TABLE III

FRICTION AND WEAR RESULTS FOR CANDIDATE MATERIALS

Material		*Wear factor* k (in^2/lb)	*Friction coefficient* μ
HDPE Hi-fax 2601		6.3×10^{-12}	---
HDPE Hi-fax A63-200		2.7×10^{-10}	—
UHMWPE M.W. 1.25×10^6		2.6×10^{-12}	0.03
UHMWPE Hercules 1900		3.1×10^{-12}	0.025
UHMWPE M.W. 3×10^6		1×10^{-12}	0.02
Hi-fax A63-200+10% Graphite		1.2×10^{-11}	—
Irradiated UHMWPE	20 Mrad	3.6×10^{-12}	0.03
	200 Mrad	1×10^{-12}	0.06
	1000 Mrad	1.4×10^{-12}	0.06
UHMWPE+10% graphite		2×10^{-12}	0.02
Pyrolytic carbon		2×10^{-11}	0.06
+8% silicon		2.6×10^{-12}	0.05
+15% silicon		1×10^{-12}	0.04
Graphitar RCG 35		2.3×10^{-11}	0.08
CG 110		5.9×10^{-11}	0.08
RG 2976		1.5×10^{-10}	0.08
PTFE–PE alloy		2.7×10^{-12}	0.02
AP-4*		5×10^{-11}	0.05

TABLE V

Comparison of Wear and Creep of Polyethylene Specimens

Specimen	Load	Height Loss due to Wear, h (um)	Total Height Loss, H (um)	Unrecovered Creep, $D = H - h$ (um)	Creep/Wear Ratio D/h
S-1	3.45 MPa	4	61	57	14
S-2	(500 psi)	6	61	55	9
S-3		6	69	63	11
S-4	6.90 MPa	11	74	63	6
S-5	(1000 psi)	12	71	59	5
S-6		12	58	46	4
C-1	6.90 MPa	4	75	71	18
C-2	(1000 psi)	7	64	58	7
C-3		6	65	59	10

The height loss due to wear was calculated by multiplying the wear rate (Table IV) by the total number of cycles. The total height was determined from direct measurement of the specimens before and after the wear test. The difference in the two is an indication of the unrecovered creep. The values are comparable to the 60 μm obtained with control specimens (Fig. 2).

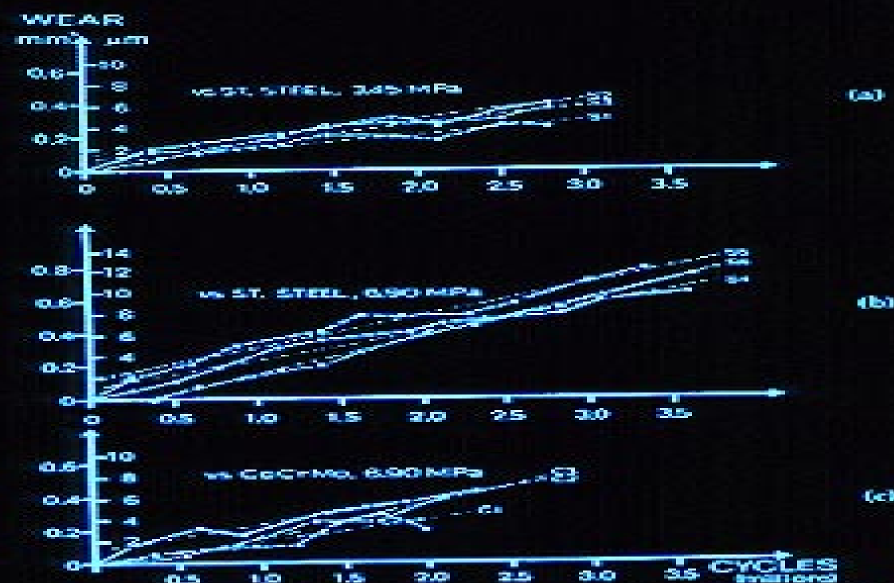


Fig. 6. Wear of UHMW polyethylene as a function of sliding distance (one cycle = 50 mm) using serum lubrication and highly polished counterfaces. (a) 316 stainless steel at 3.45 MPa, (b) 316 stainless steel at 6.90 MPa, (c) cobalt-chrome alloy at 6.90 MPa. The dashed lines are the best-fit straight lines for each set of data, calculated using linear regression. The slope of this line is the wear rate for each specimen (Table II).

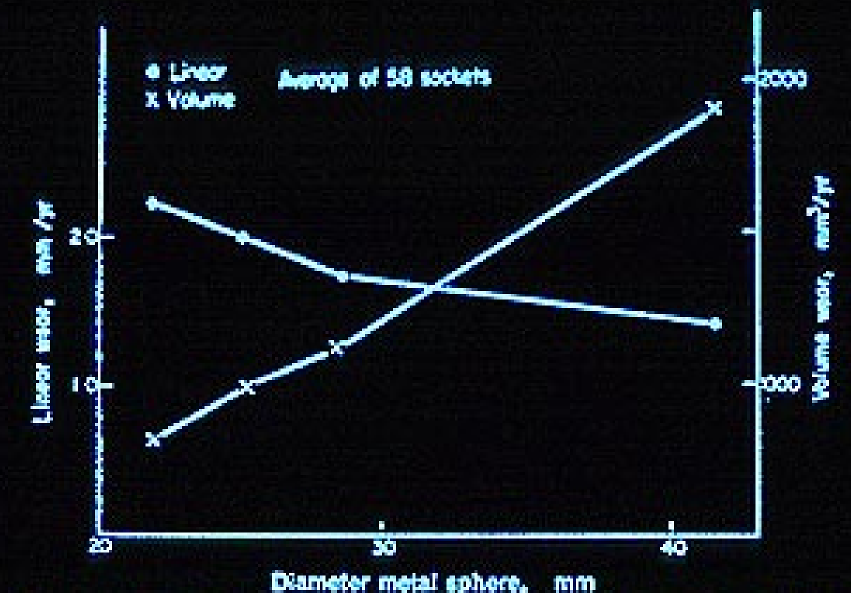


FIG. 3. Rate of linear wear plotted against diameter of steel head, compared with rate of volumetric wear calculated from diameter and distance of penetration.

FIG. 4. Plot representing patients of different weight in relation to the rate of wear and the grade of functional activity of each case.

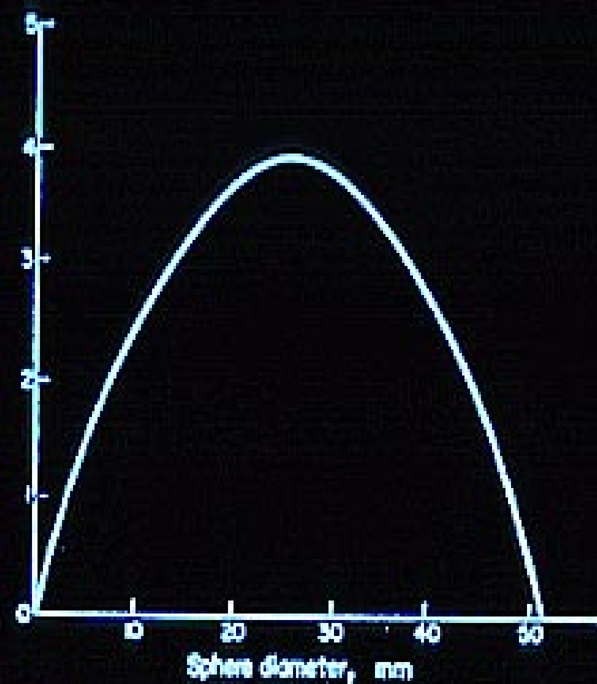


FIG. 5. Length of life of a socket of external diameter 51·5 mm when failure is judged by penetration to the external surface. Outside the limits of 21 to 31 mm the life of the socket falls rapidly. The optimal life will be at 25·75 mm.

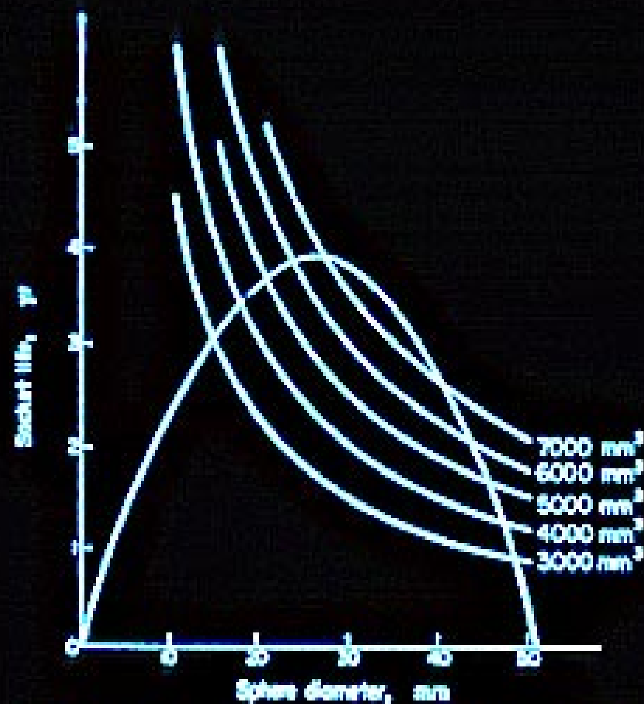
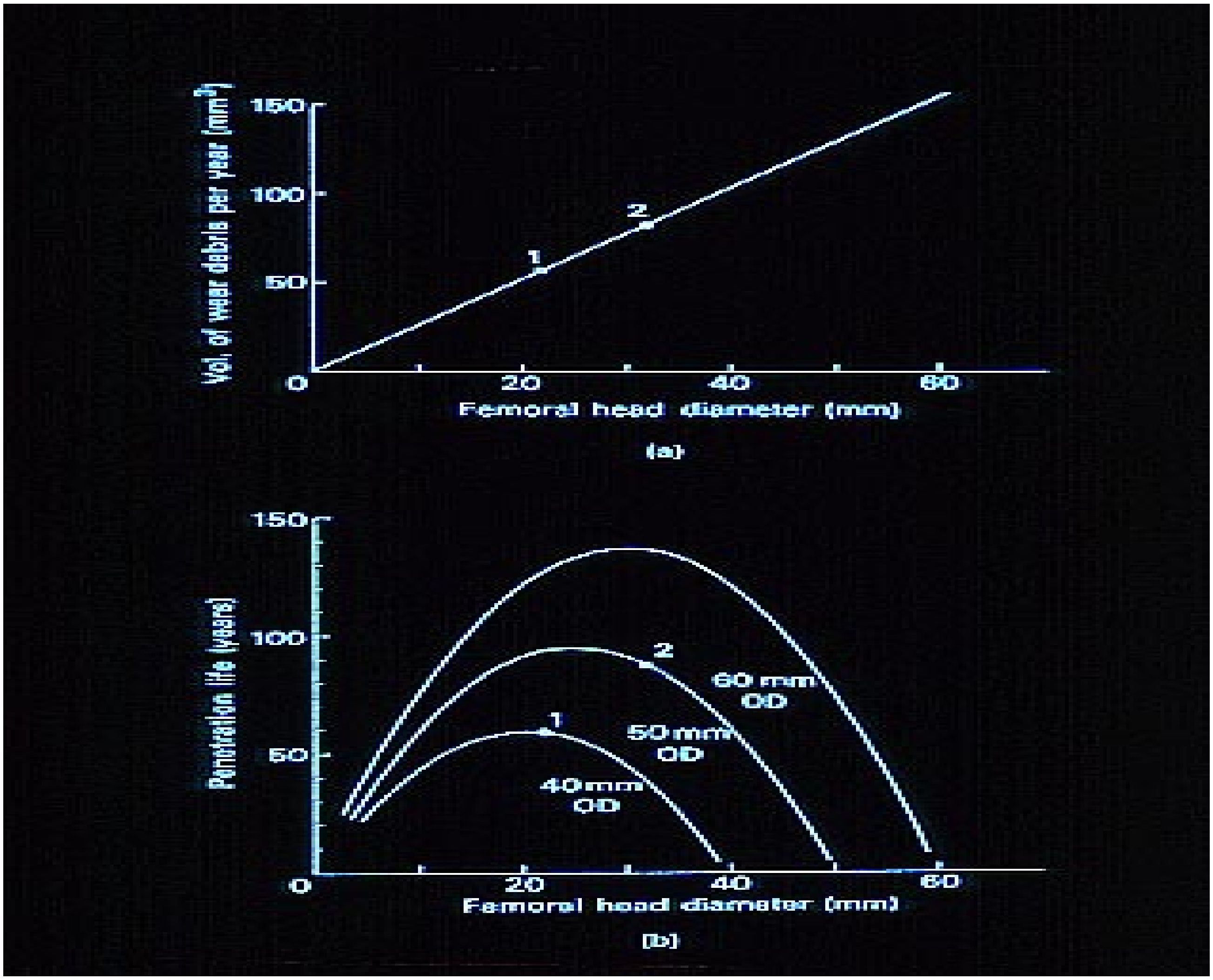


Fig. 6. Assuming maxima for the volumes of plastic debris which can be permitted to accumulate (3000 mm³ to 7000 mm³) the diameter of metal head for slowest rate of accumulation can be deduced.



Vol. of wear debris per year (mm³)
150
100
50
0
20
40
60
1
2
Femoral head diameter (mm)
(a)
150
100
50
Penetration life (years)
0
20
40
60
1
2
60 mm OD
50 mm OD
40 mm OD
Femoral head diameter (mm)
(b)

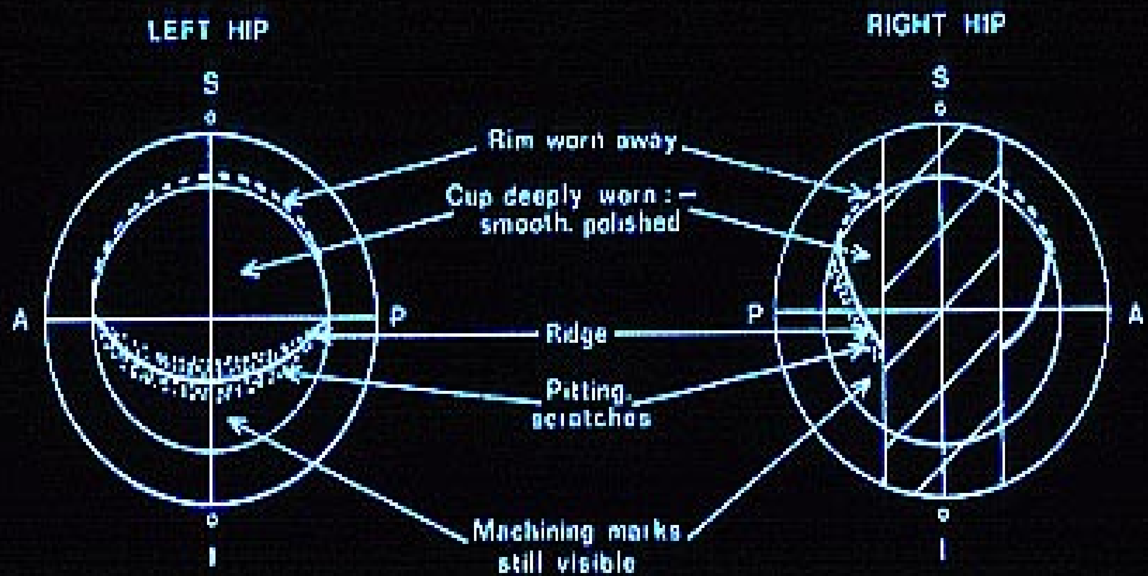


Fig. 2

Appearance of two acetabular cups which have been worn in the human body (Patient HB3). S, superior; P, posterior; I, inferior; A, anterior. (Not to scale.) The clinical details of this patient were: age of left hip 9 years 9 months, and of right hip 9 years 11 months; age at time of operation 74 years; weight 7 stone 4 pounds; activity, light housework; gait normal; walking ability 2 to 3 miles.

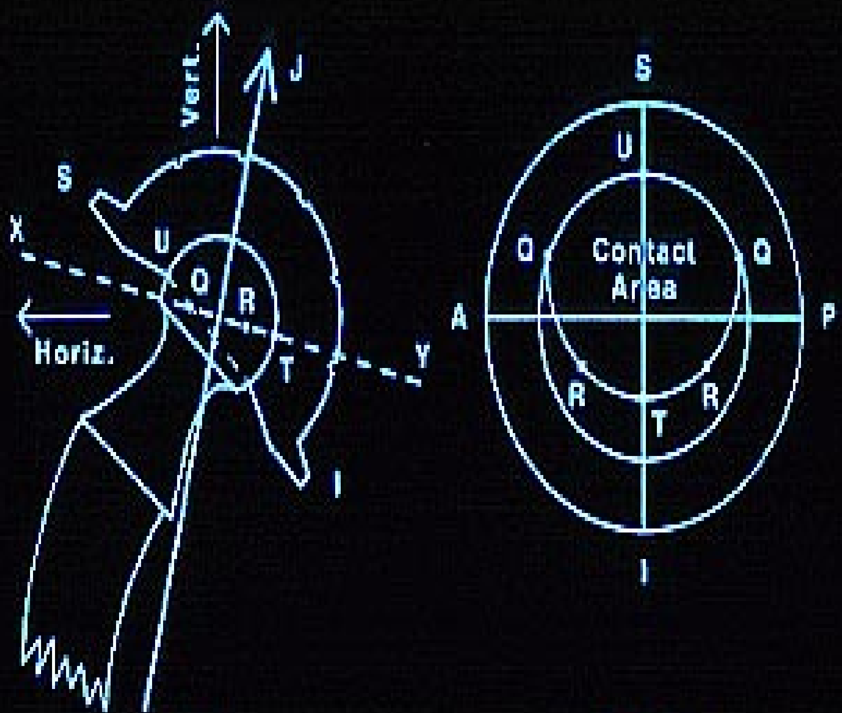


Fig. 4 Fig. 5

Orientation of the Charnley hip joint and joint force, *J*, in relation to the observed contact area on the acetabular cup. Figure 4—Loading geometry of the hip (see text). Figure 5—Main contact area on acetabular cup obtained by plotting points U, Q, R and T seen in Figure 4.