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KIEL BONE IN THE SURGICAL TREATMENT OF TIBIAL CONDYLAR FRACTURES

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Autogenous bone is generally recommended for bone grafting, but the requirements of reconstructive surgery have prompted trials with both homogenous and heterogenous materials. Probably the best known heterogenous material is the Kiel bone, developed by the German Bauermeister (1958) and commercially produced by Messrs. Braun, Melsungen. The Kiel bone, manufactured from the bone of young calves, is treated with hydrogen peroxide, washed in water and acetone, air dried and finally sterilized in ethylene oxide gas. The final graft material consists only of fibrils and crystallites with a residue of 31 per cent protein (Maatz & Bauermeister 1957). Since opinions seem to differ concerning the usefulness of processed heterologous bone, we feel justified in reporting our impression of Kiel bone in a uniform clinical series.

MATERIAL

At the Clinic for Orthopaedics and Traumatology, Helsinki University Central Hospital, Kiel bone was mainly used for filling cavities at the beginning of the 1960's. Our series consists of 91 patients with tibial condylar fractures who were operatively treated in 1962–1967. In 55 of these cases a bone graft was used for filling the cancellous bone defect resulting from elevation of the compressed condyle. In the remaining 36 operations no bone grafting was done. The mean age of the patients was 52 years. A cancellous Kiel graft was used in 37 cases, an autogenous graft (from iliac crist or femoral condyle) in 18. In addition, the fracture was routinely treated in all cases by fixation with a transcondylar Ackerman bolt or screw. Postoperatively the knee was immediately mobilized in 9 patients in the Kiel bone group, whereas in the remaining 28 a high plaster cast was used for an average of 7½ weeks. In the group of autogenous grafts one patient was immediately mobilized; in the remaining 17 a plaster cast was used for an average of 8½ weeks. Full weight-bearing was allowed in the Kiel bone

group after an average of 14½ weeks, in the autogenous bone group after an average of 16 weeks.

RESULTS

The average follow-up period was 4½ years. The result was classified as functionally acceptable if the patient was able to do work corresponding to his occupation or age, if there was full extension of the knee and flexion of at least 90 degrees and the knee was subjectively stable, and if the patient only experienced transient pain occasionally in connection with exertion. A result was considered anatomically acceptable if the articular surface was dislocated by a maximum of 3 mm, varus/valgus was under 10 degrees, and there was no or only minimal osteoarthritis in the joint. The late results in both groups are shown in Table 1.

Table 1. Results with different kinds of bone graft.

Source of graft	Acceptable anatomical results	Acceptable functional results	Total
Heterogenous (Kiel bone)	17	18	37
Autogenous	8	12	18
	25	30	55

Table 2. Results with different kinds of bone graft in tibial condylar fractures classified according to the primary depression.

Depth of primary condylar depression	Source of graft	Alignment after reduction		Functional results		Total
		Maintained	Deteriorated	Acceptable	Unacceptable	
> 10 mm	Kiel bone	10	7	9	8	17
> 10 mm	Autogenous bone	8	2	7	3	10
< 10 mm	Kiel bone	16	4	12	8	20
< 10 mm	Autogenous bone	6	2	5	3	8
		40	15	33	22	55

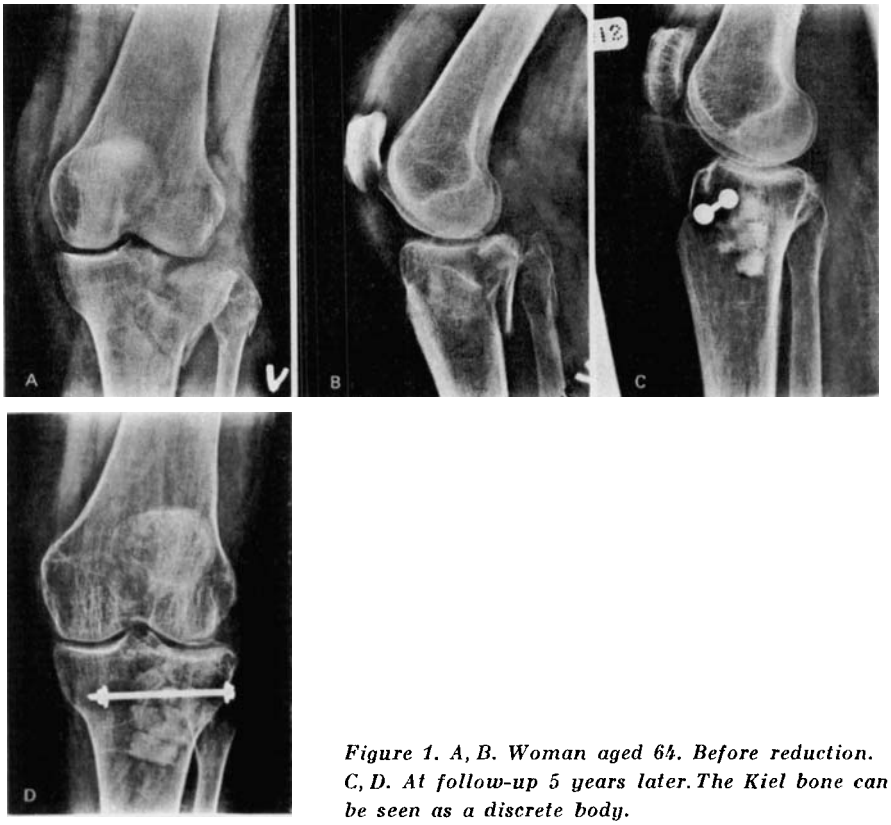

Figure 1. A, B. Woman aged 64. Before reduction. C, D. At follow-up 5 years later. The Kiel bone can be seen as a discrete body.

As may be seen in the table, the functional results were better in the autogenous bone group, but the difference was not significant. No similar tendency was observed for the anatomical results. When the primary severity of the fracture was compared to the end result, poorer results were obtained in the Kiel bone group (Table 2). When the primary depression of the condyle was at least 10 mm, the alignment achieved by reduction was impaired during the observation time (Figures 2 and 3) more often in the Kiel bone group (7/17 cases) than in the autogenous bone group (2/10 cases). The corresponding figures for the cases in which the primary depression was under 10 mm were 4/20 in the Kiel bone group, 2/8 in the autogenous bone group. Similar observations were made for the functional results, but the differences were smaller.

In the follow-up investigation attention was paid to the radiological incorporation of the graft. In 21/37 patients the appearance of the

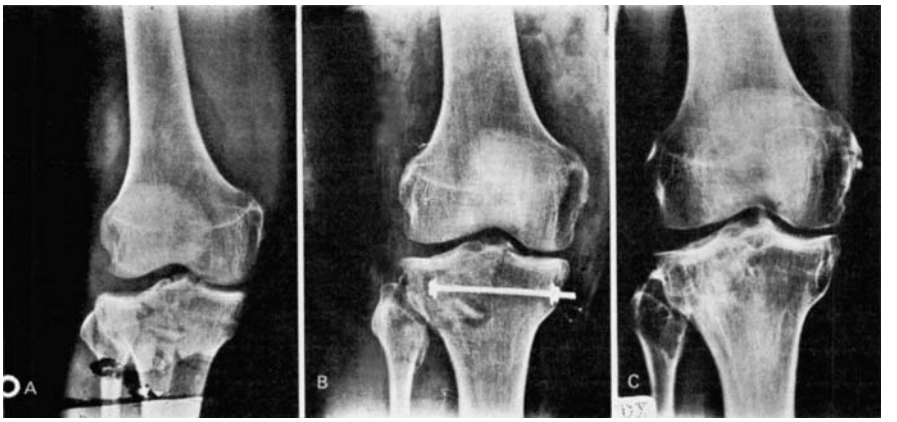

Figure 2. A. Man aged 32. Before reduction. B. After satisfactory reduction and application of Kiel bone. C. 6 years later. Sclerotic density and impaired alignment.

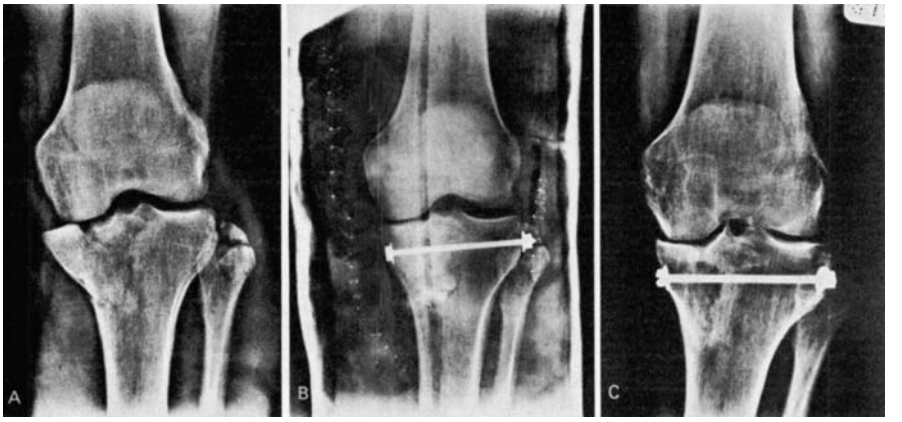

Figure 3. A. Woman aged 38. Before reduction. B. After satisfactory operative reduction and application of Kiel bone. C. 4½ years later. Sclerotic density and impaired alignment.

Kiel bone was the same as that of autogenous bone, both in the films taken immediately after operation and in those taken at follow-up examination. In 5/37 cases the Kiel bone was seen both postoperatively and at follow-up as a discrete body resembling a lump of sugar (Figure 1), although the contours were less distinct in the films taken at follow-up. Sclerotic density and coarse-fibered trabeculation (Figures 2 and 3) were seen both in areas filled with autogenous bone (8/18 and in areas filled with Kiel bone (12/37)). Since the same phe-

nomenon was observed in cases where no graft had been applied (12/36), it may however be considered in part, at least, an element of the normal postfracture state. No rejection of the Kiel bone was observed. In one case osteitis was treated by trepanation five weeks after operation. The end result was acceptable both anatomically and functionally.

DISCUSSION

Heterogenous bone has been extensively used in clinical series in Germany (Maatz & Bauermeister 1961, Haasch 1963, Lubinus 1963) and in the United States (Hurley et al. 1960, Andersson et al. 1963), and to some extent in Great Britain (Williams 1966, Churchill-Davidson et al. 1967). Both favourable results (Hurley et al. 1960, Maatz & Bauermeister 1961, Andersson et al. 1963) and unfavourable (Hopf 1957, Witt 1967, Baadsgaard 1970) have been reported. The type of host bone has been considered as decisive for a successful result (Meznik & Slancer 1969). Under favourable conditions, when both the host bone and the graft are cancellous, the Kiel bone has been rated as equal to autogenous bone (Halldèn 1966). In our series these optimal conditions were present, and the results indicate that Kiel bone is useful to a certain degree. No immune reaction occurred, and in the majority of patients the Kiel bone graft was obviously incorporated with the host bone. But the Kiel bone seemed to be less resistant to compression than autogenous bone. This may be due in part to the slow reorganization of the Kiel bone demonstrated both by earlier investigations (Andersson et al. 1964, Fuchs & Schlachetzki 1966, Meznik & Slancar 1969) and our own radiographic findings. Our impression is that Kiel bone may be used for filling small cancellous bone cavities, but if the area is exposed to weight-bearing, autogenous bone is preferable.

SUMMARY

A series of 55 cases of tibial condylar fractures is presented. The cancellous bone defect resulting from elevation of the compressed condyle was filled with Kiel graft in 37 cases and with autogenous graft in 18 cases.

It seems possible that the use of Kiel bone is connected with greater risk of impairment of reduction. Therefore caution is recommended in its use for filling large bone cavities in weight-bearing areas.

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