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VERTEBRAL COLUMN AND OS CALCIS FRACTURE PATTERNS IN A CONFINED COMMUNITY (SINGAPORE)

*Notes on Fracture Incidences as Clinical Evidence of Disturbed
Bone Metabolism with Increasing Age*

By

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Received 15.V.66

INTRODUCTION

The present study aims primarily at the establishment of fracture patterns for both the vertebral column and the os calcis in the population of Singapore. This has now been possible for the first time.

A further object is to prove that the increase in fracture incidence of the vertebral column with age also provides important clinical evidence of disturbed skeletal metabolism which is progressive with aging.

Both in Sweden (Bauer 1960) and Singapore (Wong 1965) evidence of such disturbed metabolism has already been produced with reference to the distal radius and the proximal femur; and Bauer has also pointed out that in females this disturbance is manifested in the distal radius some 15-17 years before the proximal femur. The present investigation also determines this "lag" period but the scope has been widened to include three fractures *i.e.* distal radius, proximal femur and the vertebral column, and for both sexes of the local population.

MATERIAL AND METHODS

Population at Risk

Singapore is the largest city in Malaysia and is inhabited principally by Chinese (75 per cent) with smaller proportions of Malays (14 per cent) Indians (9 per cent) European and Eurasians (2 per cent).

In 1962 this mixed Asian population was estimated to be 1.8 million.

All the age specific estimates in this study have been based on this projected population (Table 1).

Table 1. Singapore population 1962.

Age groups	10-19	20-29	30-39	40-49	50-59	60-69	70+
♂	181.6	131.4	108.9	86.3	61.6	26.4	6.9
♀	170.2	123.5	91.1	67.5	49.1	26.1	11.5

MATERIAL

The material consists of all os calcis, vertebral fractures and dislocations diagnosed in the whole State of Singapore over the complete two year period 1962-1963. Neither sacral, old or pathological fractures were considered. There are 171 fractures of the os calcis in 149 patients, 22 of whom (15 per cent) sustained bilateral fractures in the one episode. Fractures and fracture dislocations of the spine totalled 328. These were diagnosed in 255 patients of whom 48 or 18 per cent represented multiple fractures.

RESULTS

Fractures and Fracture—Dislocations of the Spine

Classification

These injuries are classified in Tables 2 and 3.

Sex Distribution

Of the 255 patients who presented these injuries 189 were males and 66 were females giving a male to female ratio of 3:1.

In the Singapore population, age 10 and above, 603,000 are males and 539,000 are females—a ratio of 11 to 10. There is thus a true male predominance in the sex distribution of these fractures.

Table 2.

	♂	♀
Fracture dislocations	9	0
Compression fractures of the vertebral bodies	206	81
Fractures of the transverse processes	22	3
Chip fractures of vertebral bodies	2	1
Fractures of lamina	3	0
Pedical fractures	1	0

Table 3. Fractures of the vertebral column.

Age groups		10-19	20-29	30-39	40-49	50-59	60-69	70+
No. of patients	♂	22	45	38	23	39	16	6
	♀	7	4	7	3	17	15	13
Ratio of moderate to severe trauma	♂	2/20	17/66		25/37		17/5	
	♀	4/3	2/9		16/4		23/5	

Age Specific Incidences

These are calculated from the population figures (Table 1) as the annual incidence of patients and not the number of fractures per 10,000 males or females in each 10 year age group.

In both sexes there is a tendency for incidences to rise with age with those of the males exceeding the females in all age groups except the elderly (Figures 1 and 2).

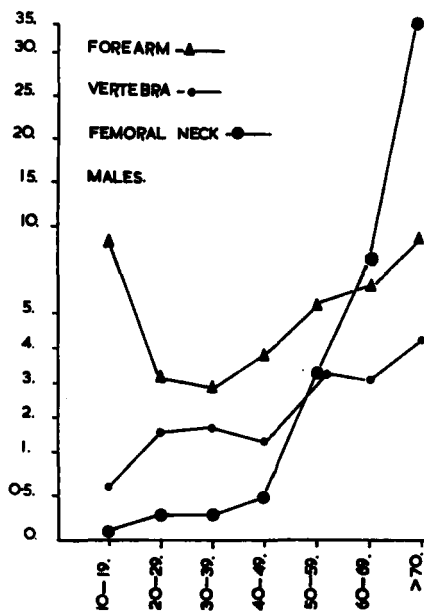


Figure 1.

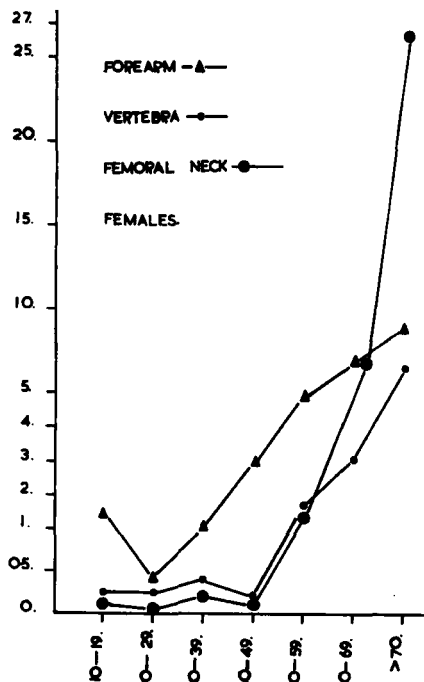


Figure 2.

Level of Fracture

The most vulnerable part of the spine is between T₁₂—L₂ inclusive, 218 fractures or 66.4 per cent. L₁ is the most frequently involved vertebra, 83 fractures or 25.3 per cent.

In the present series 72 of the fractures occurred in people 60 years and above. Again the most common site was between T₁₂ and L₂, 41 fractures or 57 per cent and the vertebra most often involved was also L₁, 17 fractures or 24 per cent which accords well with the figures of 26 per cent quoted by *Key & Conwell* (1961) and 24 per cent by *Rowe & Sorbie* (1962).

Associated Os Calcis Fractures

Four of the males in the 10–19 group had accompanying fractures of the os calcis, 9 in the 20–29 group and 1 each in the 30–39 and 40–49 groups *i.e.* 8 per cent. Only one of the females sustained vertebral and os calcis fractures in the one episode.

Relationship to Trauma (Table 3)

The two degrees of trauma as defined by *Bauer et al.* (1962) have also been the ones adopted in this study *viz.* direct high energy trauma and indirect low energy trauma.

In males, although fractures which are due to severe trauma prevailed at all ages except in the elderly, the proportions of such fractures decrease with age. In females on the other hand, severe trauma fractures prevail only in young adults; the proportions of fractures due to moderate trauma increase from young adults through middle age to a maximum in the elderly.

Vertebral Fractures and Electro Convulsive Therapy

Five of the patients (4 males, 1 female) sustained their fractures during the course of electro-convulsive therapy *i.e.* approximately 2 per cent, and all were located between T₅ and T₇.

Incidence of Vertebral Injuries with Neurologic Complications

There were 9 fracture-dislocations in the series, all diagnosed in males and none above the age of 55. Only 1 escaped neurologic complications. There were 3 deaths, all tetraplegics; 3 were paraple-

gics, one a hemisection of the cord and there was one with root involvement. Neurologic complications among the males in the present series was therefore 4.2 per cent.

Incidence of Paralytic Ileus

In the Rowe and Sorbie series (1963) paralytic ileus developed in 15 per cent and was most commonly associated with fractures involving T₁₂—L₁ and therefore would appear to support the generally held view that the underlying factor is a retroperitoneal haematoma which either by the bulk of the latter or by direct irritation disturbs the coeliac plexus.

No less than 120 or 47 per cent of the patients of this series sustained fractures involving T₁₂—L₁ only one was complicated by paralytic ileus. This would appear to contradict the coeliac plexus irritation theory.

Two females and 5 males presented signs with mimicking an acute abdomen (*i.e.* abdominal tenderness, guarding and rigidity). This is probably due to blood or haematoma from the fracture site irritating the parietal peritoneum which is known to be segmentally supplied by intercostal and lumbar nerves (*Last* 1954).

Fractures of the Os Calcis (Table 4, Figure 3)

In this series 136 males presented with 157 fractures and only 13 females with 14 fractures. The male to female ratio was 11 to 1.

Bilateral fractures were diagnosed in 21 of the males *i.e.* 15. 4 per cent and in 1 of the females *i.e.* 8 per cent.

Os calcis and vertebral fractures sustained in the one episode occurred in 15 of the males (11 per cent) and one of the females (8 per cent).

Table 4. Fractures of the os calcis.

Age groups		0-19	20-29	30-39	40-49	50-59	60-69	70+
No. of fractures	♂	18	37	33	32	28	9	0
	♀	1	6	1	4	1	1	0
Ratio of moderate to severe trauma	♂							
	♀	1/17	7/30	11/22	19/13	18/10	8/1	0

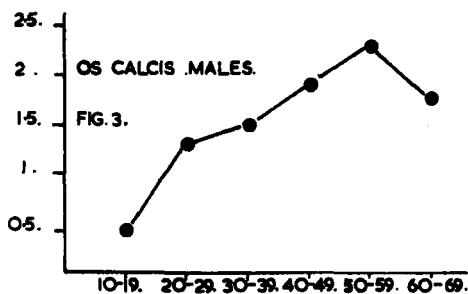


Figure 3.

Age Specific Incidences

In males incidences increased with age attaining a maximal in the 50-59 group, whence it declined a little. No calculation was made for the females.

Relationship to Trauma

Severe trauma predominated till the end of the third decade, moderate trauma was more important thereafter *viz.* the proportion of fractures due to moderate trauma increased with age.

Fracture Incidence as Clinical Evidence of Disturbed Bone Metabolism with Increasing Age

* Incidence of fractures of both the femoral neck and distal forearm of both sexes in the Singapore population have already been shown to rise with the increase in age (Wong 1965). Although the rises are less dramatic than those of European communities, (Stewart 1955, Bauer 1960, Buhr & Cooke 1959, Allfram & Bauer 1962, Allfram 1964) they can, however still be interpreted as indicating an increasing fragility of these parts of the skeleton with age (Figures 1 and 2).

The increasing age specific incidences together with the increase in the proportions of vertebral fractures due to moderate trauma with age in both sexes in the local population would similarly indicate that the vertebral column among them becomes also increasingly fragile as age progresses.

* In the present discussion the age specific incidences of both femoral neck and distal forearm fractures have been recalculated, considering only those fractures which were diagnosed over the period 1962-63 and using the 1962 population figures.

Incidences of femoral neck and vertebral fractures together rise noticeably at the end of the fourth decade. This is more convincing in females than males.

Distal forearm fracture incidences, however, in females rise at the end of the second decade whilst in the males this occurs some 10 years later. The lag period between the rise of fractures of the distal radius and ulna and that of the femoral neck and vertebral column is therefore some 20 years in females and 10 years in males (Figures 1 and 2).

The explanation for the increased risk of fractures of the proximal femur, distal forearm and vertebral column among those progressing in age can certainly in part be attributed to their accident proneness (Boucher 1959, Buhr & Cooke 1959) but primarily the reason is a progressive change in the quality of bone. This opinion was offered as long ago as 1824 by Astley Cooper and it has recently been revived by Buhr & Cooke 1959, Bauer 1960, Alffram & Bauer 1962 and Alffram 1964. Recent work in Singapore (Wong 1964, 1965) further confirms this.

The nature of this change however, is not precisely known. It may be an osteoporosis, or as suggested by Alffram & Bauer (1962), it may be a disease with a broad spectrum of penetration not necessarily to be identified with osteoporosis. Further work in fracture epidemiology may help in elucidating this.

Whatever the mechanisms responsible for the increasing fragility, from fracture incidences deduced for Swedish and Asian communities (Bauer 1960, Wong 1964, 1965) it would appear that different bones differ in their response to such mechanisms. The distal forearm in both Swedish and local females responds early, some 15 to 20 years before the proximal femur.

The present investigation shows that the distal forearm in the local males also responds early but at a decade later than the females, and that in both sexes the proximal femur and the vertebral column respond at the same time.

SUMMARY AND CONCLUSIONS

In an Asian population of 1.8 million people fracture patterns for the vertebral column and os calcis fractures diagnosed over the 2 year period 1962-63 are determined. The series consists of 499 fractures.

The principal conclusions are:

1. Age specific incidences of vertebral fractures rise with age. Those of the males exceed those of the females.
2. The most vulnerable part of the spine is between T₁₂—L₂.
3. Fractures of the os calcis are rare in women.
4. Bilateral fractures of the os calcis are not infrequent (15 per cent of males).
5. Fractures of the os calcis and vertebral column sustained in the same episode are 11 per cent in males.
6. Whatever the mechanisms responsible for the increased fragility in bone with increasing age might be, different bones respond differently to such mechanisms.
7. The vertebral column and femoral neck respond at the same time but the distal radius responds some time before this (lag period).
8. The lag period differs between the sexes.

RESUME

Chez une population asiatique de 1.8 million d'individus, le modèle des fractures de la colonne vertébrale et de l'os calcis, diagnostiquées pendant la période de deux ans 1962-63 est déterminé. La série comprend 499 fractures.

Les principales conclusions sont:

1. Les incidences spécifiques de l'âge sur la fracture vertébrale augmentent avec l'âge. Elles sont plus fréquentes chez les hommes que chez les femmes.
2. La partie la plus vulnérable de la colonne vertébrale se trouve entre la 12ème vertèbre dorsale et la 2ème vertèbre lombaire.
3. Les fractures de l'os calcis sont rares chez les femmes.
4. Les fractures bilatérales de l'os calcis ne sont pas rares (15 pour cent des hommes).
5. Les fractures de l'os calcis et de la colonne vertébrale survenues à l'occasion du même incident ont une fréquence de 11 pour cent chez les hommes.
6. Quels que soient les mécanismes responsables de la fragilité accrue des os avec l'âge, les différents os réagissent différemment à ces mécanismes.

ZUSAMMENFASSUNG

In einer asiatischen Bevölkerung von 1,8 Millionen Menschen wurden die Bruchformen der Wirbelsäule und des Calcaneus, die in einem

Zeitraum von 2 Jahren, 1962–63, diagnostiziert wurden, bestimmt. Die Gruppe besteht aus 499 Brüchen.

Die wesentlichen Schlussfolgerungen sind:

1. Altersspezifische Einflüsse an Wirbelbrüchen nehmen mit dem Alter zu.

Die der Männer überwiegen jene der Weiber.

2. Der am meisten verletzbar Teil der Wirbelsäule liegt zwischen Th. 12–L2.

3. Brüche des Calcaneus sind selten bei Frauen.

4. Doppelseitige Brüche des Calcaneus sind nicht selten (15 Prozent der Männer).

5. Brüche des Calcaneus und der Wirbelsäule, die im gleichen Unfall erlitten wurden, findet man bei 11 prozent der Männer.

6. Welche Mechanismen auch immer verantwortlich sein mögen (die vermehrte Zerbrechlichkeit der Knochen mit zunehmendem Alter), verschiedene Knochen reagieren verschieden gegenüber solchen Mechanismen.

ACKNOWLEDGEMENTS

The writer thanks Professor *D.R. Gunn* and Mr. *D.C. Gawne* for access to the material from their departments analysed in this investigation. Special thanks are due to Professor Gunn for his helpful criticisms.

The photographic reproductions of the writer's graphs are by Mr. *S.H. Tow*.

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