Review article

COMPLICATIONS OF ARTHROSCOPY OF THE KNEE

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Although arthroscopy of the knee is a minimally invasive procedure with less risk than endoscopy of the visceral cavities complications can and do occur. The operation is performed in very large numbers worldwide and although the percentage of patients experiencing problems is relatively small the total number is not insignificant. Complications are more likely to occur with more complex procedures such as meniscal repair, synovectomy and intra-articular reconstruction of both the anterior (ACL) and posterior (PCL) cruciate ligaments.

DeLee¹ reported a retrospective review of 118 590 arthroscopies carried out by the Arthroscopy Association of North America (AANA). There were 930 complications (0.8%). It was felt that this probably underestimated the total number of complications since it was a retrospective review based on surgeons' memories. In 1986 Small² carried out a retrospective review of 395 566 arthroscopies. There was an overall complication rate of 0.56%. The percentage was higher in the more complex procedures, 2.4% in meniscal repair and 1.8% in reconstruction of the ACL. In a further prospective study in 1998³ reviewing 10 262 procedures he found an overall complication rate of 1.68%. The most common complications in this study were haemarthrosis (60.1%), infection (12.1%), thromboembolic disease (6.9%), anaesthetic complications (6.4%), instrument failure (2.9%), complex regional pain syndrome 1 (CRPS 1) (2.3%), ligament injury (1.2%) and fracture or neurological injury (0.6% each). Sherman et al⁴ retrospectively reviewed 2640 arthroscopies performed by four surgeons. Overall, there were 216 complications (8.2%) of which 126 were designated as major and 97 as minor. The major complications were infection, haemarthrosis, adhesions, effusions, cardiovascular and neurological problems, CRPS 1 and instrument breakage, and the minor were difficulties with wound healing and ecchymoses. A number of predisposing factors were recognised. There was a higher incidence of neurological complications and CRPS 1 in patients with an

industrial injury. As would be expected the lowest complication rate occurred with diagnostic arthroscopy. A higher overall complication rate occurred with partial medial meniscectomy and the incidence of haemarthrosis was highest in this procedure. Instrument breakage occurred most frequently during partial lateral meniscectomy. The largest number of problems with wound healing occurred after abrasion arthroplasty and lateral release was the commonest cause of adhesions. Slightly surprisingly, the complication rate was unrelated to the experience of the surgeon. The gender of the patient and the use of a tourniquet also had no influence. The length of time of inflation of the tourniquet did appear to be significant, with a higher risk in those patients who had a tourniquet time of 60 minutes or longer. In addition patients over 50 years of age were more likely to have complications.

Operative complications

Leg holder. Leg holders or posts are commonly used to aid exposure, particularly of the posterior horn of the medial meniscus. As in any surgical procedure in the anaesthetised patient there is the potential for damage by the injudicious application of force and it is possible to rupture the medial collateral ligament by the use of excessive valgus stress to open up the medial compartment. Injury to the lateral ligament because of varus stress is much less likely. Small² reported 160 knee ligament injuries, 143 of which were related to the use of a leg holder. These were reported in 0.04% of all cases of arthroscopy in the AANA.¹ Treatment is normally conservative by functional bracing with initial restriction of extension. Care needs to be taken in the application of a valgus force (Fig. 1), particularly when trying to view the posterior horn of the medial meniscus in a tight medial compartment in a middle-aged or elderly patient in whom the soft tissues are likely to be less flexible.

Tourniquet. A temporary paresis may occur after prolonged inflation of the tourniquet. It is important that regular checks are made on the accuracy of tourniquet pressures and it should be deflated after a maximum of two hours.

In the series of Sherman et al⁴ the incidence of complications was directly related to age and tourniquet time.

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0301-620X/02/713637 \$2.00
J Bone Joint Surg [Br] 2002;84-B:937-45.

Fig. 1

Photograph showing that care should be taken when using a valgus force to open up the medial compartment with a leg holder.

Patients less than 50 years old with a tourniquet time of less than 40 minutes were in the low-risk group with a predicted complication rate of 6.7%. Patients over the age of 50 with a tourniquet time of less than 40 minutes or under the age of 50 with a tourniquet time of between 40 and 59 minutes were categorised as of average risk with a predicted complication rate of 10.1%. Those older than 50 years with a tourniquet time of between 40 and 49 minutes were classed as a moderate risk with a predicted complication rate of 16.4%. The high-risk patients were those who had a tourniquet time of greater than 60 minutes, regardless of age, when the predicted complication rate was 28.6%. Regarding major complications, patients under the age of 30 years with a tourniquet time of less than 40 minutes were in the low-risk group with a predicted complication rate of 3.2%. Patients over the age of 30 with a tourniquet time of less than 40 minutes or under the age of 30 with a tourniquet time of between 40 and 59 minutes were in the average-risk group with a predicted complication rate of 5.2%. Patients over the age of 30 with a tourniquet time of between 40 and 59 minutes were in the moderate-risk group with a predicted complication rate of 8.1% and in the high-risk group the tourniquet time was greater than 60 minutes regardless of age with a predicted complication rate of 14.3%.

Compartment syndrome. There have been isolated reports of a compartment syndrome in association with arthroscopic surgery.^{5,6} For this to occur there must be a defect in the capsule. Increased irrigation pressure or blockage of the drainage will increase the risk. Noyes and Spievack⁷ demonstrated in a cadaver study that fluid can extravasate into the thigh from a rupture of the suprapatellar pouch and into the calf from a rupture of the semimembranosus bursa. Peek and Haynes⁵ showed in an animal model that the elevated compartment pressure in the calf returned to normal after 15 minutes, but in the presence of a fascial defect the pressure remained elevat-

ed for eight hours leading to muscle necrosis. In the cases reported by Peek and Haynes⁵ and Fruensgaard and Holm⁶ fasciotomies were carried out.

It is important to perform a preliminary examination under anaesthesia in the patient with an acute injury. If there is a significant disruption of a collateral ligament the risks of arthroscopy may outweigh any possible benefits. If a decision is made to proceed, care should be taken with infusion of the irrigation fluid and the thigh and calf need to be checked at regular intervals to ensure that no leakage is occurring.

Intra-articular damage. Any intra-articular structure can be damaged in an invasive procedure. It is important not to use a sharp trocar to introduce the arthroscope into the knee. A portal of adequate size should be made so that a blunt obturator can be used (Fig. 2). The anterior horns of the menisci are vulnerable when the incisions for the anteromedial and anterolateral portals are being made and it is wise to cut upwards with the knife away from the meniscus rather than downwards. Apart from the first portal the knife blade should be observed from within the joint

Fig. 2

Photograph showing the use of a blunt obturator to introduce the arthroscope into the knee.

Fig. 3

The knife blade being observed from within the joint.

(Fig. 3). Damage to the articular cartilage is not uncommon, but decreases with experience. It is essential that the placement of the portal is correct to allow easy passage of instruments within the joint. Operating instruments should not be used unless they can be seen clearly and tissue should never be cut blindly, but always under direct vision. Great care needs to be taken with power instruments since they can do much damage very quickly, particularly to soft tissue. The inflow of fluid must be sufficient to maintain a clear operating field because power shavers remove relatively large quantities of fluid from the knee by suction.

It is important to limit meniscal resection to areas which are clearly unstable. The meniscus is the shock-absorber of the knee and overenthusiastic removal of meniscal tissue will lead to increased mechanical stress on the articular cartilage with a greater risk of post-traumatic osteoarthritis. The surgeon should always try to preserve a rim of meniscal tissue so that the hoop stress function can at least be partly maintained.

The cruciate ligaments can be vulnerable during meniscal excision when an intercondylar attachment is being removed.

Instrument breakage. This problem is less frequent than in the early days of arthroscopic surgery since the design of instruments has been improved and they have become more robust. It does, however, still occur. When this happens, if the broken fragment is visible the flow through the knee should be stopped by switching off both the irrigation and the outflow. A grasping instrument such as a pituitary rongeur needs to be passed carefully and gently across the joint to remove the fragment. If the fragment is not visible, irrigation may wash it into the field of vision. The use of an image intensifier may be necessary to localise it. It may be prudent to leave the fragment if it is small and inaccessible since removal may cause more harm than good. Magnetised instruments are available and may help in a difficult situation.

Neurological injury. Rodeo, Forster and Weiland⁸ reported four mechanisms by which neurological damage can occur during arthroscopy. These are: 1) direct trauma; 2) pressure secondary to a compartment syndrome occurring as a result of extravasation of fluid; 3) damage related to the use of a tourniquet; and 4) dysfunction due to the ill-understood condition of CRPS 1.

Injury to a nerve is rare. In Small's initial series² there were 229 nerve injuries in 375 069 knee arthroscopies, an incidence of 0.06%. The saphenous nerve was the most commonly involved (42%). The peroneal nerve was damaged in 5%, the femoral nerve in 3% and the sciatic nerve in 3%. In the remaining 47% the details of the involved nerve were not specified. In a further study by Small³ there was only one instance of nerve damage in 8791 knee arthroscopies (0.01%). This was an injury to the saphenous nerve which occurred during a repair of the medial meniscus. In DeLee's study¹ there were 63 neurological complications in 118 590 arthroscopies, an incidence of 0.05% of

which 25 involved the peroneal nerve, 23 the saphenous nerve, seven the femoral nerve, four the tibial nerve and four the sciatic nerve. On the medial side of the knee the saphenous nerve is potentially vulnerable posteromedially. It can be damaged by a posteromedial portal or during repair of the medial meniscus. The nerve lies deep to sartorius and is protected to a certain extent when the knee is flexed. The safe area for a posteromedial portal or incisions for medial meniscal repair lie between the posterior edge of the medial collateral ligament and the anterior margin of the tendon of pes anserinus. If there is any doubt, the nerve can be exposed directly or may be visualised by transillumination. During meniscal repair, as long as the needles exit anterior to the pes anserinus tendon, the nerve should be safeguarded. The anatomy of the saphenous nerve is variable making it very difficult to avoid injury completely during repair of the medial meniscus. Austin and Sherman,⁹ in a review of the complications of this procedure, felt that saphenous neuropathies are an unavoidable and acceptable complication of this procedure.

Injury to a superficial nerve is not uncommon. The infragenicular branch of the saphenous nerve (IGBSN) runs a variable course and at times damage by anterior portals may be unavoidable. Injury to the IGBSN has been reported after knee arthroscopy.^{4,10} In the study of Sherman et al⁴ there was an incidence of 22.2% of sensory change in the distribution of the IGBSN after standard portals had been used. Although 'safe zones' have been advocated, the wide variability in the course of the nerve precludes the absolute avoidance of damage.^{11,12} Mochida and Kikuchi¹³ recommended that arthroscopic portals should be positioned close to both the patella and the patellar tendon if injury to the IGBSN is to be avoided.

On the lateral side the common peroneal nerve is vulnerable and the effects of injury to this structure are significant. Again damage is most likely to occur during meniscal repair. There has been one report of injury to the common peroneal nerve during lateral meniscectomy,¹⁴ but in all other cases injury has occurred during meniscal suture.¹⁴ Proximally, above the level of the knee, the nerve lies medial to the biceps tendon, between the biceps and the lateral head of gastrocnemius. At the level of the joint it passes posterior to the biceps to wind around the neck of the fibula. Flexion of the knee will allow the nerve to drop back posteriorly making it less vulnerable. The safe area is between the posterior edge of the iliotibial band and the biceps, preferably deep to the lateral head of gastrocnemius. To aid identification of the correct site for placement of a portal or an incision for meniscal repair, the joint can be transilluminated from within or a needle can be passed into the posterolateral joint and its position checked with the arthroscope. The interval between the iliotibial band and the biceps is developed. To confirm the position a probe can be passed across the joint from the anteromedial portal to tent the posterolateral capsule from within. The lateral head of gastrocnemius can be identified and its

lateral border freed by blunt dissection. During in-to-out meniscal suture, the needles must be passed out of the joint under direct vision and as long as they are anterior to the biceps and lateral to the lateral head of gastrocnemius the peroneal nerve will be safeguarded. Use of the contralateral portal allows a relatively anterior and lateral deviation of the repair needle further safeguarding the nerve, and this is also true posteromedially. Occasionally, formation of a neuroma can be troublesome and it is possible that a relatively minor nerve injury can lead to CRPS 1.

Vascular injury. Jackson¹⁵ reported the occurrence of injury to the popliteal artery leading to amputation. In the AANA review¹ there were six cases of penetrating injury of the popliteal artery. Four of these patients required amputation. There were 12 vascular injuries in Small's 1986 report,² but no vascular complications were listed in his later study.³ Beck, Robison and Hallett¹⁶ described a case of a pseudoaneurysm of the popliteal artery after arthroscopy and in 1987 Jeffries et al¹⁷ presented two cases of injury to this vessel occurring during arthroscopic lateral meniscectomy using power tools. Both lesions required repair. The popliteal neurovascular bundle is in close proximity to the posterior capsule of the knee and is clearly potentially vulnerable. It is important that the tip of any surgical instrument must be seen clearly at the back of the knee. Particular care needs to be taken with power tools and it is imperative that the operative field is clear at all times with adequate irrigation. If a vascular injury is suspected because of either excessive bleeding at the site of operation or compromise of the distal circulation, it is imperative that an urgent vascular opinion is sought followed by prompt arteriography and appropriate surgery when indicated. Any delay may result in the need for amputation. Fasciotomy may also have to be considered after any period of ischaemia. Vascular injury is more likely to occur during meniscal repair and the precautions outlined previously must be followed to safeguard the popliteal artery, particularly during repair of the lateral meniscus.

The superior lateral geniculate artery is vulnerable during a procedure for lateral release. The risk of bleeding can be minimised by the use of electrocautery. It is wise to infiltrate the incision with Marcaine and adrenaline and to use a drain for 24 hours. There is also the possibility of damage to this vessel during synovectomy.

The saphenous vein may be damaged when using a posteromedial portal or during repair of a medial meniscus and the same precautions need to be taken as outlined in the previous section on neurological injury.

Diagnostic errors. Arthroscopy is an invasive procedure and it is not a substitute for other methods of diagnosis. It is vital that a careful evaluation of the patient is carried out by standard clinical means with a history, examination and appropriate investigations. Often the history alone will provide the diagnosis. A careful systematic examination is essential. Plain radiographs should always

be taken. MRI is a very effective non-invasive method of diagnosis and rarely should the arthroscope now be used solely for this purpose. Its function is predominantly to enable appropriate intra-articular surgery to be carried out after a definitive diagnosis has been made. Joyce and Mankin¹⁸ described 12 cases in which significant diagnostic errors were made because of inadequate preoperative evaluation. Six patients had a significant neoplastic lesion visible on plain radiographs.

During the procedure itself the inexperienced surgeon may have problems with visualisation because of poor technique. It is important that adequate supervision is given in the early stages of the learning curve so that the important technical aspects of the operation are addressed. These include placement of the portals, positioning of the knee, triangulation and adequate irrigation.

Postoperative complications

Pain. Control of pain after operation is of the utmost importance. It is rarely a problem after diagnostic or simple operative arthroscopy but may occur after more complex procedures such as meniscal repair, synovectomy or intra-articular reconstruction of ligaments. There are a number of options for the management of pain. Opiates and other potent analgesics can be given as an intermittent fixed dose, into the epidural space, or as an intra-articular injection.¹⁹ Local anaesthetic can also be given by the intra-articular route.²⁰ Non steroidal anti-inflammatory drugs (NSAIDs) are effective orally, by injection or rectally. Physical measures such as cold therapy have also been used with variable success.²¹⁻²⁷ All these methods have disadvantages and none is ideal. As well as the important factor of the comfort of the patient the level of pain experienced on coming round from the anaesthetic in the recovery room may well determine progress in the early stages after operation. A minimal level of pain has a very positive effect on the morale of the patient which may help the early programme of rehabilitation, particularly in the recovery of movement. Severe pain will impede this.

Haemarthrosis. The incidence of this complication is approximately 1%.²⁸ It is more common after lateral release because of damage to the superior lateral geniculate artery, and an incidence of between 5% and 42% has been reported after this procedure.²⁹ If a painful tense haemarthrosis develops the knee should be washed out arthroscopically, local anaesthetic with adrenaline infiltrated into the joint and a pressure bandage applied. Consideration should be given to introducing a suction drain for 24 hours.

Thromboembolism. The risk of thromboembolic disease after arthroscopy is clearly low since the procedure is relatively short and mobilisation is quick. The incidence in the AANA study¹ was 0.1% and in Small's studies,^{2,3} 0.17% and 0.13%, respectively. In the AANA study¹ 23% of patients with a deep-vein thrombosis (DVT) developed a

pulmonary embolism (PE) and there were four deaths. The figures for DVT were probably an underestimate since the reviews were based on clinical symptoms. The overall reported incidence of DVT after arthroscopy of the knee ranges from 0% to 7.3% and PE from 0% to 0.32%.³⁰ In a study using venography³¹ the incidence of DVT was 4.2%. There are a number of factors which are associated with an increased risk of thromboembolism. Patients over the age of 40 years are more likely to develop postoperative thrombosis. A prolonged operating or tourniquet time is also a risk factor but there is no definite evidence that the tourniquet itself increases the risk. When there is a previous history of thrombosis or embolism the risk of thromboembolic complications increases significantly. Kakkar et al³² reported an incidence of DVT of 100% in a group of patients with a history of previous PE. There is no indication for routine thromboprophylaxis in arthroscopic surgery, but the operating and tourniquet times should be kept to a minimum and postoperative mobilisation should be as rapid as possible. Some form of prophylaxis should be considered for patients in the risk groups mentioned above particularly those with a previous thromboembolism.

Infection. Infection after arthroscopy is uncommon. The knee is the largest synovial cavity in the body and septic arthritis is therefore a very serious complication. DeLee¹ reported an incidence of 0.08%, Sherman et al,⁴ 0.1%, D'Angelo and Ogilvie-Harris,³³ 0.23% and Armstrong, Bolding and Joseph,³⁴ 0.42%. Diagnosis is not always straightforward. In classical septic arthritis there is acute pain, swelling, warmth and erythema accompanied by the systemic signs of fever and malaise together with a leucocytosis, with a raised ESR and an increased level of C-reactive protein (CRP). *Staphylococcus aureus* is the most common infecting organism under these circumstances. The presentation, however, can be more insidious with a subacute onset of pain, swelling, mild fever and minimal or no leucocytosis, which may be associated with a coagulase-negative staphylococcus. Under these circumstances a Gram stain of the synovial fluid may be negative and a culture is required to confirm the diagnosis. Infection is more common among patients with longer operating times, an increased number of procedures during surgery, prior procedures and in those having chondroplasty or soft-tissue debridement.³⁴ A number of authors have also reported an increased incidence of septic arthritis after the administration of intra-articular corticosteroids at the time of arthroscopy. There is almost certainly impairment of local and systemic immune defence mechanisms.^{34,35} Prophylactic antibiotics are not routinely used for arthroscopic surgery apart from more complex procedures such as reconstruction of the ACL. D'Angelo and Ogilvie-Harris,³³ however, have suggested that there may be a case for their use from the point of view of cost-benefit. Certainly, the treatment of septic arthritis of the knee is expensive. The patients in the series of D'Angelo and Ogilvie-Harris³³ were in hospital for a mean of 20 days, but this length of stay may not always be necessary. There is

no definite consensus in the literature regarding the management of established septic arthritis after arthroscopy. There is general agreement that intravenous antibiotics are indicated initially based on the sensitivities from the synovial Gram stain or culture. The duration of treatment recommended varies from a few days to six weeks. It would seem wise to continue with intravenous antibiotics until the patient is clearly responding and the systemic signs resolving. Any pus or infected synovial fluid in the knee should be removed. Simple aspiration under local anaesthesia can be carried out, but this is likely to be a painful procedure and it is very difficult to remove all the fluid and the fibrin and other debris related to the infective process. Adequate removal of all infected material can only be achieved by an arthroscopic washout using copious lavage with several litres of fluid. After this a drain may be inserted for 24 to 36 hours. An irrigation-suction system can be set up but these are difficult to manage and there is no definite evidence that there is any advantage over lavage itself. This may have to be repeated after 48 to 72 hours. The joint should be rested initially but as soon as the infection is under control a graduated programme of rehabilitation needs to be instituted concentrating on the return of movement. Continuous passive motion (CPM) may be useful in the early stages of recovery.

Armstrong et al³⁴ made the following recommendations concerning infection.

- 1) Local injection of intra-articular corticosteroid should not be given at the time of arthroscopy.
- 2) If a patient develops persistent pain and swelling after arthroscopy culture of the synovial fluid is required. The absence of erythema, fever, leucocytosis or obvious infection in the synovial fluid does not exclude infection.
- 3) Coagulase-negative staphylococci may cause a post-operative septic arthritis and a positive culture may indicate infection rather than contamination.
- 4) The appropriate treatment of established septic arthritis is arthroscopic lavage.
- 5) The administration of intravenous antibiotics for two weeks is sufficient if the condition is diagnosed and treated promptly.
- 6) An irrigation-suction system is not necessary.

Effusion and synovitis. An effusion is not uncommon after arthroscopy but rarely causes a problem. The reported incidence varies between 0% and 15%.³⁶ It may persist after arthroscopic surgery particularly for degenerative joint disease. The knee will remain painful, irritable and swollen because of postoperative synovitis. This can be a difficult and recalcitrant condition. Treatment is essentially conservative with rest, ice, compression and elevation together with NSAIDs and physiotherapy. If symptoms continue further investigation may be indicated. A full blood count, ESR and CRP should be undertaken to exclude infection, and also plain radiography. An isotope bone scan can be useful to determine the extent of the inflammatory response. MRI

may be necessary to exclude a continuing mechanical problem. A further arthroscopic procedure with a wash-out should be considered if the joint does not respond to conservative measures, but there is no guarantee that this will lead to resolution of the symptoms of a postoperative inflammatory synovitis.

Synovial fistula. In DeLee's survey¹ there were 30 cases of synovial fistula, 70% of which responded to immobilisation in a cast. Details of treatment in the remaining 30% were not given. Proffer, Drez and Daus³⁷ retrospectively reviewed 976 arthroscopies over a period of three years. Six patients developed synovial fistulae; all were men, with a mean age of 35.8 years. The fistulae developed between three and ten days after surgery with a mean of six days. Significant degenerative changes were present in at least one compartment in five cases. The portals involved were the posteromedial in three, superomedial in two and posterolateral in one. All cultures were sterile. Treatment was by immobilisation in extension and the prophylactic administration of oral cephalosporins. The fistulae closed after a mean of nine days (7 to 14). No patient required surgery and there were no recurrences. The combination of degenerative joint disease and posterior portals was felt to increase the risk but the numbers were not of statistical significance. The authors concluded that simple immobilisation in extension until the fistula closed, using a commercially available knee immobiliser, was all that was required. Since no positive cultures were obtained prophylactic antibiotics were not necessary.

Complex regional pain syndrome 1. The International Association for the Study of Pain³⁸ has renamed reflex sympathetic dystrophy as CRPS 1. The purpose of the change in nomenclature is to introduce a descriptive diagnosis as opposed to one based on the questionable assumptions that the syndrome is always reflex in nature, mediated through the sympathetic nervous system with a consistently displayed dystrophy. The new definition expresses the complexity and variety of clinical presentations of the condition and the regional distribution of the characteristics presented where pain is considered to be a constant feature. CRPS 1 of the knee displays many symptoms and signs which are characterised by a disproportionate amount of pain, loss of function and a number of features which appear at first sight to be difficult to evaluate. Some are so random, bizarre and unconfined to dermatomes that it is tempting to regard the patient as mentally disturbed. Most symptoms, however, are sufficiently constant to demand further questioning and investigation.

CRPS 1 can occur after any type of injury to the knee including arthroscopic surgery. In making a diagnosis when the patient presents with a painful knee after an arthroscopic procedure it is essential to carry out appropriate investigations to exclude a mechanical or inflammatory disorder. When these have been eliminated those features which would support a diagnosis of CRPS 1 should be sought. Does the patient suffer from Raynaud's disease or

migraine? Women appear to be at a considerably greater risk of developing CRPS 1 than men. The syndrome may occur at any age and may be seen both in children and in the elderly, with the peak incidence between the third and fourth decades. The patellofemoral joint seems to be particularly vulnerable and most series in the literature report a relatively high incidence of problems associated with patellofemoral injury, disease or surgery. Injury to cutaneous nerves may also precipitate an exaggerated autonomic response and the saphenous nerve and its branches appear to be particularly vulnerable.^{39,40} Katz and Hungerford³⁹ described 36 patients with CRPS 1, 69% of whom were female. Their mean age was 39.6 years (13 to 70). Of these 64% had had either an injury or an operation involving the patellofemoral joint, 41% had had previous surgery and 47% trauma to the front of the knee. The average number of operations before diagnosis was 1.2 and in 17% there was evidence of nerve injury. The mean delay in diagnosis was 29 months (3 weeks to 11 years). One patient had been submitted to an arthroscopy, three manipulations, another arthroscopy, an arthrotomy and patellar realignment, reconstruction of the PCL and a further manipulation followed by a total knee replacement without resolution of symptoms! In a review of 19 patients Ogilvie-Harris and Roscoe⁴⁰ described 13 women and six men with a mean age of 40 years (15 to 49). Sixteen had sustained injuries and three had undergone surgery, two meniscectomies and one Maquet procedure. Poehling, Pollock and Koman⁴¹ found that all 35 patients with CRPS 1 had evidence of damage to the infrapatellar branch of the saphenous nerve, either by trauma or surgery. Their mean age was 42 years (19 to 80) and 73% were women. Cooper, DeLee and Ramamurthy⁴² reviewed the results of epidural anaesthesia in CRPS 1 in 14 patients in a younger age group with a mean age of 29 years (21 to 39); there were eight women and six men, of whom 11 had had surgery to the patella. Fulkerson and Hungerford⁴³ also highlighted the vulnerability of the patellofemoral joint because of the superficial subcutaneous position of the patella. In their experience the most common type of trauma is a direct blow to the patella, such as occurs in a dashboard injury or a fall onto the front of the knee. Indirect injuries such as twisting injuries or patellar dislocation are considered to be less likely to lead to CRPS 1.

In a large series of 60 patients from the Hospital for Special Surgery, New York, O'Brien et al⁴⁴ reported a similar age distribution with a mean age of 37.5 years (15 to 70). Of the 60 patients, 41 were women. Two-thirds had had previous knee surgery and 13 of the remaining 20 patients had pain arising from the patellofemoral joint.

The only certainties about this syndrome are its unpredictability and variability. The spectrum of severity ranges from mild transient symptoms to a severe disabling long-term problem. Pain is the main symptom and typically is out of proportion to that expected after injury or operation. Night pain may be particularly troublesome. Anatomically,

the pain does not specifically follow the distribution of a single peripheral sensory nerve.⁴⁵ The knee will be diffusely tender and hyperaesthetic and there may be trigger points which can cause excruciating pain. The other clinical features of this syndrome relate to vasomotor instability. The initial response is one of vasodilatation and the skin becomes pink, warm and dry. Changes in sweating are termed sudomotor changes. The combination of swelling and inactivity due to the constant pain leads to stiffness. The clinical picture then changes and after a variable period of time vasoconstriction occurs. The knee becomes blue and cold and the skin shiny or contracted. Hair growth and on occasions ipsilateral nail growth are affected. Later, the knee becomes atrophic with thinning of the skin and loss of subcutaneous fat. Changes in pigmentation may also occur, leading to dark or pale patches due to redistribution of melanin.

Most authors have described three phases in the vasomotor changes in CRPS 1 as follows.

Phase 1. The early vasomotor response of swelling and vasodilatation when the knee is hot pink and dry. This usually occurs within three months of the precipitating episode.

Phase 2. The dystrophic phase with predominant vasoconstriction, continuing oedema and cold thin skin together with increasing stiffness, developing between three and 12 months after the onset.

Phase 3. The atrophic phase with increasing atrophy of skin, muscle and soft tissue with fibrosis and contracture. Diffuse bony changes also occur which may be irreversible and cause a permanent disability. This phase occurs at a variable time but usually after at least 12 months.

The diagnosis depends very much on awareness of the condition and it should be considered in any patient who has persistent pain after arthroscopic surgery which is out of proportion to the normal postoperative discomfort. Radiological changes normally appear between two and eight weeks after the onset of symptoms. The essential change is one of demineralisation. The osteoporosis is commonly patchy with a band-like distribution predominantly affecting the subchondral bone, epiphysis and metaphyseal region. Both cortical and cancellous bone is involved. The changes are different from the generalised ground-glass appearance of disuse atrophy. The joint space remains normal and there is no evidence of an inflammatory arthropathy such as erosions. Soft-tissue swelling may also be visible. The severity of the radiological changes is very variable as is the clinical syndrome and in a small proportion of patients the radiographs may be normal. The osteoporosis resolves after clinical recovery but some of the radiological changes may be irreversible. Bone scanning is useful and is sensitive although not specific. Typically, the ⁹⁹Tc scan will show increased uptake in the early stages of the disease (Fig. 4). The bone scan is abnormal before the radiological changes appear. There is increased uptake in the whole area affected by the disease. Both the blood-pool

phase and the delayed image show increased activity. The changes may be widespread with increased activity in the other joints of the affected limb, and the whole limb may be involved. Changes may be seen in the contralateral leg. The exception to this is in children, in whom the bone scan may appear normal. Later, the scan returns to normal. Ogilvie-Harris and Roscoe⁴⁰ reported that all patients who presented early had positive scans, whereas in the group presenting later, only six of eight scans were positive. In the large series described by O'Brien⁴⁴ all 19 patients who had bone scans demonstrated some asymmetry of uptake, and two with good results from treatment had repeat scans which showed decreased activity. Bone scanning is therefore a reliable indicator of CRPS 1 and, if the bone scan is normal in an adult, particularly in the early stages, the diagnosis must be doubtful. Other investigations such as MRI and CT do not provide useful information.

Other causes of unresolved pain are infection, inflammatory joint disease and circulatory disturbances including DVT. The patient with CRPS 1 will be well, with no systemic signs, and the appropriate haematological investigations including full blood count, ESR, CRP, rheumatoid factor, uric acid and serum biochemistry will be normal. The radiological signs will be confined to the bone and the joint space will be normal or at least unchanged from previous radiographs. A venogram is advisable if DVT is clinically suspected.

The main objective of treatment is to alleviate pain as a prelude to rehabilitation.⁴⁶ The mainstays of treatment are the use of analgesics including NSAIDs, neurotransmitter blockers, physiotherapy and regional blocks. The transcutaneous nerve stimulator is also thought to be effective. The management of this condition is difficult and a prolonged treatment and rehabilitation programme is almost invariably required. The services of a pain clinic are invaluable particularly with respect to sympathetic blockade. Progress can be painfully slow and much patience is required on the part of the patient, surgeon and physio-

Fig. 4

Bone scan in CRPS 1 showing marked increased activity.

therapist. The recovery period is measured in years rather than months or weeks.

Infrapatellar contracture syndrome. Paulos et al⁴⁷ and Paulos, Wnorowski and Greenwald⁴⁸ have described a group of patients with a combination of both significant loss of movement and reduced patellar mobility after operation or trauma. It most commonly occurs after reconstruction of the ACL but may arise after less complex arthroscopic procedures. In the original series⁴⁷ there were 28 patients, in 26 of whom the condition developed after operation and in two after minor trauma to the anterior aspect of the knee. There were 19 reconstructions of the ACL, two of the PCL, two arthroscopic meniscectomies, one arthroscopic lateral retinacular release, one diagnostic arthroscopy and one each of proximal and distal patellar realignment. All patients had a significant lack of extension ranging from 7° to 35° of fixed flexion. Knee flexion ranged from 60° to 139°. Common symptoms were stiffness, pain, swelling after activity, crepitus, weakness and giving-way. Physical signs included an antalgic or flexed knee gait, quadriceps atrophy and patellofemoral crepitatus with a shelf sign at the distal attachment of the patellar tendon because of induration around the tendon. There was significant loss of patellar mobility. The patellar tendon was short with obvious patella infera in 16% of cases. Radiographs showed disuse osteoporosis in the patellofemoral joint in most cases. Patella infera was usually associated with narrowing of the joint space and the formation of osteophytes.

The management is very difficult. Paulos, Wnorowski and Greenwald⁴⁸ described three stages of this syndrome. In stage I, the prodromal stage, there is diffuse oedema and a painful range of movement together with restricted patellar mobility. Patients fail to gain the expected range of movement after operation. Stage II, or the active stage, follows with restriction of movement, atrophy of the quadriceps and patellofemoral crepitus. At this stage vigorous physiotherapy or manipulation will only aggravate the problem. In stage III, there is patella infera and evidence clinically and radiologically of patellofemoral osteoarthritis. The key to the diagnosis clinically is reduced patellar mobility. A zero or negative passive patellar tilt or superior or inferior glide of less than 2 cm confirms the diagnosis. It is then important to determine whether the problem is predominantly suprapatellar or infra- and peripatellar. Suprapatellar entrapment with adhesions in the suprapatellar pouch usually responds to arthroscopic debridement and manipulation. If the lesions are infra- and peripatellar then all vigorous rehabilitation should cease. The patient is placed on a gentle exercise programme with NSAIDs. If these measures do not resolve the problem open surgery is indicated, with intra- and extra-articular removal of adhesions, release of the patellar tendon and a lateral retinacular release. If patella infera of 8 mm or more is present, osteotomy of the tibial tubercle may be advisable, moving it proximally and anteriorly. The postoper-

ative regime consists of CPM with a graduated range of movement, with splintage in extension if necessary. A further arthroscopic procedure may be required. Paulos et al⁴⁸ reported that after this regime the desired range of movement was achieved in most patients, but residual symptoms, patellofemoral dysfunction and activity-related pain and swelling were considerable.

Conclusions

No invasive procedure will be entirely free from risk and arthroscopy of the knee is no exception. Patients should be made aware of this fact. Complications are relatively rare but can have serious and significant consequences when they occur. Not all are unavoidable and it is important to exercise due care in all phases of the surgical process, including preoperative assessment, the surgery itself and aftercare.

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