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FRACTURE OF THE SHAFT OF THE TIBIA

Incidence of Complications as a Function of Age and Sex

By

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INTRODUCTION

In a consecutive series of 173 fractures of the shaft of the tibia, *Bauer, Edwards & Widmark* (1962) showed that the occurrence of poor results was frequent in fractures caused by direct, high energy forces, and infrequent in fractures caused by indirect, low energy forces. It was suggested that this difference in final status of the cases was related to the degree of skin injury seen in the two groups of fractures: those caused by direct forces had suffered crush injury of the skin, obvious in open fractures but probably present also in closed fractures. In a series of experimental fractures of the tibia in dogs (*Edwards* 1965a) it was found that the rate of healing was delayed in those fractures which had a crush injury of the skin over the fracture. It seemed possible that poor results in fracture of the shaft of the tibia could be prevented by paying close attention to the associated skin injury. *Edwards* (1965b) accordingly modified the treatment of such fractures. In a Prospective Series of 109 transverse or comminuted displaced fractures of the shaft of the tibia, 47 of which were open, only one had a poor final status, whereas in a Control Series, 21 of 165 transverse or comminuted displaced fractures had poor final status. The one case in the Prospective Series which had a poor final status had necrosis of the skin and osteomyelitis; there was a high incidence and close correlation between these complications in the 21 fractures in the Control Series which had poor final status. The importance of necrosis of the skin and subsequent osteomyelitis as a factor in the etiology of poor results of fracture of the shaft of the tibia was thus established.

Edwards also confirmed the correlation between crush injury of the skin and subsequent necrosis of the skin: this complication did not occur in the 149 longitudinal displaced fractures in the combined series in spite of a high frequency of open reduction and internal fixation (76 per cent) which in the Control Series was always performed through an incision over the antero-medial surface of the tibia. In the closed transverse or comminuted fractures necrosis of the skin was observed only in those treated by open reduction through an incision over the fracture.

In an attempt to further analyze the cause of necrosis of the skin, osteomyelitis, and poor final status in fracture of the shaft of the tibia, the effect of age and sex on these variables was studied in the transverse fractures of *Edwards'* (1965b) Control Series.

MATERIAL AND METHODS

A. *Definitions.*

In accordance with *Edwards* (1965b) the following definitions were used:

Transverse fractures: all fractures in which the fracture line formed an angle of 45 to 90 degrees with the long axis of the shaft and all comminuted fractures, *i.e.*, those with one or more intermediate fragments involving at least half of the bone diameter. By definition double fractures were thus included in this group.

Longitudinal fractures: all other fractures, *i.e.*, fractures which have been classed long spiral fractures or long oblique fractures.

Superficial necrosis of the skin: necrosis of the skin located over the antero-medial surface of the tibia *and* over the fracture region with no exposure of bone.

Deep necrosis of the skin: necrosis of the skin located over the antero-medial surface of the tibia *and* over the fracture region with exposure of bone.

Mild osteomyelitis: obvious infection with fistula formation where the time required for healing and cessation of drainage was less than one year.

Severe osteomyelitis: obvious infection with fistula formation where the time required for healing and cessation of drainage was more than one year.

Good Final Status: essentially complete recovery of normal function.

Fair Final Status: minor limitation of function and/or subjective complaints.

Poor Final Status: Amputation, pseudarthrosis, chronic osteomyelitis or severe limitation of function and subjective complaints.

In addition a distinction was made between patients according to age:

Young patients: patients below age 45.

Old patients: patients 45 years old or older.

B. *Selection of Patients.*

The patients selected for the analysis reported here belonged to the Control Series of *Edwards* (1965b). As seen in Table 1 only 1 of the 29 fractures with complications, and none of 21 fractures classified as poor with regard to final status belonged to fracture types other than displaced, transverse, either open or closed.

Therefore, *displaced, closed and open transverse fractures* (subsets 4 and 5 of Table 1) *formed the material studied here.* Evaluation of complications (necrosis of the skin and/or osteomyelitis) was made in all 165 transverse fractures, 71 of which were open, and evaluation of final status 2 to 10 years after fracture was made in 151 fractures, 64 of which were open.

Fractures with complications and/or poor final status are listed in Table 4. *Edwards* (1965b) contains full information on these and all other fractures analyzed here.

TABLE 1

Anatomic Classification of Fractures of the Shaft of the Tibia.

Anatomic classification	Subset number	Number of fractures		
		Total	With complicat.	Poor final status
Displaced, longitudinal, closed	1	118	1	–
Displaced, longitudinal, open	2	7	–	–
Undisplaced, longitudinal, open	3	–	–	–
Displaced, transverse, closed	4	94	7	7
Displaced, transverse, open	5	71	21	14
Undisplaced, transverse, open	6	4	–	–
Undisplaced, transverse, closed	7	17	–	–
Undisplaced, longitudinal, closed	8	–	–	–
Total		311	29	21

TABLE 2

Incidence of Primary Complications in Displaced Transverse Fractures of the Shaft of the Tibia as a Function of Age in Males.

Fracture type	Number of fractures			
	Below age 45		Above age 45	
	Total	Complicated	Total	Complicated
Closed, reduced openly	27	2	16	5
Closed, reduced closed	18	0	10	0
Open, wound smaller than 6 cm	27	3	16	6
Open, wound larger than 6 cm	5	2	12	9
Total	77	7	54	20

RESULTS

A. *Incidence of Complications.*

1. *Males (Table 2 and Fig. 1).* Twenty-seven out of 131 transverse fractures developed necrosis of the skin and/or osteomyelitis. None of

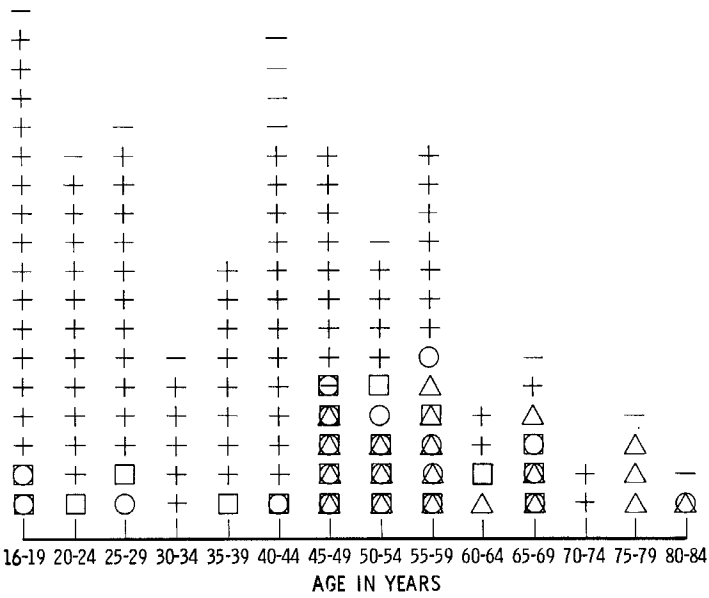

Fig. 1.
Complications and final status in transverse fracture of the shaft of the Tibia in Males.

□ Necrosis
○ Osteomyelitis
△ Poor final rating
— Not rated
\+ Rated, absence of complications

TABLE 3
Final Status of Displaced Transverse Fractures of the Shaft of the Tibia as a Function of Age in Males.

Age groups	Final status				
	Good	Fair	Poor	Unclassified	Total
16–29	32	10	–	3	45
30–44	19	9	–	5	33
45–59	15	6	12	2	35
60–90	4	3	8	3	18
Total	70	28	20	13	131

these complications developed in the 28 closed fractures which were not openly reduced. The incidence of complications in open transverse fractures and closed transverse fractures, openly reduced, was significantly higher above age 45 (20/44) than below age 45 (7/59). A combination of deep necrosis of the skin *and* severe osteomyelitis occurred in 10 fractures above age 45 and in only 1 fracture below age 45.

2. *Females.* Only 1 out of 34 transverse fractures developed a complication, a superficial necrosis of the skin in a 17-year-old with an open fracture. Sixteen of the females above age 45 had either open fractures or closed fractures treated by open reduction. The incidence of complications in this group was thus significantly lower than in the corresponding group in males.

B. *Incidence of Poor Final Status.*

1. *Males (Table 3 and Fig. 1).* The final status was found to be progressively less satisfactory with advancing age. Out of 118 fractures classifiable as regards final status, 70 occurred before age 45 and 48 after age 45. All of the 20 fractures classified as poor belonged to the latter group.

2. *Females.* Only 1 of the 33 fractures classifiable as regards final status was found to be poor.

TABLE 4

Transverse Fractures with Complications and/or Poor Final Status.

1	2	3	4	5	6	7	8
153	—	+	18	M	+	+	a
163	—	+	26	M	—	++	b
183	—	+	57	M	—	++	c
184	—	+	60	M	—	—	c
186	—	+	65	M	++	++	c
187	—	+	65	M	++	++	c
188	—	+	66	M	++	++	b
190	—	+	76	M	—	—	c
191	—	+	84	M	—	++	c
(290) 218	—	—	79	M	—	—	c
225	++	—	17	F	+	—	b
228	++	—	70	F	—	—	c
233	+	+	19	M	+	+	b
235	++	+	22	M	+	—	a
236	+	+	28	M	++	—	a
248	++	+	47	M	++	++	c
249	++	+	48	M	++	++	c

TABLE 4 (cont.)

1	2	3	4	5	6	7	8
250	+	+	48	M	++	+	x
251	+	+	51	M	—	+	b
252	++	+	54	M	++	++	c
253	+	+	54	M	++	++	c
254	++	+	54	M	++	++	c
255	++	+	56	M	+	—	c
(259) 257	+	+	58	M	—	++	c
(257) 259	+	+	58	M	—	—	c
274	++	—	38	M	+	—	b
277	+	—	44	M	++	++	a
280	++	—	45	M	+	++	c
282	++	—	47	M	++	++	c
283	++	—	51	M	+	—	a
284	++	—	56	M	++	++	c
286	+	—	58	M	—	++	a
287	+	—	64	M	+	—	b
288	+	—	67	M	—	—	c
(218) 290	+	—	79	M	—	—	c

1. *Code Number* in *Edwards* (1965b) which contains full information on these and all other fractures analyzed here.
2. *Size of wound* — none, + less than 6 cm, ++ more than 6 cm.
3. *Initial Treatment* — closed reduction, + open reduction.
4. *Age.*
5. *Sex.*
6. *Necrosis of the Skin* — none, + superficial, ++ deep.
7. *Osteomyelitis* — none, + mild, ++ severe.
8. *Final Status* a. good
   b. fair
   c. poor
   x. not classifiable

DISCUSSION

The results of the analysis reported here clearly demonstrate the multifactorial etiology of poor results of treatment of fractures of the shaft of the tibia. All fractures classified as poor with regard to final status were of the transverse type (transverse, short oblique or comminuted), *i.e.*, they were usually caused by direct, severe violence. However, in this group of fractures with a relatively poor prognosis a distinction could be made on the basis of sex and age. The incidence of poor final status was 1 in 33 females and 20 in 118 males. This

difference was not due to any corresponding difference in severity of the fractures (vide infra).

Among males all fractures with poor final status occurred above age 45. This difference between young and old males was further emphasized by the finding that the incidence and severity of complications was also significantly higher in fractures occurring in males above age 45. *Edwards* (1965b) has shown that in the material discussed here the occurrence of poor final status was correlated with the occurrence of osteomyelitis, and that the occurrence of osteomyelitis was correlated with the occurrence of necrosis of the skin. The chain of events leading to poor final status thus starts with the skin injury and proceeds through necrosis of the skin to infecion and osteomyelitis. *Edwards* (1965b) was able to prevent osteomyelitis and poor final status by paying attention to the skin injury. These findings would explain the age-and-sex-dependent difference in final status following transverse fracture of the shaft of the tibia reported here: the prognosis was relatively poor in older males because there was less resistance to skin necrosis following crush injury and, in some cases, superimposed trauma caused by open reduction and internal fixation. Unfortunately, not enough is known about the individual patients to permit analysis of this factor. One may speculate that arteriosclerosis is important.

At any rate, the relatively poor prognosis in older males was directly related to the nature of the injury and the immediate course of events; nothing in this material suggested any relation to age-dependent differences in either rate of bone healing or psychological factors such as motivation or imminent retirement.

The difference between sexes was particularly evident when a comparison was made in transverse fractures which occurred above age 45, and which were either open or closed, openly reduced. Sixteen females and 44 males met these criteria. Complications developed in 20 of the males and in none of the females.

Finally, in the entire material 92 per cent of 278 classifiable fractures were rated as good or fair. It would seem difficult to improve this value. The analysis here, however, showed that in a specific group of patients constituting only one-sixth of the entire material the prognosis was poor in one-third of the fractures. By contrast, the prognosis was poor in less than 1 per cent of the rest of the material. Unfortunately attempts at isolation of subsets with particular characteristics from fracture or other orthopaedic case materials remains difficult because few authors publish all observations made in the course of a clinical

investigation. Isolation of such subsets provides a powerful means for the identification of etiologic factors significant in the prevention and treatment of disease.

SUMMARY

In a consecutive series of 311 traumatic fractures of the shaft of the tibia the final status and the incidence of complications were analyzed as a function of sex and age. It was found that all 20 of the 21 fractures classified as poor with regard to final status occurred in males above age 45 who had an open, or a closed, openly reduced, transverse, short oblique or comminuted fracture. In this set of fractures the incidence of necrosis of the skin and/or osteomyelitis was 20/44 in males above age 45, 7/59 in males below 45, and 1/25 in females, sixteen of whom were above age 45.

It is concluded that males above age 45 with fracture of the shaft of the tibia caused by direct severe violence constitute a group in whom the skin is particularly prone to develop necrosis with subsequent osteomyelitis and poor function as a result.

RESUME

Dans une série consécutive de 311 fractures traumatiques du corps du tibia, le bilan final et l'incidence des complications ont été analysés en fonction du sexe et de l'âge. Il est apparu que 20 des 21 fractures classées comme ayant donné un résultat piètre en ce qui concerne le bilan final appartenaient à des hommes âgés d'environ 45 ans et qui avaient une fracture ouverte, ou une fracture fermée réduite ouvertement, transversale, oblique, courte ou comminutive. Dans ce genre de fractures, l'incidence de la nécrose de l'épiderme et/ou d'ostéomyélite était 20/44 chez les hommes âgés de plus de 45 ans, 7/59 chez les hommes de moins de 45 ans et 1/25 chez les femmes, dont seize avaient plus de 45 ans.

Il est conclu que les hommes âgés de plus de 45 ans avec fracture du corps du tibia causée par violence directe grave constituaient un groupe chez lequel l'épiderme a particulièrement tendance à développer une nécrose avec ostéomyélitie subséquente d'où il en résulte une mauvaise fonction.

ZUSAMMENFASSUNG

In einer Reihenfolge von 311 traumatischen Brüchen des Schaftes der Tibia wurden der Endzustand und das Vorkommen von Komplikationen als eine Funktion des Geschlechtes und des Alters analysiert. Es wurde gefunden, dass 20 von 21 Brüchen, die hinsichtlich ihres Endzustandes als schlecht bezeichnet wurden, bei Männern über 45 Jahren auftraten, die einen offenen, oder geschlossenen, offen reponierten, transversen, kurzen Schräg- oder Splitterbruch hatten. In diesem Frakturmateriale war das Auftreten von Hautnekrose und/oder Osteomyelitis folgendermassen verteilt: 20/44 bei Männern über 45 Jahren, 7/59 bei Männern unter 45 Jahren, und 1/25 bei Frauen, von denen sechzehn über 45 Jahre alt waren.

Man schliesst daraus, dass Männer über 45 Jahren mit einem durch direkte, schwere Gewalt erzeugten Bruch des Tibiaschaftes eine Gruppe darstellen, in der die Haut besonders zur Entwicklung einer Nekrose mit folgender Osteomyelitis geneigt ist, mit dem Ergebnis einer schlechten Funktion.

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