ABDOMINAL TOPOGRAPHY IN RELATION TO SENILE OSTEOPOROSIS OF THE SPINE

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It has been known for many years that there is a tendency to loss of height in late middle and old age (Roberts, 1878). Powys (1901) showed that this loss averages 0.33 in. (0.8 cm.) in every 10 years; the standard deviation of height increases with age, indicating that the rate of decline varies with the individual concerned. Progressive wasting of tissue and the develop-

ment of senile kyphosis of the spine have been regarded as the main factors involved. As a result of these changes there is an approximation of thoracic cage and pelvis (Brown and Smith, 1945), and in some individuals the costal margin may sink into the cavity of the false pelvis. An extreme example of this deformity is shown in Fig. 1.

FIG. 1.—An extreme example of the deformity produced by descent of the thoracic cage into the cavity of the false pelvis.

The subcostal and supra-iliac lines, traversing the lowest points of the thoracic cage and the

highest points of the iliac crest respectively, were originally employed in abdominal topography as the upper and lower boundaries of the umbilical and lumbar regions. Cunningham (1893) showed that these boundaries were unsatisfactory because the distance between them was so variable that in certain individuals the regions so delineated were extremely narrow or even absent. The more widely separated transpyloric and intertubercular lines have now replaced the older boundaries (*Gray's Anatomy*, 1949), but are more difficult to define in routine clinical examination. The approximation of ribs and pelvis in elderly patients results in increased abdominal protuberance and may make detailed palpation of the lumbar regions very difficult. It has even been known to cause acute intestinal obstruction as a result of incarceration of gut between the ribs and the walls of the false pelvis (E. C. Hutchinson, personal communication, 1952).

Previous workers have considered that the main aetiological factor is an increased obliquity of the ribs due to senile kyphosis and muscular weakness, but few accurate observations have been made. The present paper records the results of an investigation of the extent, causation, and possible clinical significance of this anatomical change in the aged.

Methods

Observations were made on 340 subjects (152 male and 188 female). Only adults were studied, and almost all were chronic cases in hospital, with an average length of stay of 2.5 years. This makes the results inapplicable to the general population, the changes due to ageing being probably more extreme in these subjects than in the average. All adult age groups were included, but there were a great many elderly subjects, resulting in a high average age of 68 years. In all cases accurate measurements of the height of the patient and the distance between the subcostal and supra-iliac lines were made. The latter measurement is here termed the "pelvi-costal distance," and the ratio of this to the height of the patient the "pelvi-costal ratio." The convention was adopted of recording these values as negative in the individuals in whom the subcostal line was lower than the supra-iliac line, this extreme deformity being found in only four patients.

As the investigation was designed to study the causation and significance of a low, zero, or negative pelvi-costal ratio, all individuals with a value of this ratio below 1% were subjected to full radiological examination of the lumbar and dorsal spine. This sample consisted of 22 males and 32 females, and, as expected, contained a disproportionate number of elderly patients, the average age being 74. A group for comparison was taken from the remaining 286 patients. This group was selected to contain exactly the same number of males and females as the previous group and to have precisely the same age distribution, the method of random numbers being employed in choosing between suitable individuals. It follows, therefore, that the two groups were exactly comparable except that the former consisted only of individuals with an abnormally low pelvi-costal ratio and the latter with an average ratio for the age group concerned. These two groups will subsequently be referred to as the "cases" and the "controls."

The following measurements were considered to be possible factors in the production of an abnormally low pelvi-costal ratio, and were obtained directly from the x-ray plates: (a) the angle between the lower ribs and the anterior border of the lower dorsal spine; (b) the degree of lumbar lordosis expressed as an angular measurement; (c) the length of the lumbar spine; (d) the proportion of the lumbar spine occupied by the intervertebral disks; and (e) the degree of spinal osteoporosis.

The last factor is very difficult to express in a quantitative manner, as has been well discussed by Lachmann and Whelan (1936). It was thought impossible to assess the degree of osteoporosis directly from the radiological density of the vertebral bodies, since this is partly dependent on factors which are difficult to control, particularly the exact photographic exposure and the radiological density of soft tissue superimposed on the vertebral shadow. The effect of osteoporosis on the shape of the vertebral body—that is, the production of biconcave or "fish—" vertebrae—was therefore chosen as the index of its degree. The most accurately centred lumbar and dorsal vertebrae were chosen in the lateral films, and the heights of the anterior and posterior borders and the minimum height near the centre of the vertebra were measured. The amount of biconcavity was expressed as the ratio of the minimum height to the average of the anterior and posterior heights, this ratio diminishing with increasing osteoporosis. An assessment of a single accurately centred vertebra was necessary, since parallax effects make similar measurements erroneous in other vertebrae. In practice there was no difficulty in

deciding which vertebrae were the best-centred, and, with the particular radiological technique employed, these were the eighth or ninth dorsal and the third or fourth lumbar vertebrae in the two lateral films used.

Finally, the length of stay in hospital was recorded as an estimate of the degree of immobilization. Although the great majority of the patients were not confined to bed, their activity in hospital was much less than would be likely in similar individuals in their own homes. Standard statistical methods (Snedecor, 1946) were employed in the analysis of the results.

Results

A preliminary inspection of the means of the pelvi-costal ratios of patients classified in decennial age groups (Table I) showed that there was a sudden decrease in the seventh decade. In order to decide whether the decrease of this

TABLE I

Age Group	Males		Females	
	No. of Patients	Mean Value of Pelvi-costal Ratio	No. of Patients	Mean Value of Pelvi-costal Ratio
<41	13	1.9%	7	2.4%
41-50	10	1.9%	22	2.5%
51-60	18	2.2%	24	2.6%
61-70	33	1.7%	32	1.8%
71-80	49	1.6%	52	1.8%
81-90	28	1.6%	49	1.7%
>90	1	—	2	1.7%
Total	152	1.75%	188	2.0%

TABLE II

Sex	Age Group	Mean Value of Pelvi-costal Ratio	Difference	Degrees of Freedom	t Value	P
Males	Below 65	2.04%	0.43	51	3.2	<0.01
	Above 65	1.61%				
Females	Below 65	2.47%	0.76	64	4.5	<0.001
	Above 65	1.71%				

ratio with age was statistically significant, patients below the age of 65 were compared with those above this age (Table II). It will be seen that the difference between these two age groups is highly significant in both sexes. The results are summarized in the distribution curves in Fig. 2. The distribution in females has a larger mean and scatter and is more skewed than in males owing to the comparatively large number of individuals with a high ratio in the former sex. This may possibly be connected with the

FIG. 2.—Distribution curves of the values of the pelvi-costal ratio in male and female patients. Continuous line=under the age of 65. Broken line=over the age of 65.

greater lumbar lordosis of the female, but there were too few x-ray films taken of individuals with a high pelvi-costal ratio to assess this aspect of the problem. Relevant statistical values of the distribution curves in the two sexes are given in Table III. The curve in males does not differ significantly from a normal distribution, while that for females is clearly skewed, so that the modal value is much less than the mean.

TABLE III

Sex	Mean Value of Pelvi-costal Ratio	Standard Deviation	Skewness		
			Statistic g_1	t Value	Probability
Male	1.75%	0.87	0.2	1.0	0.4 > P > 0.3
Female	2.0%	1.17	0.5	2.8	P < 0.01

Although the "t test" is not strictly applicable to such a skewed distribution, it was shown to be valid by repeating the test with derived logarithmic values of the pelvi-costal ratio, which gave a strictly normal distribution. A similar t value and probability was thereby obtained.

In the comparison of radiographs of the cases having an abnormally low pelvi-costal ratio with those of the controls no significant difference was found in the lengths of the lumbar spines, in the amount of lumbar lordosis, or in the thickness of intervertebral disks. There was, however, a clear difference in the obliquity of the ribs in the two groups. In both sexes the ribs of the cases were on an average 7.5 degrees further from the horizontal plane than those of the controls (t value=2.8; P < 0.01).

There was a significantly greater degree of osteoporosis as measured by biconcavity of lumbar vertebrae in the cases. A summary of the statistical analysis of this comparison is given in Table IV. The difference was more striking in

TABLE IV

Portion of Spine	Samples of Patients	Mean of Index of Biconcavity %	Difference	t Value	Probability
Dorsal	Cases Controls	79.7 82.2	2.5	1.6	P=0.1
Lumbar	Cases Controls	69.8 76.2			

females, eleven of whom were found to have a degree of lumbar osteoporosis of severity sufficient to give an index of biconcavity of less than 67%. All of these were in the group of cases and none in the controls. A comparison of the measurements of the dorsal vertebrae shows a similar tendency, but the difference is not quite significant at the conventional one-in-twenty degree of probability. There was striking biconcavity of vertebrae in most of the spines, the average ratio of the central height to the mean of the anterior and posterior heights of the lumbar vertebrae examined being 73%. This result is almost certainly inapplicable to a healthy elderly population, being an indication of the tendency of patients with long-term illness to develop osteoporosis as a result of relative immobility. In six of the patients examined by radiology the pathological process had progressed further and caused actual collapse of one or more vertebral bodies, almost invariably in the upper lumbar or lower dorsal regions, this being the usual location for this complication (Fairbank, 1951). Three of these were in the group of cases and three in the controls. In almost all the patients the cause of the "fish-vertebrae" appeared to be uncomplicated senile osteoporosis, but in two patients there was Paget's disease with a superimposed osteoporosis; in a third the characteristic changes of ankylosing spondylitis were found; and in the youngest individual amongst the cases osteomalacia secondary to idiopathic steatorrhea was shown to be the cause.

Rather paradoxically, no correlation was found between the degree of biconcavity of vertebrae and the age of the patients. This is probably explained by the fact that almost all the patients examined radiologically were over the age of 65 and that a maximum change is reached at an earlier age in long-term invalids than in the healthy population. There was only a slight correlation between length of stay as an in-patient and degree of osteoporosis ($r = +0.20$), and this did not differ significantly from zero correlation. It was, however, realized that length of stay was a very poor

estimate of immobilization; but it was the best available in elderly patients usually incapable of giving a satisfactory account of their activity prior to admission.

Discussion and Summary

The results demonstrate that there is a tendency to approximation of the thoracic cage and pelvis with increasing age. The most important factor involved is an increased obliquity of the ribs, which is, at least in part, secondary to the development of senile kyphosis. Radiological evidence of senile osteoporosis is more likely to be found in individuals in whom this change is greater than the average. The explanation may be that osteoporotic shortening of the spine is a further factor in causing this approximation, but, alternatively, it is possible that the rather asthenic type of elderly individual, in whom obliquity of the ribs is above the average, is constitutionally more liable to develop senile osteoporosis.

Senile osteoporosis of the spine is shown to be very common in elderly chronic invalids; indeed, some degree of osteoporosis is almost universal. As in so many other medical conditions, however, it is impossible to define any sharp boundary between the normal ageing process in the spine and pathological osteoporotic change. There is a gradual and continuous variation between spines which, at one extreme, can be regarded as normal for the age group, and those at the other extreme which show severe unequivocal pathological osteoporosis.

From a practical clinical point of view, it can be stated that there is a fair likelihood that spinal osteoporosis of significant degree will be found in elderly individuals in whom the distance between the subcostal and supracostal lines is less than 1% of the patient's height, corresponding in most cases to a distance of $\frac{1}{2}$ in. (1.3 cm.) or less.

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The third annual report of the British Empire Society for the Blind was published last week. Preliminary surveys have shown that more than a million people in the Colonies are blind, millions more have incapacitating eye diseases, and facilities are gravely inadequate. Most probably, according to the report, three-quarters of this blindness is preventable. The report describes the start of a systematic attack on "river blindness" (a variety of filariasis affecting the eyes) in West Africa. The disease is spread by a simuliid fly. At least 100,000 people in the northern Gold Coast are victims of the disease, which in the past has depopulated whole villages. The Society has sent two teams, one medical under Dr. F. Rodger, an ophthalmologist, and the other composed of entomologists, to survey the problem in the Gold Coast, the Cameroons, and Northern Nigeria. One of the objects of the survey is to obtain exact information on the life history of the vector fly. In East Africa, where conditions are rather easier, treatment of the rivers with insecticides has been followed by a notable reduction in river blindness. Trachoma is another very important cause of blindness, and a pilot survey at Aden last year showed that in some villages everyone had it in some form or another.

ACTINOMYCOSIS IN SCOTLAND

BY

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Since 1891, when Wolff and Israel first isolated the causative organism of actinomycosis, *Actinomyces israeli*, much has been written on many aspects of this disease, but the literature reveals little information regarding its incidence. It is not surprising, therefore, to find in one textbook the statement that it is "not a common disease" (Topley and Wilson, 1946), and in another that it is "not infrequent" (Christian, 1947).

Most people will agree with Cope (1949) that "we must put aside the traditional and popular fairy-tale about infection from grass and straw," since from these sources aerobic actinomycetes only have been isolated. It is now commonly held that the infection is endogenous, arising from the micro-aerophilic actinomycetes found in the human mouth, which resemble closely the pathogenic *Actinomyces israeli*. Associated with the exogenous theory of infection was the suspicion that agricultural workers were more often the victims of this disease than those in non-agricultural occupations. Although our ideas regarding the origin of the infection may have changed, it does not necessarily follow that our views concerning the occupational incidence of the disease must also alter. The question of whether agricultural workers are in fact more prone to actinomycosis than others has not so far been satisfactorily answered. Before it can be it is necessary to relate the number of cases of the disease occurring in agricultural and non-agricultural workers to the total number of individuals at risk in the two groups in the area under consideration. A survey of actinomycosis in the north-east of Scotland in which particular attention was paid to this point has already been recorded (Porter, 1951). In view of the fact that the north-east of Scotland is predominantly agricultural it has seemed desirable to extend this survey to the rest of Scotland, in which there is a large industrial belt in addition to agricultural areas.

Investigation

The extended survey was designed to cover all cases of actinomycosis admitted to hospital for treatment during the thirteen years from 1936 to 1948 in those parts of Scotland not originally reported upon—that is, in the whole of the country excluding the five counties in the north-east. Information was sought from all general hospitals and from x-ray therapy departments. Not all the hospitals were able to provide the desired information, sometimes because of inadequate case records and sometimes on account of the absence of comprehensive filing systems covering the period under review.

It is recognized that a number of patients with actinomycosis in its less acute forms may have been treated at home by their own physicians and received no hospital treatment. Such are not included in the survey, and no systematic search of the records of the out-patient departments of the various hospitals was attempted. A few out-patient cases of the disease which had been referred to x-ray therapy departments for treatment were obtained from the records of these departments, and these have been included.

Any case lacking bacteriological or pathological confirmation of the clinical diagnosis has been excluded; likewise, a few cases whose normal residence was not in Scotland.