50 Years Ago in CORR

The Repair of Articular Surfaces Following Arthroplasty of the Hip

by Marshall R. Urist MD CORR 1958;12:209–229

Arthroplasty of the hip has evolved remarkably, albeit in fits and starts, from the suggestion of Themistocles Gluck in 1891 to replace the femoral head with a carved ivory ball [3] (a suggestion that apparently failed owing to foreign body extrusion according to Jones [5]). Various

Fig. 1 (Left) Kodachrome photomicrograph of a sagittal section of the articular surface of the femoral head (longitude lines) from an autopsy specimen of the hip of a 70-year-old man. The cartilage cells in the deep layers are large and surrounded by spherical area of matrix rich in metachromatic staining azurophilic ground substance. The cartilage cells in the surface layer are small and flattened, and there is very much less ground substance and very much more fibrous material between them. (Hematoxylin = eosin and Azure II stain.) (Right) Kodachrome photomicrograph of a serial section of the same specimen shown on the left. There are large bundles of blackened fibers passing vertically and diagonally between the large cartilage cells of the deep layer. The surface layer consists of a dense matting or shell composed of argyrophilic fibers and small flat cells. The larger masses of cells surrounded by blue-staining capsules of matrix are the *chondrones*. This arrangement of chondrones and the fibers resembles the structure of an automobile tire, in which the cells serve as the rubber and the fibers serve as the cord. (Wilder's stain.) (Reprinted with permission from Urist MR. The repair of articular surfaces following arthroplasty of the hip. *Clin Orthop Relat Res.* 1958;12:209–229.).

50 Years Ago in CORR

authors recommended “interposition arthroplasty,” using a variety of materials placed between the two joint surfaces, including celluloid, ivory, chromacized pig’s bladder, and metal [2]. Jones, in 1908, reported interposing gold foil with some success [5]. Smith-Petersen, after trying a relatively thick hemispheric “mould” of various materials (among them glass, Pyrex®, and Bakelite) settled on Vitallium metal at the suggestion of his dentist [7]. Of all the interposition arthroplasties, this latter was the most lasting and unquestionably most successful, being used through the 1960s and early 1970s when the Charnley low friction arthroplasty assumed the dominant place in hip arthroplasty. Smith-Petersen [7] suggested the articular surfaces would repair by the molding of the fibrous ingrowth of the nascent blood clot and would progress through fibrocartilage to hyaline cartilage.

Remarkably, such a repair process occurred with time, although never demonstrably to normal hyaline cartilage. Marshall Urist (the Editor-in-Chief of *Clinical Orthopaedics and Related Research* from 1966–1993) demonstrated this process 50 years ago in histologic sections from a series of 15 patients [9] using a unique form of arthroplasty [8]. He noted two distinct forms of response: (1) progressive disintegration of the joint (typically in patients with posttraumatic and other forms of osteonecrosis; (2) progressive

repair (typically in patients with old acetabular fractures or developmental conditions). The latter apparently required good collateral circulation, and progressed to fibrocartilage (Fig. 1) as had been described by Smith-Petersen [7]. That cartilage, he noted, was not normal hyaline cartilage, and rather had smaller cells (often paired presumably from recent divisions) and lacked the typical organizational features such as “chondrones” (a concept more recently popularized by Poole and colleagues [6] suggesting a coherent structure of the cell and surrounding matrix) and Benninghoff’s arcades of collagen fibers extending from the subchondral bone to the cartilage surface [1]. Contrary to common opinion at the time, this repair process occurring after a period of progressive deterioration suggests when submitted to a new mechanical environment cartilage does have a capacity to partially restore itself. Similar radiographic and histologic restoration naturally occurs spontaneously in rare cases of advanced hip osteoarthritis [4]. Urist’s work and that of others raises a question as to what conditions lead to durable restoration.

Richard A. Brand MD
Editor-in-Chief
*Clinical Orthopaedics
and Related Research*

References

1. Benninghoff A. Form und Bau der Gelenkknorpel in ihren Beziehungen zur Funktion. *Zeitschr f Anat u Entwicklungsgesch.* 1925;75:783–862.
2. Campbell WC. *Operative Orthopedics.* Saint Louis, MO: CV Mosby Co; 1939.
3. Gluck T. Referat über die durch das moderne chirurgische Experiment gewonnenen positiven Resultate, betreffend die Naht und den Ersatz von Defecten höherer Gewebe, sowie über die Verwethung resorbirbarer und lebendiger Tampons in der Chirurgie. *Arch klin chir.* 1891;41:187–239.
4. Guyton GP, Brand RA. Apparent spontaneous joint restoration in hip osteoarthritis. *Clin Orthop Relat Res.* 2002;404:302–307.
5. Jones R. Production of pseudo-arthrosis of the hip without disarticulation of the head. *Br Med J.* 1908;1:494–495.
6. Poole CA, Flint MH, Beaumont BW. Chondrons in cartilage: ultrastructural analysis of the pericellular microenvironment in adult human articular cartilages. *J Orthop Res.* 1987;5:509–522.
7. Smith-Petersen MN. Evolution of mould arthroplasty of the hip joint. *J Bone Joint Surg Br.* 1948;30:59–75.
8. Urist MR. The principles of hip-socket arthroplasty. *J Bone Joint Surg Am.* 1957;39:786–810.
9. Urist MR. The repair of articular surfaces following arthroplasty of the hip. *Clin Orthop Relat Res.* 1958;12:209–229.

50 Years Ago in CORR:

The Repair of Articular Surfaces
Following Arthroplasty of the Hip
by Marshall R. Urist MD

Richard A. Brand MD