Effect of high tibial osteotomy on upper tibial venous drainage: study by intraosseous phlebography in primary osteoarthritis of knee joint

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SUMMARY The effect of high tibial osteotomy on the upper tibial venous pattern in primary painful osteoarthritis of the knee joint was studied by preoperative and three to six months post-operative intraosseous phlebograms. The normal phlebographic pattern was established by phlebograms in five patients with normal knees. The preoperative engorgement, tortuosity of the medullary sinusoids, and slow dye clearance showed a remarkable conversion to a near normal appearance after the operation. Rest pain disappeared in all patients after the osteotomy suggesting that venous congestion is the cause of 'rest pain'.

Key words: venous congestion relieved.

The aetiology of primary osteoarthritis and the cause of pain remain obscure. Hence the treatment of osteoarthritis is often empirical. After the accidental discovery of relief of pain following a fracture in an osteoarthritic hip McMurray devised his famous osteotomy.¹ High tibial osteotomy, an identical operation in principle for treatment of osteoarthritis, was also empirical to start with. Various explanations for its remedial effects have been suggested: shifting the line of weight bearing,² relieving the tension in the soft tissues,³ and relief of vascular congestion.⁴ It has been shown conclusively that in osteoarthritis there is an alteration of the intraosseous vascular pattern,⁴ leading to increased intraosseous pressure.⁵ Helal noted the changes in venous sinusoids after osteotomy,⁴ but these changes were not well documented. Data on clearance of the dye were also lacking in his study. The purpose of this paper is to demonstrate the effect of high tibial osteotomy on the vascular pattern in the upper end of the tibia in painful osteoarthritis of the knee joint.

Materials and methods

Intraosseous phlebography was performed by rapid injection of 10 ml Conray-280 into the cancellous

bone in the upper end of the tibia under anaesthesia. The outline of the venous system and rate of clearance of the dye were observed by serial *x* rays taken at 0, 3, 6, 10, 15, and 30 minutes after injection of the dye. Anteroposterior *x* rays showing the knee joint, the lower half of the femur, and the upper half of the tibia were taken by a standard technique.

The normal pattern was established by phlebography in five individuals with normal knees matched for age with the patients. These controls were about to undergo surgery for other conditions not related to the knee.

Five patients with predominantly medial compartment osteoarthritis and genu varum were studied. They all had rest pain in addition to muscular and capsular pain. None had any clinical abnormality in the leg veins. Immediately before surgery all the patients were subjected to intraosseous phlebography. High tibial osteotomy was performed by the technique described by Coventry.⁶ About three to six months after the osteotomy the patients were again subjected to intraosseous phlebography.

Results

The control series showed a more or less standard pattern (Fig. 1). The dye which was injected behaved in two different ways. A variable quantity

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Fig. 1. Intraosseous phlebographic pattern in a normal knee joint at (a) 0; (b) 3; and (c) 6 minutes. The dye dispersed by six minutes. The medullary sinusoids and central medullary vein are not delineated. Some metaphyseal veins are visible. The extraosseous venous outlines start disappearing by three minutes and are absent in the six minute radiograph. The pool of dye at the needle tip is unchanged.

Fig. 2 Preoperative intraosseous phlebogram in an osteoarthritic knee at (a) 0; (b) 3; (c) 15; and (d) 30 minutes. The engorged tortuous medullary sinusoids are well delineated as are the central medullary veins. The clearance of dye is delayed beyond 30 minutes. The extraosseous venous outline has disappeared by three minutes. The pool of dye around the needle tip remains unchanged.

was pooled around the needle tip and did not disperse even after 30 minutes. This was probably the dye which had infiltrated into the interstitial tissue. The remaining dye was rapidly drained off by the venous system, thus outlining it. The clearance time of this dye was three to six minutes. The metaphyseal venous system was well delineated. The medullary sinusoids were not clearly visible, nor was the central medullary vein. The extraosseous venous system was also outlined. This system disappeared in three minutes in two cases and six minutes in three cases.

In the patient group before operation (Fig. 2) the pooling around the needle tip was again observed and behaved in the same way as that in the control

group. The pooling was minimal in three cases, however. The medullary sinusoids were very prominent. They were engorged and tortuous over the entire upper metaphysis of the tibia. The central medullary vein was also clearly seen with increased tortuosity. The metaphyseal draining vessels were very poorly delineated in one and in the remaining four were not clearly visible. The most significant change was the clearance time of the dye, which was very slow, and none was completely cleared even at the end of 30 minutes. The extraosseous venous system was outlined as in the control group, but the outline disappeared by three minutes in all the cases, which is a slightly shorter time than for the control group. This was possibly owing to the low

dye concentration in the blood flowing through the extraosseous venous system as a result of slow outflow of the dye from the tibial metaphysis.

The osteotomy had united in all the patients. The deformity was corrected in all; 2–6.5° of valgus was achieved in four and in one the leg was neutral. The relief of pain was assessed subjectively. In all five patients rest pain, the most disabling factor, was completely relieved after osteotomy. Capsular pain was present in two patients. The mild to moderate muscular pain present in four patients was practically unchanged.

The postoperative intraosseous phlebogram performed three to six months after surgery showed notable changes (Fig. 3). The phlebographic pattern

was not materially altered by the location of the needle in relation to the osteotomy site. The most significant change was the almost total disappearance of the sinusoidal outlines which were so marked in the preoperative phlebograms. The outline of the central medullary vein was visible in only two cases. The metaphyseal draining vessels invisible in three and faint in two cases preoperatively started reappearing in all the cases.

The pattern almost resembled that of the control phlebograms. The clearance time of the dye showed a marked improvement, though it did not return to normal and ranged from six to 15 minutes. The extraosseous venous outlines behaved in the same way as preoperatively. It was obvious that the high

Fig. 3 Intraosseous phlebogram of the upper tibia six months after the operation at (a) 0; (b) 3; and (c) 6 minutes. Neither the medullary sinusoids nor the central medullary vein are delineated. The dye had dispersed by six minutes. The extraosseous venous outline has disappeared by three minutes (control in six minutes). The pool of dye around the needle tip is again unchanged.

tibial osteotomy had brought about a significant change in venous drainage pattern in the upper tibial metaphysis, though total normality was not restored.

Discussion

The pain in osteoarthritis probably does not depend on a single factor. Irregularities in the articular surfaces, abnormality in the line of weight bearing, tension in the soft tissues, changes in the synovial fluid, and, recently, changes in the vascular pattern in the juxta-articular region have been blamed for it. Helal's observation of pain at rest and pain in motion has been a significant progress.⁴ The pain at rest is very disabling and is caused by venous congestion, whereas pain in motion has its origin in the muscle and the capsule. The marked relief of pain after high tibial osteotomy has been generally recognised since it was first described by Jackson and Waugh.⁷ Coventry's theory of pain relief based on biomechanical changes is only one part of the story.² Helal's observations on the effect of high tibial osteotomy on the upper tibial venous system threw light on another aspect of the mechanism of pain relief.⁴ Our observations about pain relief, although in a small number of patients, were more or less uniform and dramatic. The disappearance of the upper tibial engorged venous sinusoids after high tibial osteotomy is the most striking. The clearance of dye reverting to near normal leads to the conclusion that the venous drainage in the area had improved markedly. The relief of the venous congestion appears to be related to the relief of venous pain after high tibial osteotomy. This conclusion is supported by the observation of pain relief after a fenestration operation and by the observation that there is no relation between the correction of deformity achieved and the immediate relief of pain after high tibial osteotomy. In addition, high tibial osteotomy in osteoarthritic joints without deformity also relieves pain.

Another consideration relates to the regeneration of articular cartilage, if any.² This has been observed after high tibial osteotomy as well as in McMurray's osteotomy in the hip.¹ Is it possible that the cartilage regenerates when the circulation is improved—that is, better nutrition? Since the beginning of the 1980s reports have appeared indicating that some of the good results achieved by high tibial osteotomy deteriorate in the course of time.⁸ Coventry has reported that 15% of good results undergo deterioration.⁹ It is not clear whether these knees deteriorated biomechanically nor is there a mention of the type of pain that recurred. If the recurrence is of rest pain this would probably be caused by the return of venous congestion in the upper tibia. It will be of great interest to observe the phlebographic changes in those patients who deteriorate after the initial relief of pain following high tibial osteotomy.

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