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TIBIAL OSTEOTOMY FOR OSTEOARTHROSIS OF THE KNEE

A Five to Ten Year Follow-up Study

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Jackson in 1958 described tibial osteotomy as a method for relieving pain in osteoarthrosis of the knee. Wardle (1962) indicated that the operation had been previously performed. Tibial osteotomy is now an accepted procedure in the treatment of osteoarthrosis of the knee, although reports of its efficacy in the long term are scarce.

The predominant indication for tibial osteotomy is painful deformity, with stiffness, instability and loss of function as other symptoms. There have been numerous reports referring to the 70–80 per cent good early results, as regards pain relief, from tibial osteotomy (Jackson & Waugh 1961, Wardle 1962, Coventry 1965, Harris & Kostuik 1970), but a follow-up time beyond four years is unusual.

How tibial osteotomy works remains debatable. The redistribution of weightbearing stresses, the relief of soft tissue tension by the correction of deformity and alteration of local blood supply all have their proponents. Analysis of the forces acting on the knee has been undertaken (Kettelkamp & Chao 1972) but whether such careful analysis to determine the angle of the osteotomy improves the results compared to merely straightening the affected limb by eye (Jackson & Waugh 1961) remains unproven.

Various techniques for performing the osteotomy have been described; ball and socket at or above the tibial tubercle (Jackson & Waugh 1961), transverse below the tubercle (Wardle 1962) and a closing wedge high above the tubercle (Gariepy 1961), with or without section of the fibula. Internal fixation techniques have also been described (Coventry 1965, Devas 1969) as alternatives to plaster cast immobilization post-operatively.

The importance of accurate correction of the deformity has been

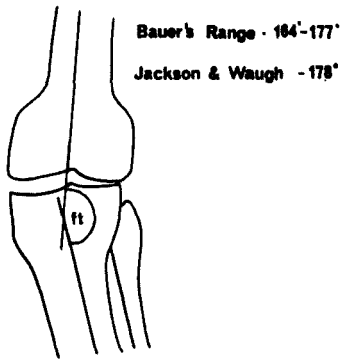


Figure 1. Femoro-Tibial (FT) angle.

stressed (Harris & Kostuik 1970, Coventry 1973) and attention drawn to the pertinence of the Femoro-Tibial (FT) angle for good results (Bauer et al. 1969). The femoro-tibial angle is defined as the lateral angle between the intersection of lines drawn along the axis of the femur and the tibia (Figures 1 and 5). Bauer et al. (1969) found that a post-operative femoro-tibial angle outside the range 164°–177° was more often than not associated with a poor result. In 50 healthy knees the average FT angle was 178° (Jackson & Waugh 1961).

It is the purpose of this study to establish the long-term results of tibial osteotomy and to study further the relevance of the FT angle in these results.

MATERIALS AND METHODS

Forty-seven patients (22 female and 25 male), having had tibial osteotomies for osteoarthrosis of the knee during the period 1962–1967 inclusive, formed the basis of this study. All but two patients (one assumed dead) were traced. Eleven patients had bilateral osteotomies, six during the same hospital admission and five between 1½ and 10 years after the first operation, two of these second procedures being outside the limits of this study. Forty-six knees were in varus pre-operatively and ten in valgus, nine of the latter cases being women. At the time of review nine patients were dead, none having died earlier than 3 months post-operatively. Thus in all, 45 knees in 37 patients were available for review and these were assessed clinically and radiologically with weightbearing films.

All except five patients were in their seventh and eighth decades and the follow-up distribution (Table 1) shows a fairly even spread over the 5 to 10 year period, the average follow-up time being 7.6 years.

Table 1. Length of follow-up in years (average 7.6 years).

Length of follow-up (years)	5	6	7	8	9	10
Number of patients	4	9	8	10	8	6

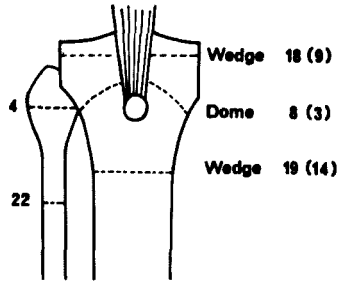


Figure 2. Techniques of osteotomies (numbers in brackets indicate osteotomies with division of the fibula).

The tibial osteotomies had been performed at various levels (Figure 2). All patients had been operated on for pain, in two cases because they refused arthrodesis. Both of these latter cases were graded as excellent at follow-up 5 and 10 years after the operation, respectively. Only two osteotomies were held by internal means, the remainder were managed post-operatively in plaster casts.

Assessment was made in terms of pain relief, mobility and function and from these three factors a final assessment was made. Each factor was graded as follows:

Pain

Grade I	No pain.
Grade II	Pain relieved by analgesics if required.
Grade III	Pain not relieved by analgesics.

Mobility

Grade I	$0° > 90°$
Grade II	$0° — 90°$
Grade III	$— 5° — 60°$

Function

Grade I	Normal: full activities and returned to work/full activities in retirement.
Grade II	Some limitation of activities, e.g. use of a cane.
Grade III	Incapacity.

Final Assessment

Excellent	1. All grades I.
	2. One grade II.
	3. No grade III.
Good	1. No more than two grade II.
	2. No grade III.
Poor	1. All grade II.
	2. One or more grade III.

RESULTS

Pain Relief

Five to ten years post-operatively, pain relief was a very striking feature of the operation. Thirty knees had no pain and 14 had marked improvement in their level of pain which was relieved by simple analgesics. Only one patient had no pain relief and this knee was eventually arthrodesed. Seven of the 14 knees had complete relief of pain for up to 4 years and then developed increasing pain. This was usually associated with a recurrence of varus deformity (Figure 5) the average FT angle being 189°. At review, six of these knees were assessed as poor and the remaining one good. Five patients claimed that the contra-lateral knee had diminished function due to pain.

The duration of symptoms was more often than not longer than 2 years and in almost half the cases longer than 5 years. Of the 26 knees with symptoms less than 5 years, 23 had an excellent or good result and three poor, whereas only 12 out of 19 knees with symptoms over a period longer than 5 years had other than a poor result.

Function is closely associated with pain relief and the predominant factor causing poor results was restricted mobility (Table 2).

Range of Movement

When the range of movement measured at follow-up was compared with that recorded pre-operatively it was found that 34 knees had an unchanged range of movement. Coventry (1973) reported similar results.

Eight knees had a diminished range of movement of between 30° and 100°. The marked loss of 100° occurred in an obese lady with bilateral osteotomies not performed at the same time, who progressed well for three and a half years and then developed increasing varus deformities of both knees to FT angles of 191° and 198°, respectively, at the time of a five-year review. This was associated with gross three compartment osteoarthrosis of both knees. Of the other six knees, one had a high segment deep venous thrombosis with subsequent chronic oedema of the leg; one had an ipsilateral femoral osteotomy for osteoarthrosis of the hip performed at the same operation; one had a patellectomy performed at the time of the tibial osteotomy; one had bilateral disease and osteotomies were not performed at the same time and the loss of range of movement in the remaining two knees followed bilateral tibial osteotomies performed at the same operation.

Two knees showed gains in range of movement of 50° and 45°, respectively, the reason for which was not apparent. One knee was arthrodesed for unrelieved pain, there being no apparent technical reason for the failure in this case. Restricted mobility was not a cause of concern to any of the patients in this study.

Function

Seventeen of the 37 patients were employed at the time of operation, the remainder being housewives or retired. Of these 17, 14 returned to their original work including, farm labouring, sheet metal working, and long-distance lorry driving. The other three failed to return to work for the following reasons; the first retired because of troublesome hypertension; the second, a 64-year-old bricklayer retired a little prematurely post-operatively, having obtained an excellent result; the third, a 55-year-old painter and decorator, with bilateral disease, had a patellectomy at the same time as his tibial osteotomy and 8 years later was assessed as poor. The majority of the retired and housewives group found their function improved post-operatively. This functional improvement was maintained for the period of this study. As expected, there is a close relationship between pain and functional activities (Table 2).

Final Assessment (Table 2)

27/45 Excellent
8/45 Good
10/45 Poor

Table 2. Final assessment.

Final assessment	Grade	Excellent	Good	Poor
Pain	I	24	1	5
	II	3	7	4
	III	–	–	1
Mobility	I	23	6	2
	II	4	2	3
	III	–	–	5
Function	I	27	–	3
	II	–	8	6
	III	–	–	1
Total		27	8	10

Objectively aceptable results 35/45

Subjectively only one patient, who subsequently came to arthrodesis, did not think the operation worthwhile. Of the ten knees which were graded poor, five fell into this category because knee flexion did not exceed 60°; whereas only four had pain which was, however, controllable with analgesics. Five had no pain. Thus even in the group graded as objective failure half had complete pain relief. The level and type of osteotomy and division of the fibula did not appear to affect the final assessment.

Femoro-Tibial Angle

In this review, 26 of the excellent and good results had a femorotibial angle range of 163°–180°. The remaining nine knees in the excellent and good groups had an average FT angle of 184° with a maximum angle of 188° in one instance. All the poor results were outside the range 163°–180° and all were in varus, the greatest angle being 198°, the least 184° and the average 189°.

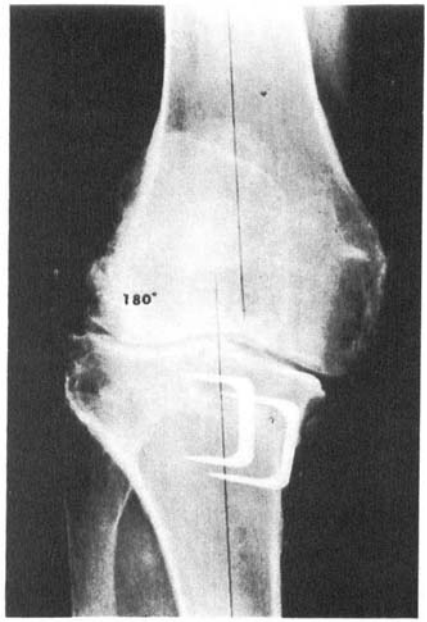
These figures confirm the findings of Bauer et al. (1969) of a safe FT angle range of 164°–177° and suggest that an angle of up to 184° is compatible with an excellent result. Above 184° a bad result is more than likely. In other words, a varus position either by under-correction of the original varus deformity or over-correction of a previous valgus deformity is undesirable.

The importance of achieving a correct final femoro-tibial angle is further emphasised by two cases which despite three compartment osteoarthrosis and a sloping joint line, maintained good results after five and ten years, respectively (Figures 3 and 4).

Analysis of the Poor Results

Of the ten knees assessed as poor, all fell within a FT angle range 184°–198° with an average FT angle of 189°. Four knees were undercorrected at the time of the surgery. Four knees had initial pain relief for up to 4 years before pain recurred; this was associated with a recurrence of a varus deformity (Figure 5). One knee was over-corrected from valgus to varus and one knee was arthrodesed for unrelieved pain, no technical reason being obvious for the failure. Two knees had other procedures performed on the same leg at the same time—one patellectomy and one upper femoral osteotomy.

Figure 3. Three compartment osteoarthrosis with subluxation and sloping joint line. Good results after 5 years. FT angle 180°.



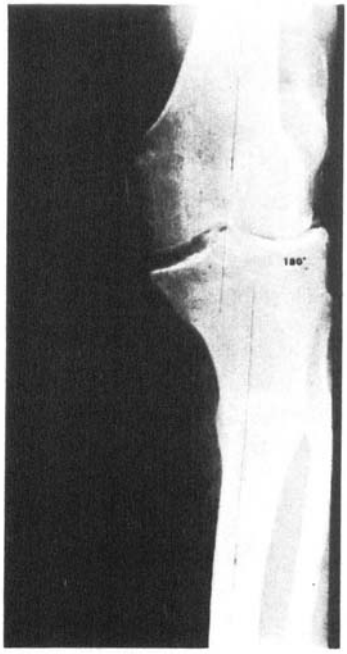


Figure 4. Three compartment osteoarthrosis with sloping joint line. Good results after 10 years. FT angle 180°.

Surgical Complications

Deep venous thrombosis – 7 (At least two high segment thromboses with subsequent chronically swollen legs).
Peroneal nerve palsy – 1 (no recovery at eighteen months).
Infection – 1.
Pain over the fibular head – 1.
Loss of correction before union – 4.
Displacement of osteotomy in antero-posterior plane – 3.

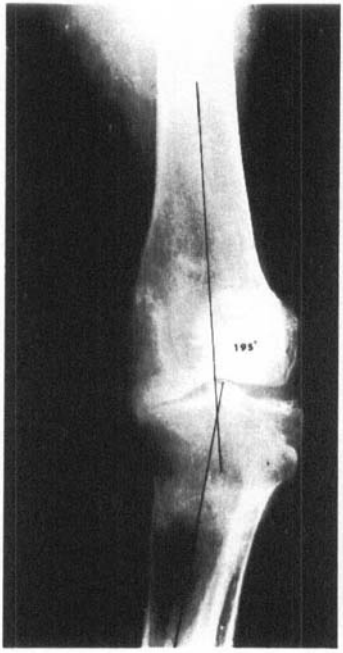


Figure 5. Late recurrence of varus deformity. Poor result after 10 years. FT angle 195°.

Delayed union – 3 (two below the tibial tubercle and one above).
Damage to the popliteal and anterior tibial vessels did not occur and damage to the tibial plateau during high osteotomies was not noted.

DISCUSSION

This study confirms the findings of previous reports of early and intermediate good results following tibial osteotomy (Jackson & Waugh 1961, Wardle 1962, Coventry 1965, Bauer 1969, Harris & Kostuik 1970). Long-term reports are relatively rare. The largest series to our knowledge is that of Coventry (1973). In his series of 86 osteoarthritic knees 27 were evaluated 4 to 9 years after surgery. This present report of 45 knees would therefore seem to be one of the largest series with a long-term report to date. It is all the more important since all but two patients (one assumed dead) were traced and assessed.

Our findings correlate closely with those of Coventry (1973). We would like to emphasise especially that it is much more common to under-correct than to over-correct the deformity at osteotomy. Coventry now recommends over-correction by five degrees and maintains that this effectively prevents late recurrence of deformity. We are also in

agreement with his recommendation for osteotomy "earlier rather than later in an effort to prevent worsening and to restore more satisfactory function by lessening pain" (see Conclusions 3).

Tibial osteotomy in our series was achieved by various means. In terms of the final assessment they all had similar functional results. However, since the most important single factor pertinent to good long-term results is adequate correction of the deformity and subsequent maintenance and, since union is most readily obtained at the upper tibial level, we would recommend the closing wedge osteotomy proximal to the patellar tendon with fixation by staples, after radiological confirmation at operation, as the method of choice (Ahlberg et al. 1968, Coventry 1969, Gariepy 1961).

CONCLUSIONS

1. Tibial osteotomy is a good pain relieving operation in osteoarthrosis of the knee, with low mortality and morbidity.
2. Relief of pain can be achieved in the majority of patients and lasts up to 7½ years in most and 10 years in some. A small number of patients develop pain again after a few years, usually associated with recurrence or under-correction of a varus deformity.
3. The best results in terms of pain relief, mobility and function are obtained if the following factors are observed:
   (a) The predominant symptom is pain.
   (b) The duration of symptoms is less than 5 years.
   (c) The pre-operative mobility of the knee is greater than 90°.
   (d) The deformity is corrected within a Femoro-Tibial angle range of 163°–180°.
4. The long-term results are not affected by:
   (a) The level or type of osteotomy.
   (b) Division of the fibula.
   (c) The age of the patient.
   (d) Bilateral osteotomies not performed at the same time.
5. The range of movement was unaffected in the majority of patients. A minority had diminished movement and two patients gained in range of movement.
6. Function and pain relief are closely related. The majority of working men, even in heavy employment, returned to their original employment.

SUMMARY

Forty-five knees with tibial osteotomy for osteoarthrosis were studied at 5 to 10 years following surgery. Twenty-seven were graded excellent, eight good and ten poor.

The best results were found in knees which maintained a Femoro-Tibial angle of 163°–180° whereas the poor results were associated with either under-correction at operation or late recurrence of deformity. The latter was closely related to pain. Provided that the initial deformity is adequately corrected and maintained, tibial osteotomy for osteoarthrosis of the knee gives good results which can last up to 10 years.

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