Arden and Ansell [1].

Haemophilia and Other Blood/Vascular Disorders

Recurrent, acute or chronic synovitis is a cause of knee swelling and stiffness. In haemophilia, the aim of modern treatment, particularly in children, is to stop or control recurrent haemarthroses and thereby avoid secondary synovitis which leads to stiffness and deformity. In an excellent review of the subject, Rodriquez-Merchan [14] outlines the intensive medical treatment now used. Surgical treatment in the form of injections into the joint (synoviorthesis) of rifampicin or a radioactive isotope such as Yttrium 90 can be used. Surgical synovectomy, which may be open or arthroscopic [18], can also be useful in preventing stiffness and loss of motion.

Sickle-cell anaemia and recurrent haemarthroses from vascular abnormalities such as the Klippel-Trenauney syndrome can also produce stiffness and progressive deformity.

Poliomyelitis and Other Neurological Conditions

Joint contractures are common in poliomyelitis, and one of the commonest sites is a flexion contracture at the knee. At the turn of the century, hamstring tenotomy, manipulation and splintage were advised. In 1926, Yount [19] pointed out the importance of the tensor fasciae femoris in flexion contracture at the knee and hip, and the importance of its release in knee flexion deformity. Connor [2] reported that conservative treatment is likely to be successful only in mild to moderate degrees of fixed flexion contracture. It is essential to avoid loss of congruity of the joint and posterior subluxation of the tibia on the femur as a result of forceful repeated manipulation and splintage. Similarly, surgery in the form of hamstring release and serial plasters will only be successful if the knee remains congruous. If surgery results in a straight but non-congruous knee with posterior subluxation, then, although it may be straight it is likely to be stiff and painful and of no help to the patient. At the conclusion of this study, he advised careful serial manipulations, avoiding posterior subluxation in the younger patient. In the older patient with severe deformity, supracondylar osteotomy was advised. Leong et al. [11]. reported good results with supracondylar osteotomy in moderate to severe flexion contractures, provided joint congruity was maintained. Their youngest patient was aged 8 and they advised splintage during growth to prevent recurrence of the deformity. A stiff knee in extension is very rare in polio, unless it is iatrogenic from forceful manipulation and splintage producing posterior subluxation and incongruity of the knee joint, or form surgery producing knee incongruity. The management of the knee in spastic cerebral palsy is dealt with elsewhere in this work. Meningomyelocele produces a variety of neurological patterns, often with a mixture of spasticity and weakness. There is also the problem of loss or disorder of the modalities of sensation. In a patient with a largely lower motor neurone type of lesion (like poliomyelitis), the type of surgery used in poliomyelitis is indicated. In those with a largely spastic or mixed neurological picture, selection for surgery is difficult, but sometimes the type of surgery used in cerebral palsy can be considered.

Conservative Management

Conservative management is the mainstay of the treatment of knee stiffness in the early stages. As always, prevention is better than radical cure, and judicious treatment with splints, serial plasters, physiotherapy and continuous passive motion are the mainstays of treatment. Surgical intervention is only indicated where conservative treatment has failed or may cause further damage.

The Stiff Knee in Extension

Stiffness in extension is nearly always due to contracture of the quadriceps apparatus. If there is major bony deformity, then sometimes a supracondylar osteotomy of the femur may have to be considered, or even arthrodesis. These bony operations will be considered elsewhere in this work.

Surgical Management

Surgical Technique

Release of Quadriceps Contracture

Except in the iatrogenic lateral quadriceps contracture, which will be dealt with separately, the problem is nearly always anterior. An anterior longitudinal approach is made from the tibial tubercle, usually to the middle or proximal third of the thigh. The skin incision is continued through the subcutaneous tissue and the abnormal quadriceps and quadriceps apparatus exposed (Fig. 1). It is essential to be meticulous with haemostasis during this approach. In older children, a tourniquet may be used high on the thigh if the surgeon prefers, but it will have to be released when assessing the amount of quadriceps release required, as it inevitably tethers the quadriceps apparatus in the upper part of the thigh. The author prefers to avoid it's use if possible. In small children with congenital contractures, there is insufficient length in the thigh to use a tourniquet satisfactorily for this operation. In patients with arthrogryposis multiplex congenital, where the anatomy is often very abnormal, it is also much safer not to use a tourniquet, as blood

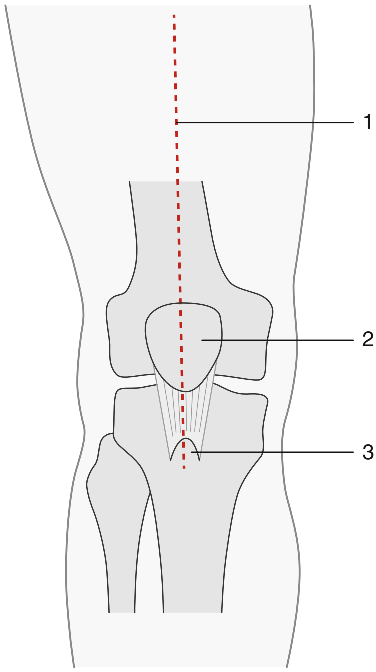

Fig. 1 Line drawing showing the site of the incision for release of a quadriceps contracture. Note that the incision extends from the mid-thigh down to the tibial tubercle in the mid-line. *1* – line of incision; *2* – patella; *3* – tibial tubercle

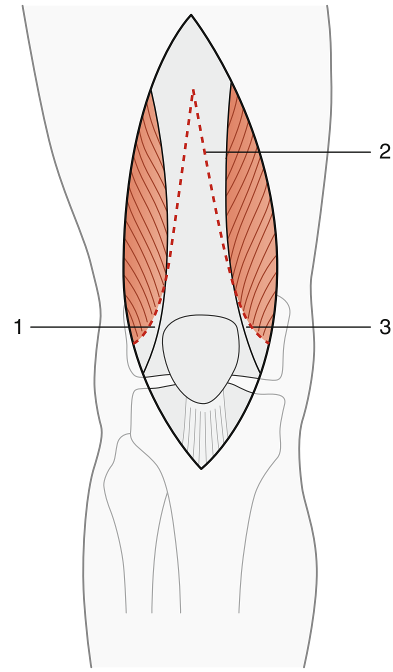

Fig. 2 Diagrammatic representation of the V-incision in the quadriceps apparatus. Note that the incision releases both the lateral and medial capsule of the knee. *1* – incision releases lateral capsule of the knee; *2* – V-incision in rectus femoris; *3* – incision releases medial capsule of the knee

vessels and nerves to the very abnormal muscular and fascial anatomy which is present in these children can be difficult to identify.

The quadriceps apparatus is exposed. The aim of the operation is to perform a V-Y-plasty in the quadriceps muscle (Figs. 2 and 3). Unlike the quadriceps contracture following a fractured femur shaft in the adult, there is usually not a specific fibrous contracture in the vastus intermedius, but a general contracture of the quadriceps apparatus which has to be lengthened to obtain flexion of the knee. The apex of the "V" should be as high as is reasonably possible in the thigh, and the rectus femoris and underlying vastus intermedius are separated from the vastus medialis and the vastus lateralis. Dissection using the diathermy needle is very helpful at this stage. The "V" of muscle is then mobilised distally. Almost invariably it is essential to open the knee, extending the base of the "V" into the medial and lateral expansions of the quadriceps apparatus. The "V" can then be turned downwards distally so that the back of the patella, which is commonly abnormal, and the articular surface of the knee can be exposed. Within the knee, there may be adhesions that must be divided. As the knee is flexed, adhesions between the lateral expansions and the femoral condyles may have to be divided. In congenital types of contracture, the knee commonly presents abnormalities or absence of the cruciate ligaments. In acquired cases and those associated diseases such as juvenile chronic arthritis, there may be severe damage to the joint surface, such that reasonable congruous movement of the joint may not be possible. In this situation, quadricepsplasty is unlikely to be successful except to a limited extent.

Once flexion has been obtained, the knee is flexion to about 80–90° and the tongue of soft tissue attached to the patella is sutured to the vastus medialis and lateralis in the elongated "Y" position (Fig. 3). In congenital and severe

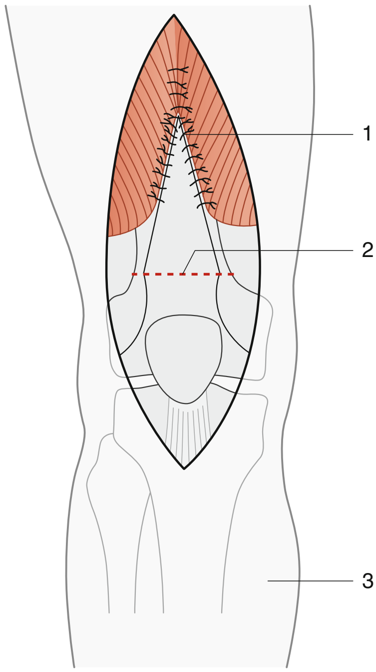

Fig. 3 Diagrammatic representation of the quadricepsplasty sutured as a Y with the knee flexed. Note that the lateral and medial capsular incisions in the knee are left open and not sutured. *1* – sutured as a Y; *2* – lateral and medial knee capsular incisions left open; *3* – knee flexed

acquired cases, it is impossible to suture the medial and lateral capsular incisions in this flexed position, and these can be left open as new synovium is rapidly formed. Attempts to suture the quadricepsplasty too tightly will fail and lead to recurrence of the contracture. At regular intervals during the suture, the tension on the suture should be tested by flexion the knee to 80–90°. If a tourniquet has been used, it is essential that it be removed at this stage. After careful haemostasis, the wound is closed in layers. There can be significant tension on all the soft tissues if the contracture is congenital or of long standing. Anterior longitudinal wounds in the thigh can heal poorly, and the author prefers a subcuticular, absorbable suture, re-inforced with adhesive strips such as Steri-strips™, for the closure.

Judet et al. [9, 10]. described an alternative method of quadricepsplasty, primarily for post-traumatic lesions in adults, which was less likely to cause an extension lag. Daoud et al. [3]. published a paper suggesting that the Judet method was superior, particularly in avoiding extension lag and maintaining the passive range of movement gained at operation. However, none of their patients were children, and none had congenital anomalies. The author has no experience of this interesting technique in releasing quadriceps contractures of congenital origin.

Post-Operative Care

In young children the author prefers immobilisation in a plaster backslab until the wound has healed. In older children, it may be possible to start early continuous passive motion as one would do with an adolescent or adult. If using this method, it is essential to have adequate pain relief, and modern methods of pain control can be very useful during the painful process of regaining flexion. Long-term splintage is often necessary, particularly in arthrogryposis multiplex congenital and conditions such as juvenile chronic arthritis. It may take many months to regain active extension, and in children with arthrogryposis, it is rare to gain or maintain more than 90° flexion.

Iatrogenic Contracture of the Vastus Lateralis

This condition is seen after multiple intramuscular injections into the quadriceps muscle in early infancy. It commonly involves mainly the vastus lateralis muscle and not the vastus intermedius, as was originally described by Hnevkovsky [6] and by Fairbank and Barrett [4], who thought that it was a congenital or progressive fibrosis. Subsequently, Lloyd Roberts and Thomas [12] pointed out the association with intramuscular injections into the thigh in infancy. This can now be shown by magnetic resonance imaging (MRI). If the contracture is mainly in the vastus lateralis and not the intermedius, then a lateral incision over the fibrosed area and excision of this area in the vastus lateralis can release the extension contracture very satisfactorily. This was reported by Jackson and Hutton in 1985 [8] where proximal lateral release gave much better results than distal quadricepsplasty.

Release of Flexion Contracture of the Knee (Posterior Soft Tissue Release)

This can be particularly difficult in arthrogryposis multiplex congenital, where flexion contracture is less likely to respond to conservative treatment than an extension contracture [13]. Pre-operatively, the knee should be assessed clinically and radiologically. If there is gross bony incongruity, then it is unlikely that soft tissue release of the posterior structures will restore useful movement.

Arthrogryposis presents the most difficult type of posterior soft tissue release surgery, and this will be described.

Surgical Technique

Position: The patient is positioned prone on the operating table. In small children, it is not possible to use a tourniquet due to the shortness of the thigh. In arthrogryposis, it may be inadvisable because of the difficulty in defining the anatomical structures. In older patients, it is undoubtedly a great help to use a tourniquet in the initial stages of the operation, but important to release it before extending the knee, and to allow for very careful haemostasis. The author prefers separate medial and lateral incisions. The more severe the fixed flexion contracture, the nearer the equatorial point of the knee this should be made (Fig. 4). With mild contractures, it is reasonable to use postero-medial and postero-lateral incisions. Alternatively, one can use a mid-line posterior incision or possibly an "S" shaped incision with the distal portion of the "S" on the lateral side as this allows good exposure of the lateral popliteal nerve. Certainly, in arthrogryposis with severe contracture, the medial and lateral incisions are very helpful and leave the largest intact skin bridge between the incisions as the surgeon attempts to straighten the knee after releasing all the posterior structures other than the neurovascular bundle. Surgeons operating on arthrogryposis will be surprised at how difficult it is to delineate the normal anatomical structures, because there is very poor development of the muscles and much of the fascia does not seem to be properly separated into its component parts. As a result, it can be very hard to identify the main anatomical structures behind the knee. In the most difficult cases, it is helpful to approach the knee both from the medial and lateral sides, working towards the middle, which is the site of the major neurovascular bundle Through the lateral incision it is essential to find the lateral popliteal nerve below the knee and the fascia lata, and beneath this the tendon of the biceps femoris (Fig. 5). Both the fascia lata and the biceps femoris tendon will have to be "Z" lengthened in severe cases. On the medial side, the 3 hamstring muscles and the sartorius are found, and all require "Z" lengthening. In the skin flap, the posterior cutaneous nerve of the thigh and the sural nerve, together with the short saphenous vein, should be preserved if possible. The fascia over the back of the popliteal fossa should be divided as it is frequently contracted, and it is essential to find and preserve the medial popliteal nerve and the popliteal artery and vein which lie beneath it. Again, in the distorted anatomy of arthrogryposis, this can be much more difficult than the surgeon might expect. Once the medial and lateral hamstrings have been elongated and the fascia at the back of the knee divided, some improvement in the flexion contracture should be obtained, but it is nearly always necessary to divide both the medial and lateral heads of the gastrocnemius muscle. It is

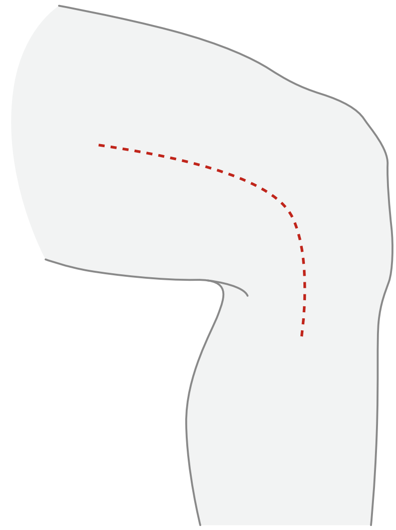

Fig. 4 Diagrammatic representation of the lateral incision in the *mid-line*, which is particularly useful in arthrogrypotic patients

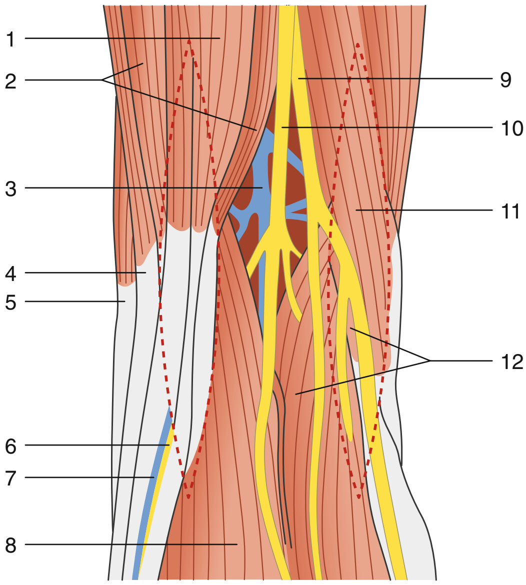

Fig. 5 Diagrammatic representatin of the important anatomical features at the back of the knee and the position of the medial and lateral incisions shown by *dotted lines*. *1* – semitendinosus; *2* – semimembranosus; *3* – popliteal vein; *4* – gracilis; *5* – sartorius; *6* – long saphenous nerve; *7* – saphenous vein; *8* – medial head of gastrocnemius; *9* – lateral popliteal nerve; *10* – medial popliteal nerve; *11* – biceps; *12* – lateral head of gastrocnemius

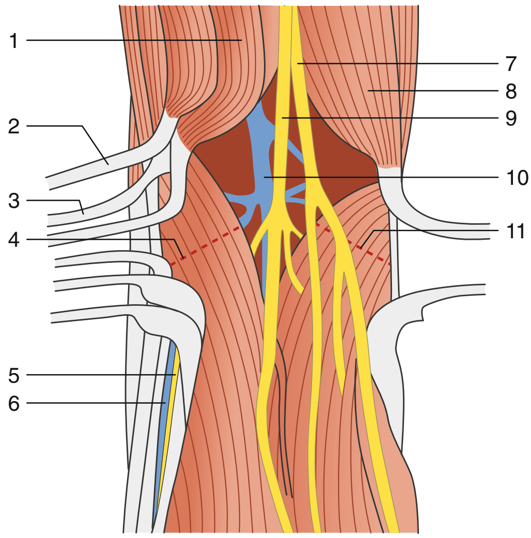

Fig. 6 Diagrammatic representation of the Z-lengthening of the medial and lateral hamstrings and the site of division of the lateral and medial heads of the gastrocnemius, indicated by *dotted lines*. *1* – semitendinosus Z-lengthened; *2* – semimembranosus Z-lengthened; *3* – gracilis Z-lengthened; *4* – line of division of medial head of gastrocnemius; *5* – long saphenous nerve; *6* – saphenous vein; *7* – saphenous vein; *8* – biceps femoris Z-lengthened; *9* – medial popliteal nerve; *10* – popliteal vein; *11* – line of division of lateral head of gastrocnemius

best to find these in their aponeurotic portion above the level of the knee joint and the arterial branches that come off the popliteal artery into the muscle. On the lateral side, the elongated biceps femoris is retracted laterally with the lateral popliteal nerve. The popliteal vessels and medial popliteal nerve are retracted medially. The lateral head of the gastrocnemius can then be divided under direct vision. On the medial side, the medial head of the gastrocnemius can be exposed and divided between the lengthened medial hamstrings medially and the medial popliteal nerve and popliteal vessels laterally (Fig. 6). This exposes the posterior capsule of the knee and, in severe cases, this will have to be divided transversely, taking care with haemostasis. Finally, in very severe cases, the posterior cruciate is contracted and may have to be divided, although this inevitably causes some degree of instability of the knee. If the posterior cruciate has been divided, care should be taken when extending the knee that the tibia does not sublux posteriorly. In the most severe cases, all the structures apart from the skin bridge and the neurovascular bundles behind the knee have to be divided. The medial and lateral hamstrings are sutured in their lengthened position. The fascia is usually left open as this is part of the contracture. The skin and subcutaneous tissue are fully sutured and will inevitably be under some tension in extension. The advantage of using a virtually mid-line equatorial lateral and medial incision is that the tension on the incisions is greatly reduced, although there is always tension on the skin bridge. Careful haemostasis prior to closure is always necessary. It is often not possible to obtain or to immobilise the knee in full extension after this type of radical release. The knee should be immobilised in as much extension as possible, depending on the state of the skin and vascularity of the limb. It is also important not to stretch the nerve and vessels too rapidly if there has been a very long, established contracture. A plaster splint is applied, usually including the foot, and it is wise to split this to allow for any swelling. A change of plaster to inspect the wound, and if possible to gain further extension, is performed at 2 weeks. In arthrogryposis and other difficult cases, it is often necessary to use serial plastering under anaesthetic, avoiding vigorous manipulation of the knee, which may cause damage and persistent stiffness. Once the maximum extension has been obtained active exercises can be started, but long-term night splintage may be necessary in some cases. Van Bosse et al. [17]. have described the use of an Ilizarov fixator to extend the knee after surgical posterior release in six patients (eight knees) with classical arthrogryposis and one patient (one knee) with popliteal web syndrome. At a mean follow-up at 4 years and 4 months there was significant improvement in the patients with arthrogryposis but failure in the patient with popliteal web syndrome.

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