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GRADING OF OSTEOPOROSIS ON BIOPSY SPECIMENS

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Received 7.II.66

The term "osteoporosis" has been defined in a variety of ways and is used to denote both disorders of the back and the gross or microscopic alterations of the actual bone. *Lindahl & Lindgren* (3) have discussed these definitions and on the basis of a determination of the apparent density of the spongiosa in vertebrae and the tibia they have defined osteoporosis as a value of less than 0.20 mg per mm³ for the apparent density of the spongiosa of the tibial epiphysis. As the apparent density is a direct measure of the porosity of the substance examined, this definition would seem to be most consistent with the etymologic meaning of the term "osteoporosis". The border between what can be regarded as normal and pathologic has been put at 0.20 because for almost all the group of young subjects in sound health the apparent density was above this figure (the mean was 0.30). This limit is, of course, arbitrary, and because of the gradual reduction in the apparent density with age, what is conceived as normal will depend on the age of the patient.

The study and the definition were based on a large autopsy series, where large parts of the spongiosa could be removed and subjected to examination.

In the present paper a method is presented for determining the apparent density for the individual patient on the basis of a bone biopsy examination.

METHOD

Since the density determinations on spongiosa in the previous study were performed on spongiosa from the upper epiphysis of the tibia about 5 cm from the articular space, this site was chosen for the bone biopsies.

The patients in whom osteoporosis was suspected or confirmed by radiography

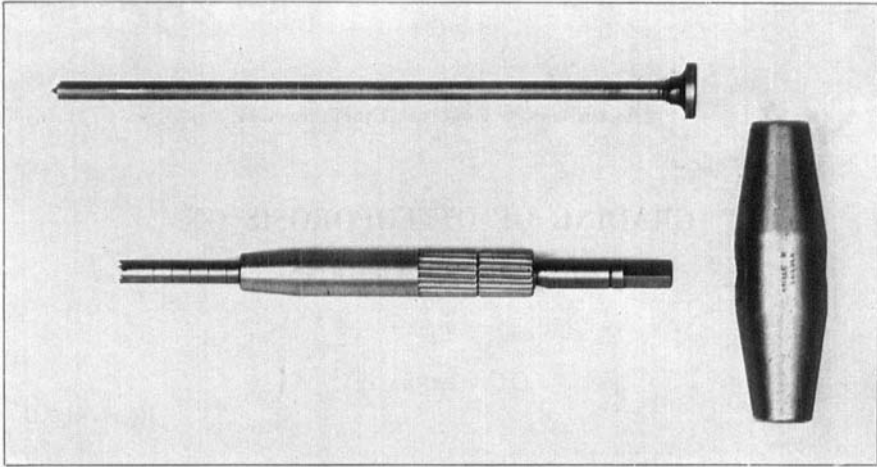


Figure 1. Bone biopsy instrument with mandrin, needle and handle.

were anaesthetized with 1 per cent lidocain with Exadrin, deposited on the medial surface of the tibia about 5 cm below the articular space. A longitudinal incision 2 cm in length was made through the skin and periosteum, which was scraped away over an area about 1 cm in diameter. A special biopsy needle (Figure 1) was then inserted perpendicular to the bone surface, usually to a depth of 25 mm. This stage of the operation sometimes caused a little pain, since the spongiosa is not reached by the anaesthetic. So that the specimen should be removed with the needle, this was moved slightly in various directions before withdrawal. The specimen was removed from the needle with a mandrin and the wound was closed with a suture.

Specimens were obtained in this way in some 80 cases without complications. Sometimes there was no discomfort after the specimen had been removed, but quite often there was pain and swelling in the region for up to a week.

THE NEEDLE

The needle has outer and inner diameters of 6 and 5 mm, respectively. The teeth were quite large and set so that the needle could be withdrawn fairly easily and the bone specimen would accompany the needle. Small deviations in the setting at first gave rise to difficulty in both these respects. To determine the depth, and hence the volume, of the specimen, the needle was furnished with an outer collar which could be adjusted on a graduated scale. A depth of 25 mm was generally used, which gives a specimen volume of 491 mm³.

As the specimen is quite firmly attached to the needle, especially if the bone is normal, it will not infrequently be compressed when expelled from the needle with the mandrin.

The needle being of fairly large calibre, there is sometimes initial difficulty in getting it to hold because it is displaced to the side. To avoid this the mandrin was inserted so as to be in place during the first part of the drilling through the cortical bone. The mandrin has a point in the centre which prevents lateral displacement.

DETERMINATION OF THE APPARENT DENSITY

Because, in the next stages of the preparation of the specimen, it tends to break up into small pieces it was enclosed in gauze from the outset. This was first flushed with hot water to remove blood and fat, and then dried overnight at 100° C. The residual fat was extracted with xylene for 24 hours in two stages and the specimen was then dried again for 24 hours at 100° C. It was weighed immediately it was taken from the drying oven; at this stage the specimen is hygroscopic and rapidly takes up atmospheric moisture.

The quotient of the weight so found and the original volume gives the apparent density.

RESULTS ON SUBJECTS

In 10 cases of radiological or suspected osteoporosis, determinations of the apparent density were performed as outlined above. At the same time the hardness of the bone, judged as the resistance to drilling, was estimated according to a four-degree scale. The results are given in Table 1. The hardness tended to increase with the apparent density.

Table 1. Apparent density for 10 cases of radiological or suspected osteoporosis, determined by the bone biopsy method. The hardness was estimated according to a 4-degree scale.

Subject	1	2	3	4	5	6	7	8	9	10
Apparent density	0.10	0.10	0.12	0.13	0.15	0.15	0.18	0.22	0.23	0.29
Hardness	1	2	2	2	3	2	2	3	4	4

COMPARISON OF THE OLD AND NEW METHODS

Since there was no way of assessing the reliability and accuracy of the method on the living subject, repeated determinations of the apparent density with the biopsy needle were performed on 10 autopsy cases, the specimens being taken from adjacent areas, and determinations

were also made on large areas of the spongiosa by the old technique (3). The results are given in Table 2. Since in the biopsy procedure the specimen will contain cortical bone the apparent density will theoretically be higher in the needle procedure than when only the spongiosa is used. Even if the technical difficulty in removing the compact bone could be surmounted there would be some difficulty in determining the residual volume.

Table 2. Comparison between apparent density of adjacent biopsy specimens and values determined only on the spongiosa. The hardness was estimated according to a four-degree scale.

Subject	Apparent density			Hardness
	Biopsy needle		Standard method	
1	0.16	0.19	0.16	2
2	0.10	0.12	0.13	1
3	0.19	0.22	0.24	3
4	0.24	0.27	0.21	2
5	0.11	0.11	0.09	1
6	0.18	0.20	0.17	2
7	0.31	0.34	0.40	3
8	0.45	0.48	0.51	4
9	0.11	0.12	0.12	2
10	0.16	0.18	0.12	2

The apparent density of the specimens from various adjacent areas varied over quite a small range and there was a fairly close agreement between the two methods. Since the values with the needle procedure will be slightly higher, it might be realistic to raise the limit between normal and osteoporotic bone by a small margin—say 0.24 mg per mm³.

DISCUSSION

Although various radiological methods have been devised by which osteoporosis can be graded in, for instance, the phalanges (2, 6), ulna (1), calcaneus (4) and, less reliably, vertebrae (5), there is still need for a method for the direct grading of porosity in the living subject. Although the present method has certain sources of error, due principally to the small size of the specimen and hence to its lack of representativeness, the method would seem to be of value for special purposes.

That the specimen contains a combination of compact and spongiosa

bone is possibly a disadvantage, but this source of error is constant so long as the specimens are taken at the same depth, and in any case in comparisons between various specimens such a source of error is not very important.

SUMMARY

Osteoporosis has been defined by *Lindahl & Lindgren* in a previous article as a change in the bone in which the apparent density is less than 0.20 mg per cent mm^3 , a value that is based on studies of a large autopsy series in which specimens of spongiosa were examined. A method is presented in which a specimen can be taken from the epiphysis of the upper tibia with a specially designed bone biopsy needle and the apparent density can then be determined. The values obtained with this method are reported and the value and limitations of the methods discussed.

RESUME

L'ostéoporose a été définie par *Lindahl & Lingren* dans un précédent article comme une modification dans l'os dans lequel la densité apparente est moins de 0,20 mg par mm^3 , une donnée qui est basée sur l'étude d'une grande série d'autopsies dans lesquelles un spécimen de l'épiphyse de la partie supérieure du tibia a été prélevé avec une aiguille spéciale pour la biopsie osseuse, ce qui a permis de déterminer la densité apparente. Les données obtenues à l'aide de cette méthode sont rapportées et il est discuté de la valeur et des limitations de cette méthode.

ZUSAMMENFASSUNG

Osteoporose wurde in einer früheren Arbeit von *Lindahl & Lindgren* als eine Veränderung des Knochens definiert bei der die scheinbare Dichte weniger als 0,20 mg per mm^3 ist. Ein Wert, der zur Grundlage Untersuchungen an einer grossen Autopsiereihe hat, in der eine Probe von der oberen Epiphyse der Tibia mit einer besonders konstruierten Knochenbiopsienadel gewonnen werden und die scheinbare Dichte dann bestimmt werden kann. Die Werte, die mit dieser Methode erhalten wurden, werden vorgezeigt und der Wert und die Begrenzung der Methode werden besprochen.

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