

From the Fracture and Orthopaedic Unit, Bridge of Earn Hospital, Perthshire,
Scotland (Head: Prof. I. S. Smillie).

FIBULAR RESECTION IN DELAYED UNION OF TIBIAL FRACTURES

By

FEDERICO FERNANDEZ-PALAZZI¹

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With modern methods of treatment, delayed union of tibial fractures is no longer a major problem. Nevertheless the problem still exists, and it is the purpose of this paper to correlate the presence of an intact fibula in slow union of the tibia, an intact fibula in the adult apparently preventing satisfactory contact between the tibial fragments.

Delayed union of the tibia frequently occurs in the presence of such an intact fibula. In some cases the fibula is not damaged at the time of injury and then exerts its deleterious influence from an early stage (a primary intact fibula). On occasions the fibula is fractured initially but unites rapidly and thereafter prevents contact between the tibial fragments.

The incidence of non-union and delayed union varies from bone to bone and is highest for the tibia (*Campbell* 1963). It is well recognized that fractures of the tibia, specially in the lower middle third and in older patients, heal slowly. Healing of compound fractures and infected fractures is also slow. Another important factor is the type of fracture. Repair of a long spiral fracture with considerable periosteal involvement requires approximately 6 to 8 weeks, while union of a horizontal fracture usually occurs within 10 to 12 weeks (*Piulachs* 1963).

A gap, especially if due to continued fraction, between the fragments, is an important cause of non-union. A gap of more than 0.5 cm prolongs the healing time to 12 to 18 months, and if the gap is more than 1 cm healing will require 18 to 24 months (*Urist et al.* 1954).

As stated by *Watson Jones* (1963), the most important factor to

¹ Present address: Servicio de Cirugía Ortopédica, Hospital del Sagrado Corazón, Borrell 303, Barcelona 15, Spain.

avoid delayed union and so reduce the risk of non-union is good immobilization of fragments. Adequate immobilization of the fragments is therefore necessary to prevent rotational and angular strains at the site of the fracture.

The role played by the fibula in delayed union and non-union of the tibia has long been known. *Irigoyen Dotti* (1966) mentions that one of the causes of delayed union is "the diminished pressure between the fragments, the influence of the interosseus membrane, and the persistence of a non-fractured fibula or a fibula that healed within the usual time". *Blumenfeld* (1947) quotes that in thirty two (55.2 per cent) of fifty eight cases of non-union of the tibia seen at Iowa University Hospital the fibula was intact.

Many procedures and treatments for non-united fractured tibiae include osteotomy to improve the position of the tibial fragments (*Campbell* 1963), or to allow the fragments to come into contact. It is used together with bone graft, *Beck* multiple drilling, etc. In some departments, in specific cases of simple transverse fracture of the tibia with intact fibula the fibula is fractured before application of the plaster to allow better contact of fragments (*Palazzi* 1966).

As stated above, a gap between the fragments retards union. The intact fibula of an adult, being stronger than the fibula in a child, acts as an internal splint and may therefore prevent approximation of the fragments and thereby delay healing. *Piulachs* (1963) said "the deleterious influence of an intact fibula is not only because it prevents longitudinal pressure at the fracture site, but also because it allows sliding movements, thus interfering with healing and consolidation" and later "in order to help longitudinal pressure on the lower limb it is advisable to apply a walking plaster and if the fibula is healed, or was never broken and due to the fact that because of its elasticity prevents good contact of fragments, it is necessary to section it". It would thus appear that if the fibula is also fractured weight-bearing in a walking plaster would promote union of the fragments, but if the fibula is intact, it would appear advisable to resect the fibula to allow good contact between the fragments.

The overall incidence of delayed union and non-union has been estimated at less than 3 per cent for the skeleton as a whole (*Owen* 1934), but in the tibia it can be as high as 7 per cent for selected non-comminuted fractures (*White et al.* 1953), 9 per cent for unselected consecutive cases (*Kuntzmann et al.* 1957) and 75 per cent for displaced, compound comminuted fractures (*Carpenter et al.* 1952).

It is important to differentiate delayed union from non-union or pseudoarthrosis. Though it is not possible to draw a sharp line of distinction between these two conditions, union may be regarded as delayed when callus formation fails to occur within the usual time. In delayed union the healing process is still active and in non-union reparative cellular activity has ceased. Therefore, in delayed union, surgical intervention on the fibula alone may promote healing but in the case of a non-union, in which the healing process has ceased, it is necessary to operate on the tibia at the site of the fracture. Treatment of stabilized pseudoarthrosis should, so to say, reproduce the conditions prevailing shortly after the fracture in order to restart the healing process. This can be done either by freshening of the bone ends and resection of fibrous tissue and sclerotic bone or, according to *Judet et al.* (1965), by "osteoperiostic decortication" with or without freshening, since freshening is secondary in importance (*Palazzi* 1966). Therefore, once the non-union is established, a procedure limited to the fibula is bound to fail. Thus, in delayed union, if contact between the fragments can be obtained by intervention on the fibula without direct operation on the tibia, this procedure would appear to be the one of choice.

INDICATIONS

Some signs of union should normally be demonstrable within 6 to 8 weeks. If the fibula alone has by then united it can probably prevent union of the tibia. Delayed healing of a tibial fracture in the presence of an unfractured or healed fibula appears to indicate resection of the fibula before non-union is established.

In delayed union, the fracture line is still roentgenographically demonstrable: initially there is no gap between the fragments, no cavitation of the bone ends and no sclerosis, but later the fracture line widens with the formation of a hazily outlined cavity, and the bone ends are decalcified. Union is still only delayed. Once non-union has been established the surface of the ends of the fracture fragments are well defined, smooth and sclerotic. Clinically, when there is mobility at the fracture site without pain on pressure or swelling of soft tissues, this indicates that healing has ceased and therefore, this is not delayed union but non-union. If there is mobility but pain and oedema, there is still some activity and union is still only delayed.

Excision of fibula alone in the treatment of delayed union of the tibia does not appear to have been widely reported in the literature.



Figures 1a(1) and 1a(2). Case No. 7. P.D. Original anteroposterior and lateral X-rays of this patient's comminuted fracture of the middle of the tibia and lower third of the fibula caused by fall of a heavy weight on his left leg. (19 March, 1958).

Figure 1b(1). Anteroposterior X-ray on 8 October, 1958 (after 29 weeks) of the fracture just before the operation.

Figure 1b(2). Anteroposterior X-ray on 4 November, 1958, after excision of one and a half inches of the fibula.

Figures 1(c) and 1c(2). Anteroposterior and lateral X-rays on 3 December, 1958, 7 weeks after the operation. The fracture is healed radiographically as well as clinically.

Alistair Morrison (1966) used such treatment in two unpublished cases of Law Hospital, Carlisle, Scotland. One of the patients was a 60 year old man with a comminuted fracture of the upper left tibia and fibula originally treated by open reduction and screwing. After 16 weeks of delayed union, two inches of the fibula were excised and union occurred within 10 weeks. The other patient was an 80 year old man with an oblique fracture of the upper third of left tibia and fibula. His general condition was very poor and the fracture was treated by immobilization in plaster. After 24 weeks, two inches of the fibula were excised and 8 weeks later the fracture was united.

Urist et al. (1954) reports three cases of a long oblique saw cut or resection of the fibula performed to allow closure of a gap in the tibia after 8, 11 and 18 months of non-union in the hope that this would permit the muscles forces to compress the ends of the fragments together. In all three cases the fibula healed within 4 weeks, while the fracture of the tibia remained non-united and a bone graft was performed 4 to 18 months later. He concludes that there is no proof that this



Figures 2a(1) and 2a(2). Case No. 8. A.S. Original anteroposterior and lateral X-rays on 25 April, 1958, after a motorcycle accident showing the comminuted fracture of the middle of the left tibia and fibula.

Figure 2b(1). Anteroposterior X-ray on 30 September, 1958, showing the screw and state of the fracture before excision (23 weeks after admission).

Figure 2b(2). Anteroposterior X-ray on 29 October, 1958, after operation.

Figures 2c(1) and 2c(2). Anteroposterior and lateral X-rays on 15 December, 1958. The fracture was then clinically and radiographically healed (9 weeks after the operation).

procedure is sufficient by itself to produce union of an non-united tibia.

Fibular resection is NOT treatment for non-union of the tibia, but only to accelerate healing when union is delayed.

CASES AND TECHNIQUE OF OPERATION

This paper reviews fourteen cases of resection of the fibula carried out from 1952 to 1965 at Bridge of Earn Hospital because of delayed union of tibial fractures. All fourteen patients were males. Of the fourteen fractures, 8 were compound, 10 comminuted and in 2 cases the fibula had only a crack (Figures 1 and 2).

The operation was performed through a longitudinal lateral incision exposing the fibula subperiosteally. The fibula was resected at a level below that of the tibial fracture, the fibula being more readily accessible in its lower third. Two to three inches of the fibula were excised. Resection was preferred to osteotomy because of the possibility of osteotomy's healing too rapidly. Postoperatively the leg was immobilized in a midthigh plaster cast and weight-bearing was not allowed for 10 to 14 days. As soon as the wound had healed, weight-bearing in a walking plaster was allowed to promote good contact between the ends of the fracture fragments.

Table

Initials and age	Date and type of original injury	Date and type of initial treatment	Subsequent treatment
1) T.M. 21	18 April 1952 Compound fracture midshaft right tibia and fibula with loose fragments anteriorly.	18 April 1952 Toilette and suture. Insection of Steinman's pins above and below the fracture. Manipulation and plaster of Paris.	Series of plasters. Fibula healed in July.
2) C.A. 27	17 July 1954 Compound fracture midshaft right tibia and fibula with butterfly fragment mid-tibia. Involvement of tibial vessels suspected.	22 July 1954 Toilette. Internal fixation with 2 screws. Plaster of Paris.	Series of plasters. 1 April 1955 Fibrous tissue from fracture site and screws removed. After freshening, cancellous chips were packed. Plaster of Paris. Fibula healed on 30 Aug. 1955
3) J.H. 48	20 May 1955 Comminuted compound transverse fracture upper shaft right tibia and fibula.	20 May 1955 Toilette and suture. Manipulation and plaster of Paris.	Series of plasters. Fibula united on 29 September 1955.
4) R.M. 51	7 January 1956 Compound comminuted midshaft right tibia and fibula with longitudinal crack running down distal fragment of tibia.	7 January 1956 Toilette and suture. Steinman's pins above and below fracture. Manipulation and plaster of Paris.	Series of plasters. Fibula united on 7 May 1956.
5) G.M. 64	2 August 1957 Compound comminuted fracture middle shaft tibia with double fracture upper and lower fibula.	2 August 1957 Toilette and suture. Steinman's pins above and below fracture. Manipulation and plaster of Paris.	Series of plasters. Fibula united on 20 November 1957.

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Number of weeks without union	Excision of fibula	Date of union	Remarks
41 weeks (9 months and 2 weeks)	30 January 1953 Half an inch of lower third of fibula.	1 April 1953 9 weeks (2 months)	
94 weeks (1 year, 9 months and 2 weeks)	9 May 1956 One inch of lower third of fibula.	26 June 1956 7 weeks (1 month and 3 weeks)	Fell again and refrac- tured tibia on two further occasions, on 22 October 1956 and 28 April 1957. Had a slid- ing graft in October 1956. In April treated with plaster of Paris until 9 October 1957.
35 weeks (8 months)	19 January 1956 Three inches of lower middle fibula.	13 April 1956 12 weeks (2 months and 3 weeks)	Refractured tibia on 30 April 1956. Plaster of Paris until 29 June 1956.
32 weeks (7 months and 1 week)	17 August 1956 One inch of lower middle fibula.	5 Nov. 1956 11 weeks (2 months and 3 weeks)	
17 weeks (3 months and 4 weeks)	26 November 1957 Two inches of lower third of fibula.	26 Febr. 1958 13 weeks (3 months)	Had a caliper until 6 August 1958.

Table

Initials and age	Date and type of original injury	Date and type of initial treatment	Subsequent treatment
6) J.G. 34	13 November 1958 Compound fracture lower right tibia and fibula.	13 November 1958 Toilette, removal of 2 loose pieces of bone and suture. Manipulation and plaster of Paris.	Series of plasters. Fibula united on 4 Februar 1959. Series of plasters. Doubtful non-union on 13 July 1959.
7) P.D. 41	19 March 1958 Comminuted fracture midshaft of left tibia and lower shaft of fibula undisplaced.	19 March 1958 Manipulation and plaster of Paris.	Series of plasters. Fibula united on 1 September 1958.
8) A.S. 26	25 April 1958 Comminuted fracture lower midshaft of left tibia and fibula.	25 April 1958 Manipulation and plaster of Paris.	29 April 1958 Open reduction and screwing. Fibula healed on 17 July 1958.
9) J.A.S. 43	28 December 1958 Compound fracture right tibia and fibula.	28 December 1958 Toilette and suture. Manipulation and plaster of Paris.	Series of plasters. 13 January 1961 Bone grafting with cancellous bone. Wound infection developed and lasted some months.
10) P.M. 48	5 August 1959 Oblique fracture middle third of right tibia and fibula.	5 August 1959 Open reduction and internal screw fixation. Plaster of Paris.	Series of plasters. Fibula healed on 21 December 1959.

1 (cont.)

Number of weeks without union	Excision of fibula	Date of union	Remarks
26 weeks (6 months)	15 May 1959 Half an inch of middle fibula.	---	The second operation is not a straight for- ward fibular resection alone and was accom- panied by bone chip graft on tibial fracture site. Done in doubtful non-union. At the end of treatment the leg was three quarters of an inch short.
35 weeks (8 months)	17 July 1959 One and a half inches of middle fibula. Through other incision the fibrous bone ends were removed as well as sclerosis. Packing of tibia with bone chips.	19 October 1959 13 weeks (3 months)	
30 weeks (6 months and 3 weeks)	14 October 1958 One and a half inches of lower fibula.	3 December 1958 7 weeks (1 month and 3 weeks)	
24 weeks (5 months and 3 weeks)	14 October 1958 One and a half inches of lower fibula. Removal of the screw from tibia through other incision.	15 Dec. 1958 9 weeks (2 months)	
141 weeks (2 years, 8 months and 2 weeks)	14 September 1961 One inch of lower fibula.	14 Dec. 1961 13 weeks (3 months)	Continued on plaster for another month because of previous history of infection and length of delayed union.
26 weeks (6 months)	2 Februar 1960 One inch of lower fibula. Removal of screw from tibia through other incision.	13 April 1960 10 weeks (2 months and 2 weeks)	

Table

Initials and age	Date and type of original injury	Date and type of initial treatment	Subsequent treatment
11) D.B. 26	22 April 1962 Fracture middle shaft left tibia and upper shaft left fibula.	27 April 1962 Open reduction and tibia plated. Plaster of Paris.	Series of plasters.
12) D.B. 25	26 February 1964 Compound fracture lower third of left tibia and fibula.	26 February 1964 Toilette and suture. Manipulation and plaster of Paris.	Series of plasters.
13) B.S. 32	10 April 1964 Transverse fracture lower third of tibia with undisplaced crack of fibula.	10 April 1964 Plaster of Paris.	Series of plasters.
14) D.A. 18	5 May 1965 Fracture lower third right tibia and fibula. Fracture shaft right femur.	5 May 1965 Kuntscher nail to femur, Steinman's pins above and below fracture. Manipulation and plaster of Paris.	Series of plasters. 20 October 1965 Bone graft operation on tibia. (Bone slabs and marrow packed).

RESULTS

In all fourteen cases the fracture consolidated within 18 weeks (4 months).

Of the fourteen cases:

Five healed between 1 and 2 months (three in 7 weeks and two in 9 weeks).

Seven healed in 2 to 3 months (one in 10 weeks, two in 11, one in 12 and three in 13 weeks—one of these three after a second excision

1 (cont.)

Number of weeks without union	Excision of fibula	Date of union	Remarks
17 weeks (3 months and 4 weeks)	17 August 1962 One inch of lower fibula. Through anterior incision the plate was removed and the fracture site drilled.	19 Dec. 1962 18 weeks (4 months)	Not a straight-forward resection because of drilling. Had a below-knee walking caliper until 18 March 1963.
18 weeks (4 months)	30 June 1964 One inch of lower fibula.	26 October 1964 17 weeks (3 months and 4 weeks)	
11 weeks (2 months and 3 weeks)	30 June 1964 One inch of lower fibula.	7 weeks (1 month and 3 weeks)	Had a fall on 30 October 1964 sustaining a fracture of anterior lip left lower articular tibia that resulted in an anterior subluxation of the talus leading to ankle arthrodesis on 21 September 1965.
32 weeks (7 months and 2 weeks)	17 December 1965 Two inches of lower fibula.	2 March 1966 (2 months and 3 weeks)	

because there was no definite improvement in healing two months after the first operation.

One healed between 3 and 4 months (17 weeks).

One healed in 4 months (18 weeks).

These fractures would, perhaps, have healed with prolonged, probably markedly prolonged, immobilization in plaster without resection of the fibula.

After resection of the fibula the tibial fractures healed between 7 and 18 weeks later. It is therefore obvious that this operation hastens tibial

union. Resection should, perhaps, have been done somewhat earlier. Generally speaking, it would appear that if radiography 6 to 8 weeks after the fracture shows that union is delayed, resection of the fibula is indicated.

Fibular resection avoids the definite risk of long immobilization in plaster, possibly with stiffness of the joints requiring mobilization after the fracture has healed, as well as long impairment or loss of healing capacity and not to mention the extra costs of treatment.

SUMMARY

1. The importance of an intact fibula in delaying union of tibial fractures is emphasized.

2. The theory of excision of 2 to 3 inches of the fibula, to allow adequate contact between the ends of the fracture fragments, impaction and better contact of the fragments to accelerate healing, is set forth and a survey of the literature is given.

3. Fourteen cases of such an operation because of delayed union of fractures of the tibia are reported and discussed.

4. The results of this procedure showed that all fractures healed within 7 to 18 weeks after the operation was performed.

5. "In delayed union of fractured tibiae, if impaction of the fragments can be obtained by acting on the fibula, without direct operation on the tibia, this procedure would appear to be the one of choice. On this basis, resection of a portion of the fibula should be considered as a simple but effective measure at quite an early stage in treatment".

RESUME

1) L'importance d'un péroné intact en cas de non-soudure d'une fracture du tibia est soulignée.

2) La théorie de l'excision de quelques centimètres du péroné, pour provoquer le collapsus du niveau de la fracture tibiale afin d'obtenir une impaction et un meilleur contact des fragments dans l'espoir d'accélérer le moment de la guérison est exposée et il est donné un compte rendu de la littérature.

3) Quatorze cas d'opération pour union différée de fractures du tibia sont expliqués et discutés.

4) Les résultats de cette méthode montrent que toutes les fractures ont été guéries dans l'espace de 7 à 18 semaines après l'opération.

5) Dans les cas de non-soudure d'une fracture du tibia, si l'on peut obtenir l'impaction des fragments en agissant sur le péroné, sans opération directe du tibia, cette méthode apparaîtra comme une des meilleures. Sur cette base, la résection d'une partie du péroné peut être considérée comme un moyen simple et efficace à un stade précoce du traitement.

ZUSAMMENFASSUNG

1) Die Wichtigkeit einer intakten Fibula bei verzögerter Heilung von Tibiabrüchen wird hervorgehoben.

2) Die Theorie der Exzision von 2 bis 3 Zoll der Fibula um ein Zusammensinken auf der Höhe des Tibiabruches und eine Zusammenstauchung mit besserem Kontakt der Fragmente, mit der Hoffnung auf eine Verkürzung der Heilungszeit, zu gestatten, wird besprochen und eine Übersicht der Literatur wird durchgegangen.

3) Vierzehn Fälle dieser Operation verzögerter Heilung von Tibiabrüchen werden erklärt und besprochen.

4) Die Ergebnisse dieses Vorgehens zeigten, dass alle Brüche im Zeitraume von 7 bis 18 Wochen nach Ausführung der Operation heilten.

5) Bei verzögerter Heilung von Tibiabrüchen, wenn Zusammenstauchung der Fragmente mittels Operation aus der Fibula ohne direkten Eingriff an der Tibia erreicht werden kann, scheint dieses Vorgehen die Methode der Wahl zu sein. Auf dieser Grundlage sollte die Resektion eines Teiles der Fibula als eine einfache aber effektive Massnahme bereits in einem frühzeitigen Stadium der Behandlung angesehen werden.

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