FROM THE ORTHOPAEDIC DPT. (HEAD: CARL HIRSCH), ACADEMIC HOSPITAL, UNIVERSITY OF UPPSALA, SWEDEN

THE WEIGHT BEARING CAPACITY OF THE FEMORAL NECK WITH SOLITARY BONE CYST

By

A. BRODETTI

The development of the X-ray technique, permitting a better identification and definition of bone cysts—"a typical solitary cyst is represented by a central, circumscribed, sharply defined, oval shaped, hollow defect in the metaphysis or diaphysis of a long tubular bone" (Luck)—was an important contribution to the study of this field, especially with respect to early diagnosis and treatment. The latter at present is well defined and produces excellent results.

But the insidious evolution of the bone cyst still very often presents a problem for the surgeon as a result of the fracture which frequently develops. Geschickter & Copeland (who have studied a total of 202 cases) and many other authors consider the latter to be a revealing symptom of the cyst in 45 % of all cases. For all the authors the most frequent localization is in the femur, with the following percentages for the neck: Geschickter & Copeland 13 % of 63 cases; Elmslie 60 % of 10 cases; Silver referring to 31 cases of localization in the femur gives only once the exact site in the neck. Monesi in 1954 reports 66 % of 9 cases localized in the femur.

PURPOSE OF THE INVESTIGATION

The purpose is to determine the probability of a fracture occurring in a femoral neck with a solitary bone cyst by comparing experimental data with roentgenological and clinical findings. Although a discussion of the surgical treatment is outside the field of this investigation, the question whether an indispensable operation may be delayed without

TABLE 1

Case No.	Sex	Age	Source of case	Location	Symptoms	Observations
1	m	37	Karolinska Hosp. Orthop. Clinic	Neck and head r. femur	Pain	Suffering from childhood. No trauma
2	f	7	idem	Neck and metaphysis r. femur	Pain	No trauma. Suffering for 2 m. but she did walk and play
3	f	12	idem	Neck l. femur	Pain and limp Little fracture of the inf. cortex	Suffering for 3 years but she did walk
4	f	13	idem	Neck r. femur	Pain. Little fracture of the inf. cortex	Severe fall 20 days before observation
5	m	5	Karolinska Hosp. Pediatric Clin.	Neck r. femur	Pain	Severe trauma some days before
6	f	10	idem	Neck l. femur	Pain and limp	Suffering for 5–6 m. No trauma
7	m	9	idem	Neck r. femur	Pain	No trauma. The cyst has healed without any treatment
8	f	5	idem	Neck and metaphysis r. femur	Pain and limp Fracture	Suffering for some m. The day before the observation severe fall playing with a ball
9	m	43	Karolinska Hosp. Radiolog. Dpt.	Neck r. femur	Pain	It seems that when he was young he had some pain in the hip joint. Now pain for some m. No trauma
10	m	59	idem	Neck r. femur	Pain	Some pain when he was young. Always normal life. Trauma some days before observation.

11	m	38	idem	Neck r. femur	Pain	Never had trouble. Some days before observation trauma occurred
12	f	32	Academic Hospit. Radiolog. Clin.	Neck and metaphysis r. femur	No symptoms	The cyst was discovered on the occasion of an X-ray examination for pregnancy
13	m	36	idem	Neck r. femur	Pain	Soldier. Pain after trauma in service
14	f	7	Geschickter & Copeland	Neck	Limp	Suffering for 9 m.
15	m	69	idem	Neck	Pain	
16	m	36	idem	Neck		Suffering for about 20 years. Trauma
17	f	4	idem	Neck		
18	m	36	idem	Neck	Limp	Suffering for 4 years.
19	f	25	idem	Neck		Suffering for 3 years. Trauma.
20	m		idem	Neck and shaft	Fracture	
21	m	8	Froelich	Neck	Fracture	No trouble before severe trauma. Able to walk after the fracture
22	m	4	Silver	Neck r. femur	Fracture	1 year and a half before severe fall; limp for 10 days, afterwards was well. 6 weeks before observation pain and limp again
23	m	5	Elmslie	Neck and metaphysis	Pain. Fracture	

TABLE 1 (cont.)

Case No.	Sex	Age	Source of case	Location	Symptoms	Observations
24	f	18	idem	Neck	Pain	Suffering for 4 years
25	f	29	idem	Head, neck, metaphysis	Fracture	Fracture occurred at the age of 11
26	f	40	idem	Neck bilateral	Fracture	
27	m	6	idem	Neck and greater trochanter	Fracture	Pain after a fall one year before. 3 m. ago second fall and fracture
28	f	35	Kleinberg	Neck l. femur	Pain	Case followed for 20 years
29	f	38	Monesi	Neck and upper part of the l. femur	Pain	Pain for many years
30	m	12	idem	Neck and metaphysis left femur	Fracture	Trauma occurred
31	m	9	idem	Neck l. femur	Fracture	In the first stage pain and limp
32	f	11	idem	Neck l. femur	Pain and limp	Suffering for 4 m.
33	m	8	idem	Neck r. femur	Fracture	2 years before, direct trauma to the hip; a fracture was recognized after some m. In plaster the fracture healed and after the patient was able to walk without trouble
34	f	8	idem	Neck and metaphysis l. femur	Fracture of the inferior cortex	Suffering for 3 m.

fear of complication such as a fracture has been considered. There are very many reasons, and all of them important, for the patient and for the surgeon to delay an operation. And, while waiting for the operation, must the patient be immobilized in plaster? We think that we can say with assurance when a solitary bone cyst of the neck of an unfractured femur must be immediately immobilized and when the immobilization can be safely avoided while waiting for surgical treatment.

MATERIAL OF THE INVESTIGATION

The X-ray pictures and the clinical records of the Orthopedic Clinic, the Pediatric Clinic and the Radiological Dpt. of the Karolinska Hospital and of the Radiological Clinic of the Academic Hospital of Uppsala were kindly made available for the examination. In addition cases were used from the literature of those authors who give complete information or iconographic documentation useful for this purpose; in this way 34 cases were collected. Of these 18 are males and 16 are females, their ages ranging from a minimum of 4 years to a maximum of 69 years, the average being 21 years (Table 1).

In the first 10 years of life 14 cases were found, representing the largest percentage; 5 cases in the second decade; 2 cases in the third; 9 cases in the fourth and, finally, 3 cases after 40 years (it must be noted that in one of the cases quoted by Geschickter & Copeland there is no specification of age).

It is quite clear that the majority of cases belong to the first two decades of life, but that a high percentage can also be noted in the.following two decades. This indicates quite positively that when the cyst does not reach a degree of expansion such as to compromise noticeably the bearing capacity of the femoral neck, it may well not give any trouble for quite a few years.

Geschickter & Copeland have demonstrated that the lesion appears in childhood, that is, "the period of life when the proliferating power of the bone cell is at its height". On the other hand experience tells us (and is confirmed by this and other case series) that a solitary bone cyst of the femoral neck can be asymptomatic for many years and be discovered either accidentally (case 12) or as a result of trauma. Considering the number of fractures (14 in all) in relation to the proportional frequency of the cases in the different ages, we obtain the following results illustrated in figure. 1. This shows the frequency of fractures compared to age: the decade of life between 31 and 40 years

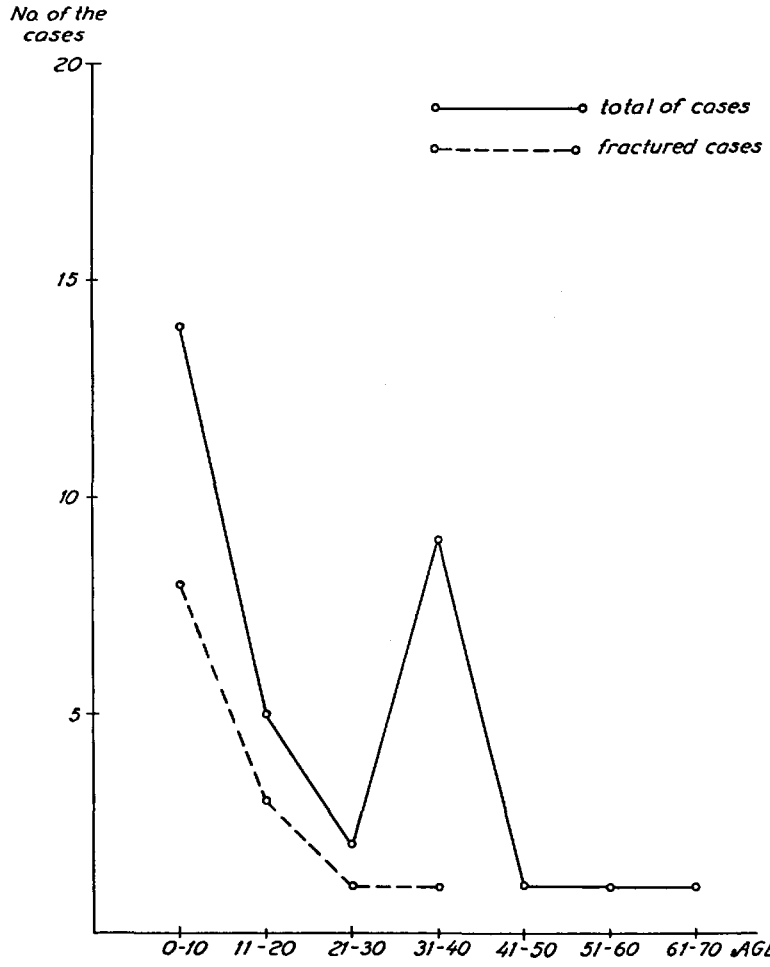
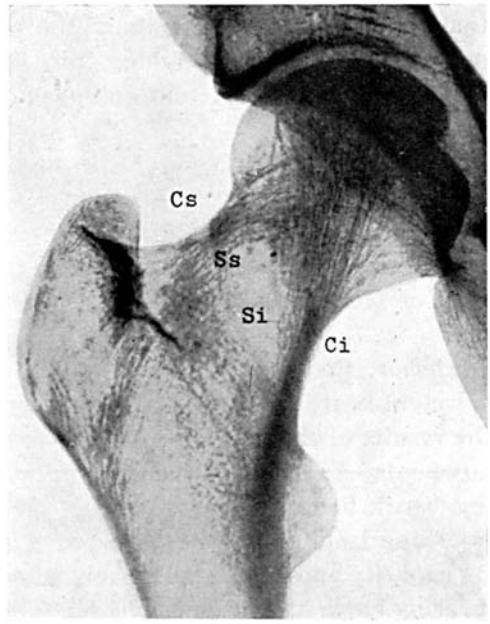


Fig. 1.

Age distribution of bone cyst and frequency of fractures in various ages. There is a noticeable increase in the number of cysts in the 10 years between 31 and 40 years of age but a decrease in the number of fractures.

corresponds to noticeable relative increase of the frequency, and at the same time to a decrease of the registered percentage of the fractures. Thus 57 % of the fractures are found in the first decade of life and only 11 % in the fourth.

The experimental material is that which was recently published by Hirsch and the author: we shall now reconsider some of the main points in order to be able to explain the present investigation and to understand the conclusions.



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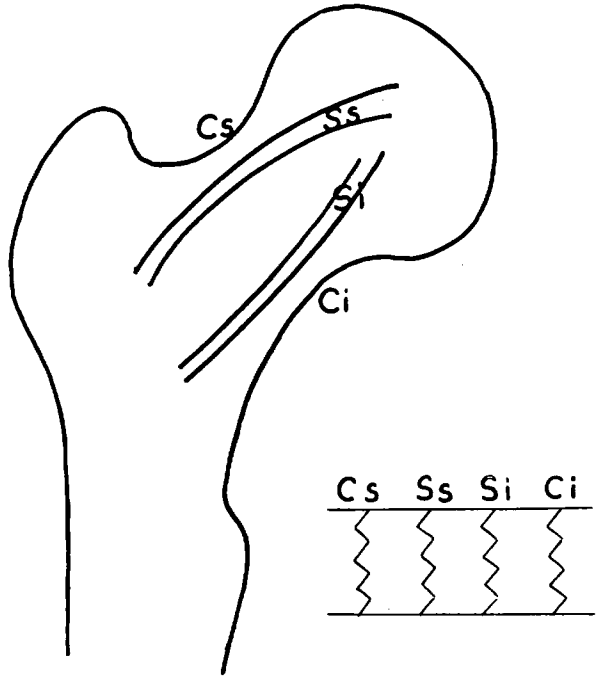


B

Fig. 2.
The four components supporting the weight-bearing of the femoral neck according to Hirsch & Brodetti (see text). In B) they are schematically drawn.

Fig. 2 shows that the supporting elements of the weight-bearing of the normal femoral neck have been divided into four components, which can be identified with the different components of the classic anatomical descriptions:

Cs = cortical superior, compact bone of the superior part of the neck;

Ss = spongiosa superior, fascium arciforme:

Si = spongiosa inferior, in this component Ward's triangle is located so that the number of trabecula arches is here smaller than in the upper part;

Ci = cortical inferior, the lamina femoralis, the most important component in the weight-bearing system of the femoral neck.

According to the results of the experimental work we know that the two external components—Cs + Ci—support 70 % of all the weight-bearing when they "work together", but 40 % and 20 %, respectively, when they are "working isolated". Ss + Si together provide 30 % of the weight-bearing capacity and 15 % respectively when isolated. Moreover the weight-bearing capacity without Si is 85 %, without Ss 85 % too. All the experiments were performed on specimens under mechanical conditions occurring in a femoral neck with a solitary bone cyst (Fig. 3 and 4).

RESULTS AND DISCUSSION

On the basis of the degree of destruction caused by the cyst, the clinical material has been divided into groups, in the following way.

1) *group Cs + Ss + Ci or Cs + Si + Ci:* when the X-ray finding of a solitary bone cyst of the neck of the femur is like one which can be related schematically to the formula Cs + Ss + Ci or Cs + Si + Ci of the experimental data (Fig. 5), it can surely be said that for this femoral neck there are as many probabilities of a fracture as in the normal neck, and there are no indications (with the exception of the indications required for other reasons, such as pain etc.) for immobilizing the joint, while awaiting a convenient time for surgical treatment. The percentages of the weight-bearing of the two systems—Cs + Ss + Ci and Cs + Si + Ci—are 85 %, or very near to the normal. Therefore a traumatic force which can produce a fracture of the cystic femoral neck is quite the same as that required to fracture a normal neck; the patient can be free to carry on his normal life without any limitation.

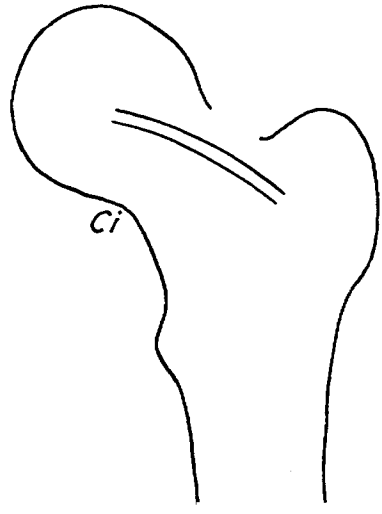
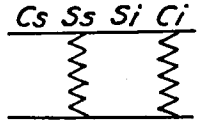
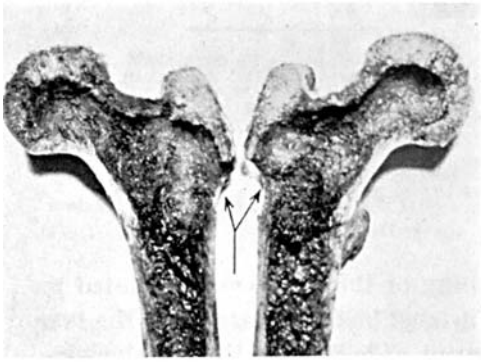
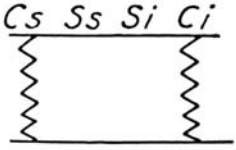


Fig. 3.
One of the specimens of the experiments. In this one only two components are left: Ss and Ci.







A B

Fig. 4.
Specimen from the experimental material. From a hole below the great trochanter all the spongious bone has been taken away (arrows in picture a) in order to leave only the two components Cs and Ci.

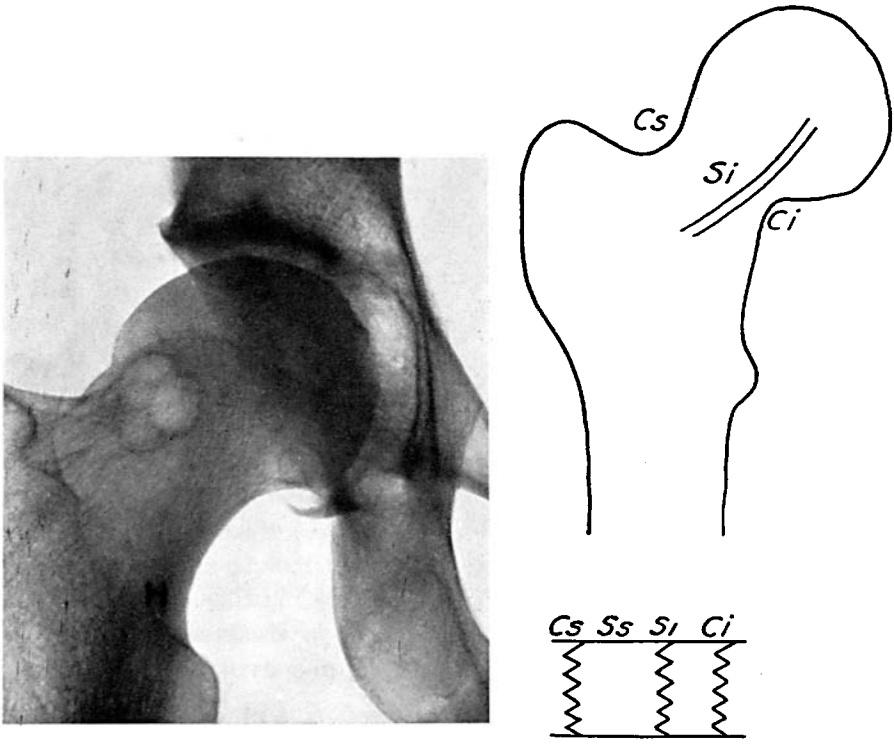


Fig. 5.
Case 9. Male 43 years old. In childhood some disturbance in the right hip. In the last few m. pain. No trauma; throughout life he has always carried on his normal activity without any limitation. This type of bone cyst has destroyed only Ss and the weight-bearing capacity of a femoral neck like this one is 85 %, which is very close to the normal.

2) *group Cs + Ci;* the X-ray finding of the bone cyst is related to the group Cs + Ci (Fig. 6 and 7) C it must be emphasized that the two components Cs and Ci, which together provide 70 % of the total weight-bearing capacity, *must be intact*). Here there is no reason for immobilization and the patient can be allowed to walk, though some care should be taken, particularly to avoid excessive exercise and possible injury. In these cases we still have a femoral neck with a ¾ weight-bearing capacity. Therefore a rigorous immobilization is not required, but all possible care is needed in order to avoid trauma which in normal conditions would not be dangerous, but in a case like this could easily be.

An interesting and illustrative case has been described by Kleinberg

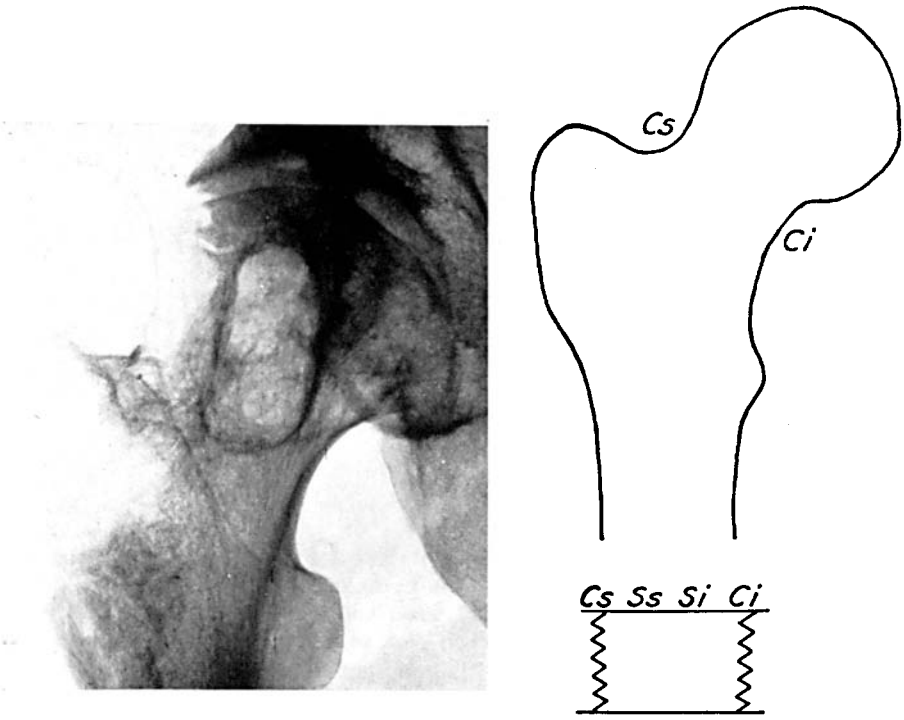


Fig. 6.

Case 1. Male aged 37 years. Pain in the right hip, but not continuously, from childhood. The diagnosis of the bone cyst was made at the age of 28 and a surgical treatment was suggested; with the diminution of the painful symptoms the patient went back to his job, in which he is on his feet the entire day. Recently, pain again. The expansion of the cyst has destroyed both Ss and Si (the interruption of the trabecular arches in the zone of Ss is evident) and in a case like this the only two cortices, Cs and Ci, are supporting the total weight-bearing of the femoral neck.

(Fig. 8): a patient with a cyst of the left femoral neck who, during the 20 years he was followed-up, was not treated and could follow his normal activity without any limitation. This case comes into the group under examination—Cs + Ci—and it is quite appropriate for demonstrating how the preservation of the two cortices is sufficient to avoid fracture without any help from surgical appliances or plaster. G. E. Bennet declared after reading Kleinberg's paper that he also had seen many similar cases, followed-up for many years, without the occurrence of fractures.

3) *group Cs or Ci:* now we come to the last group: in this one the components Cs and Ci are still present but they are thinned and com-

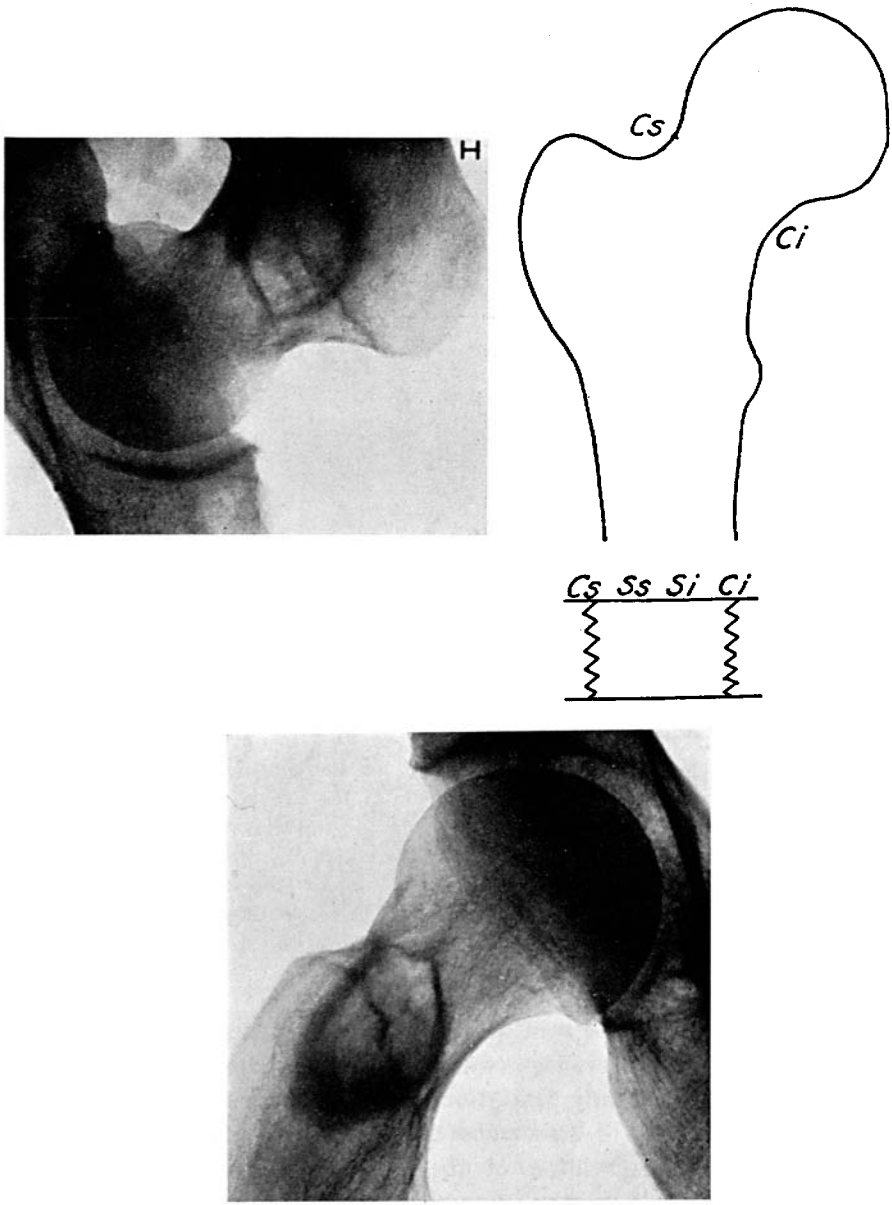


Fig. 7.

Case 10. Male 59 years old. Pain, not continuously, in the right hip from childhood. No treatment has been performed, no care taken. The two components, Ss and Si, are destroyed by the cyst (a little more in the lateral part) and the only two components left, Cs and Ci, take the all weight-bearing in this case also. In a) ant. post. and in b) lateral roentgenogram.

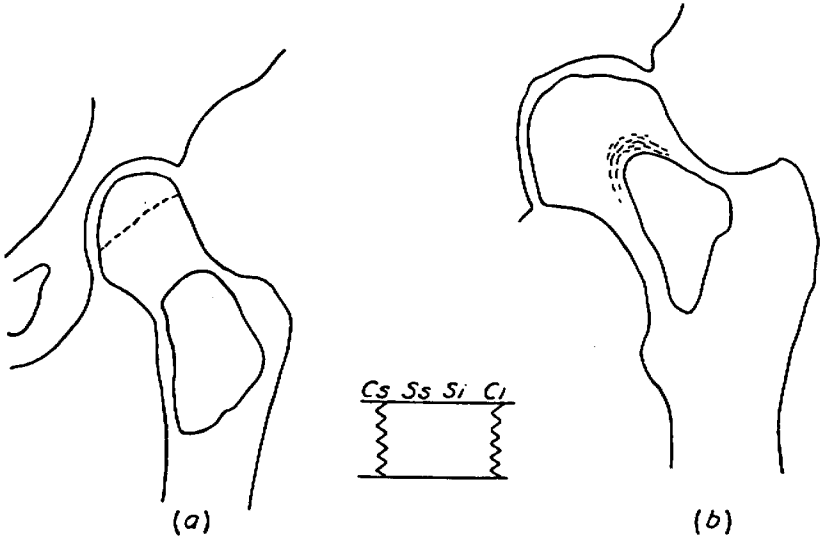


Fig. 8.

The case published by Kleinberg. Female 35 years old. This patient was followed-up for 20 years during which she received no treatment; a) is the first X-ray picture taken in 1922 and b) the last one taken in 1942 when a surgical treatment was performed. During the 20 years the only two components left, Cs and Ci, were able to support the total weight-bearing of the femoral neck without any fracture occurring. (Redrawn schematically from Kleinberg).

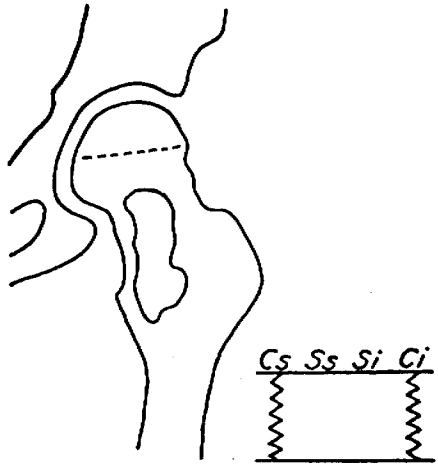


Fig. 9.

One of the cases published by Monesi. Female 11 years old. Pain and limp for about four m. The patient received no treatment before the examination. In this case also the only two cortices, Cs and Ci, are taking the all weight-bearing of the femoral neck. (Redrawn schematically from Monesi).

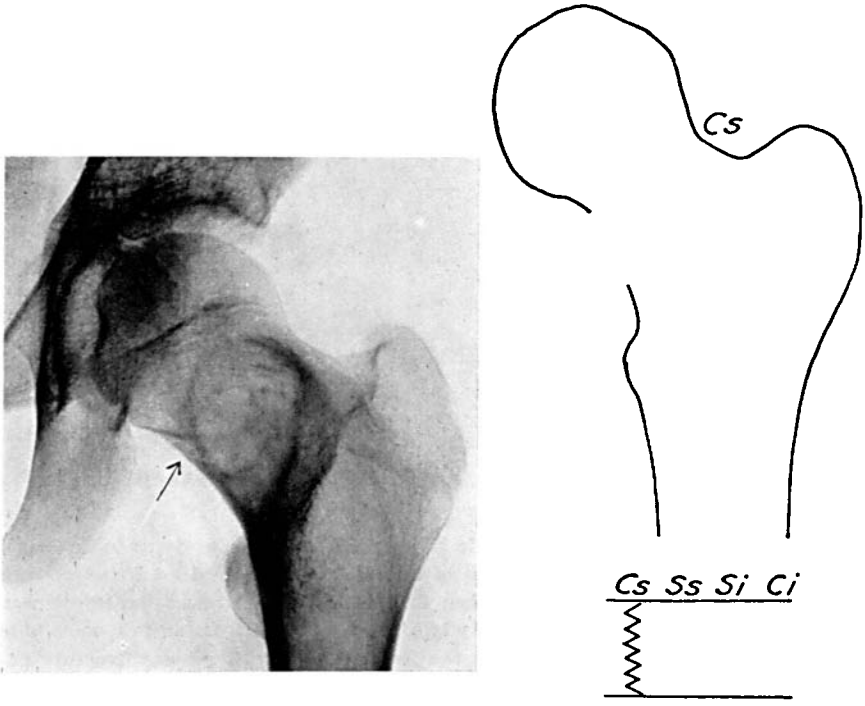


Fig. 10.

Cace 3. Female aged 12. Pain and limp for 3 years but she was able to carry on her normal life without any treatment. Recent increase of the pain which, at the time of observation, does not compromise the ambulation. The bone cyst in this case has destroyed 3 of the 4 components, i.e. Ss. Si and Ci; only Cs is still intact, and that explains why the patient, even with the little fracture (arrow) of the thinned Ci, is able to walk.

promised in their structure by the expansion of the cyst. In these cases the cortical bone around the cyst is not perforated, (otherwise there would be a fracture; fig. 12) but is very reduced. Therefore its own bearing capacity is even smaller. Afterwards we can say that in some cases in this group the bearing system is reduced to only one of the components Cs (fig. 10) and Ci (Fig. 11) and that most of them are seen when already fractured. Sometimes there is an opportunity for diagnosis before the fracture occurs (Fig. 13) and in these cases a rigorous immobilization in plaster is urgently required, allowing the patient to walk and load if Cs or Ci, although thinned, are both present; the Weight-bearing cannot be permitted when only one of the components is left.

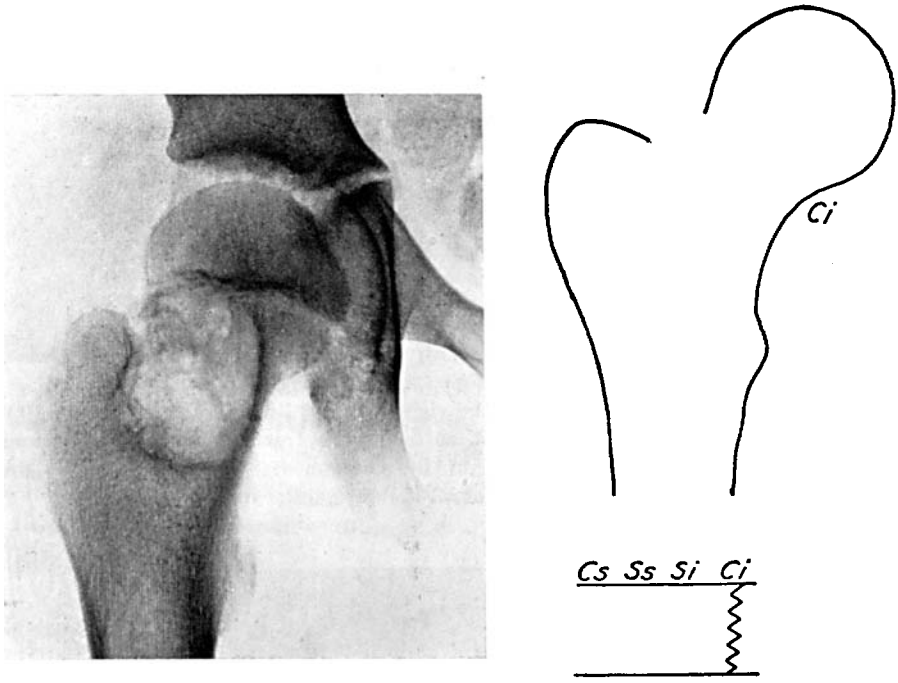


Fig. 11.

Case 4. Female 13 years old. Never any disturbance. About 20 days before the examination she fell, with resultant severe pain in the right hip. The X-ray picture shows that the bone cyst has destroyed the 3 components Cs, Ss and Si: only Ci is left but quite thinned. Only a little infraction of the inferior cortex occurred at the time of the fall and this can be explained by considering that Ci is the strongest (40 % of the whole weight-bearing) of the four components of the femoral neck.

SUMMARY

The weight-bearing elements of the femoral neck are reduced to four components and compared with the clinical and X-ray findings of 34 cases of solitary bone cyst of the femoral neck:

a) when the bone cyst has destroyed only one of the four components the spongiosa superior (Ss) or the spongiosa inferior (Si)— there is no reason for immobilization of the hip joint, and the patient is allowed to pursue his normal activity without any limitation.

b) when the bone cyst has destroyed both Ss and Si, but the cortical superior (Cs) and the inferior (Ci) are preserved immobilization is

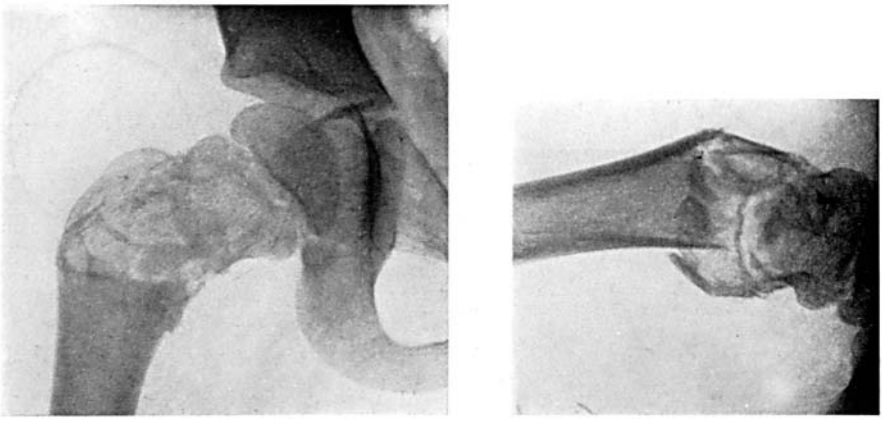


Fig. 12.

Case 8. Female 5 years old. Pain in the right hip and limp for some m.; the day before the picture was taken she fell, suffering the fracture which is a normal occurrence considering that all four of the components supporting the weight bearing of the femoral neck are destroyed.

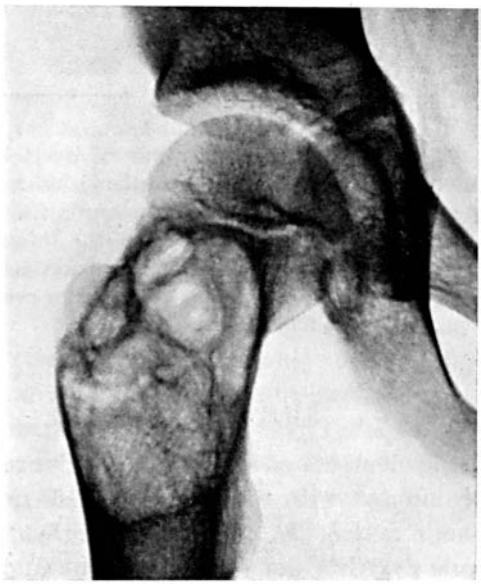


Fig. 13.

Case 2. Female 7 years old. Pain in the right hip for about two m.; she was always able to walk and play. The X-ray picture shows how the bone cyst has destroyed completely Ss and Si, but not Cs and Ci although they are very thin. In a case like this the immobilization is absolutely necessary in order to avoid a fracture which would surely occur on the occasion of trauma.

not required, but the patient must take care to avoid trauma and violent exercises.

c) when the bone cyst has destroyed or reduced not only the structure of Ss + Si but also Cs or Ci immobilization is immediately needed as an absolute rule.

RESUME

Les éléments porteurs du col fémoral sont réduits à quatre composents et comparés aux decouverts cliniques et radiologiques dans 34 cas de kyste osseux solitaire du col fémoral:

a) Lorsque le kyste osseux n'a détruit que l'un des quatre éléments du spongieux supérieur (Ss) ou du spongieux inférieur (Si), il n'y a aucune raison d'immobiliser l'articulation de la hanche et le malade est autorisé à poursuivre son activité normale, sans aucune limitation.

b) Quand le kyste osseux a détruit aussi bien Ss que Si, mais que le cortical supérieur (Cs) et inférieur (Ci) sont intacts, l'immobilisation n'est pas nécessaire, mais le malade doit éviter les traumas et les exercices violents.

c) Lorsque le kyste osseux a détruit ou réduit non seulement la structure de Ss + Si, mais aussi Cs ou Ci, l'immobilisation immédiate est nécessaire, et c'est là une règle absolue.

ZUSAMMENFASSUNG

Die gewichttragenden Elemente des Femurhalses werden auf vier Komponenten reduziert und mit den klinischen und röntgenologischen Befunden in 34 Fällen von vereinzelten Knochenzysten des Schenkelhalses verglichen:

a) Wenn die Knochenzyste nur eine der vier Komponenten die Spongiosa superior (Ss) oder die Spongiosa inferior (Si) zerstört hat, ist kein Grund für die Ruhigstellung des Hüftgelenkes vorhanden und der Patient hat die Erlaubnis seiner normalen Beschäftigung ohne jede Begrenzung nachzugehen.

b) Wenn die Knochenzyste Ss und Si zerstört hat, aber die Corticalis superior (Cs) und die Corticalis inferior (Ci) erhalten sind, dann ist Ruhigstellung nicht erforderlich, aber der Patient muss Trauma und Anstrengung vermeiden.

c) Wenn die Knochenzyste nicht nur Ss und Si sondern auch Cs und Ci vollständig oder teilweise zerstört hat dann ist sofortige Ruhigstellung absolut notwendig.

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