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The origin(s) of the periarticular osteophytes of osteoarthritic knee joints

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Summary
Oestophites obtained from the margins of 25 osteoarthritic knee joints undergoing replacement have been investigated using a battery of tinctorial stains. The microarchitecture of the osteophyte appears to be identical to that of the normal articular cartilage. Other findings suggest that oesteophytes are derived from hyperplasia of the surface chondrocytes at the 'marginal transitional zone'.

Keyword: *Osteophytes, knee joints, cartilage chrondrocytes*

Résumé
Les osteophytes obtenuent des marges de 25 osteoarthrite des articulations du genoux en remplacement ont été investigué en utilisant une batterie de colorant tinctoriale. La microarchitecture de l'osteophyte appariat entre identique à celle des cartilages articulaires. D'autres observations suggerent que les osteophytes sont dérivés de l'hyperplasie à la surface des chondrocytes à la zone de transition marginale.

Introduction

Osteophytes are osteochrondral overgrowths or spurs which develop at the margins of degenerating joints forming a continuous lip around the joint margins (Fig. 1). Clinically, they are important causes of local pain and/or restriction of movement. The stimuli for osteophyte formation and the mechanisms involved in their generation are not known. It is possible that osteophytes represent a reparative process, but the cellular origin(s) is unclear. This is in part because osteophyte formation occurs in a region where a number of different tissue types (i.e. articular cartilage, synovium and periosteum) converge (Fig. 2). The individiual contributions of each of these tissues /cell types is not known with any certainty. This study investigates this matter using an array of finctorial staining techniques which distinguish bone and cartilage from other tissues.

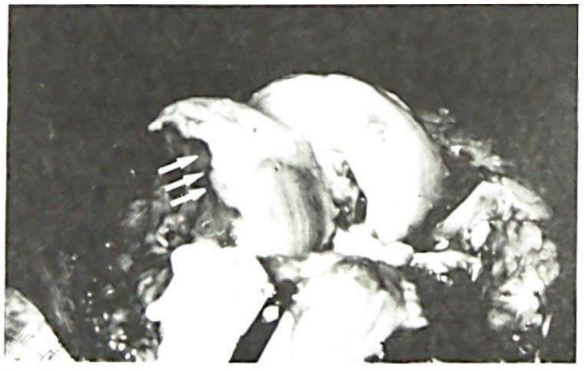

Fig. 1 Intra-operative photograph showing osteophytes around the margins of the knee joint (arrow)

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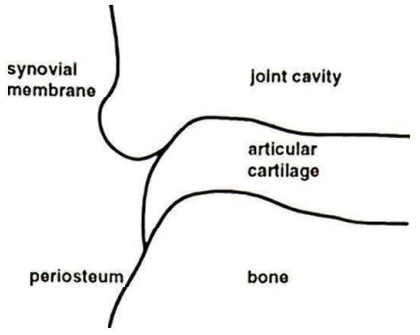

Fig. 2: The 'marginal transitional zone' of the articular cartilage.

Materials and methods

The osteophytes were obtained from the margins of 25 osteoarkthritic knee joints during operation for a total knee replacement using an osteotome. It is possible visually to distinguish an osteophyte from normal articular cartilage.

Decalcified specimens

Specimens were fixed in formalin, decalcified, routinely processed and embedded in paraffin. Comparative 6 u thick sections were obtained and stained using, respectively, haematoxylin-eosin (He), toluidine blue (TB) which preferentially stains cartilage, von Gieson method (VG) which preferentially stains collagen [1] and the Ralis and Rais universal tretracherome technique (RR) which highlights different aspects of osteogenesis [2].

Undecalcified specimens

In a parallel study, specimens were also prepared and stained according to the Tripp and Mackay's technique [TM] for identifying mineralisation, bone and osteoid [3].

Results

In the femur, osteophytes were observed at the margins of the trochlear, the medial and lateral margins of the condyles and at the margins of the intercondylar notch. In the tibia, they were observed on the tibial spines and at the medial and lateral margins of the tibial plateau. Osteophites were also observed around the periphery of the patella.

Macroscopic examination

On excision, the osteophyte was observed to be a cartilage-capped bony outgrowth freely communicating with the marrow of the underlying normal bone.

Microscopic examination

In all cases, two distinct layers were identified: hyaline cartilage and trabecular bone with a well-developed marrow (Fig. 3). At the joint surface, the chondrocytes were small in size and flattened. There are hyperplasia of surface cells at the junction with a vascularised fibrous tissue (Fig. 4). At the cartilage-bone boundary, the cells were larger, rounder, fewer in number and widely dispersed. The cells in the middle layers appeared to be isogenic, arranged in parallel columns and separated from one another by matrix (Fig. 5). Following VG staining, collagen fibrils were observed arranged in longitudinal bundles separating columns of chondrocytes one from another. The arrangement was transverse in the superficial layers, but haphazard in the ossifying layer

Fig. 3 TM-stained section of an osteophyte showing its two layers cartilage and bone (darker staining). Note hyperplasia of surface cells (arrows) – mag x 20

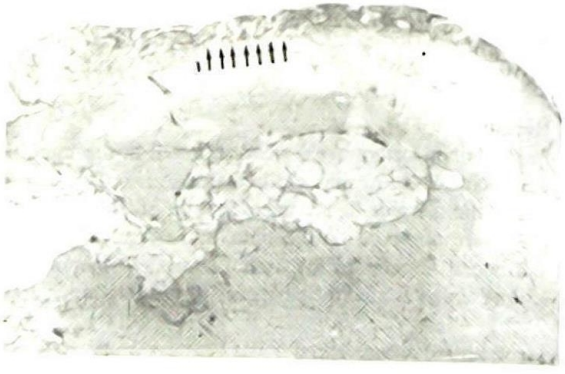

Fig. 4 HE-stained section of an osteophyte showing hyperplasia of the surface chondrocytes (arrows) at the marginal transitional zone – mag x20

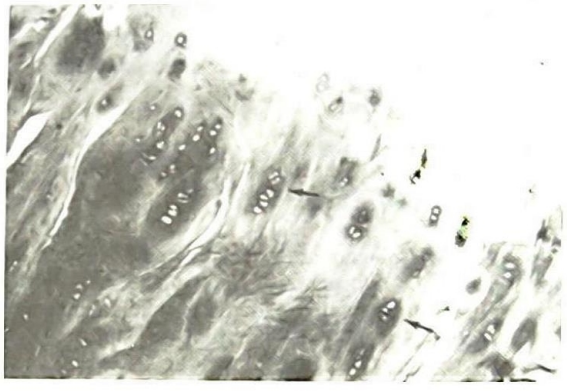

Fig. 5 TB-stained section of osteophyte showing the columnar cells (arrows) in the middle zone – mag x 20

Discussion

This study reveals that the micro-architecture of the osteophyte is identical to that of the articular cartilage and the epiphysis of growing bones (Fig. 6). The cells immediately adjacent to the joint surface appear to be chondrogenic and to give rise to cell columns. The cartilage is converted into bone at the base of the osteophyte by the process of endochondral ossification. The chondrogenic surface cells appear to arise from hyperplasia of the surface chondrocytes located at the joint margins [4].

The normal articular cartilage has three ill-defined zones (Fig. 6): the superficaial zone consists of small and flattened chondrocyes; in the middle zone, the cells are arranged in columns; and the deep zone is calcified. During growth, the layer of calcified cartilage is continuously being replaced by new bone in the same manner as occurs on the diaphyseal side of the epiphyseal plate [5] and the middle zone is continuously being prepared for ossification. New cells are continuously required and, to keep up, proliferation occurs in the chondrocytes of the superficial zone. Ordinarily, hyaline cartilage is covered on its external surfaces by a perichondrium [5-7]. This thick membrane, like the periosteum of bones, can be separated into an outer fibrous layer and an inner cambium or chondrogenic layer. Appostional growth, by which the cartilage increases in width, occurs in the cambium layer. Findings from the present study suggest that this layer at the periphery of the joint is responsible for osteophyte formation. Articular cartilage differs from othery hyaline cartilages only in the fact that it does not have a fibrous perichondrial layer [5]. Perhaps, this is responsible for its propensity to suffer abrasive wear.

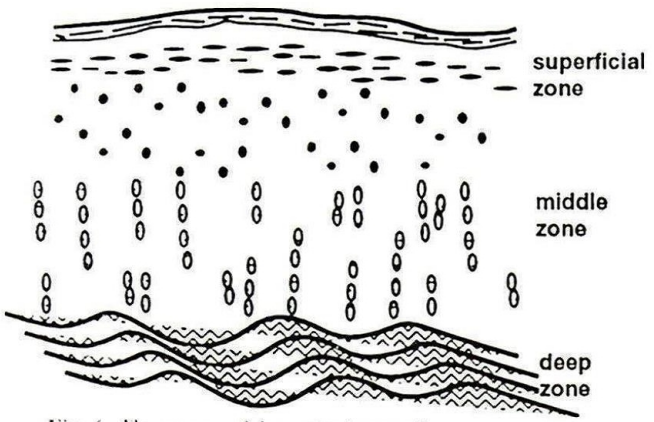

Fig. 6 The zones of the articular cartilage

Two contrasting theories of the origins of osteophytes have previously been enuciated One holds that chondrocytes throughout the articular cartilage proliferate and form cell clusters or 'chondrones' in response to the arthritic process [8,9]. Presumably as a consequence of mechanical forces, a collar of 'new cartilage' forms at the joint margins and these are subsequently converted into bone by the process of endochondral ossification [10]. The other theory proposes that a 'traction injury' [11] causes a vascular [12] inflammatory process [13,14] as a consequence for which the juxta-articular soft tissues are induced to form bony nodules via the ndochondral [15] and or the oppositional [16] pathway. The bony nodules eventually fuse and become confluent with the underlying metaphyseal bone. The findings from this study do not support either of these propositions. Instead, the results suggest that surface chondrocytes at the margins of the joint are induced to proliferate The resulting cartilage 'bud' is subsequently invaded by endochondral ossification extending into it from the subchondral bone. Hence, the layer of the osteophyte are continuous with comparable layers of the articular cartilage and the osteophyte surface is continuous with the articular surface.

References

1 Van Gieson I. Laboratory notes of technical methods for the nervous system. NY Med J 1889; 50: 57

2 Ralis ZA, Ralis HM. A simple method for the demonstration of osteoid in paraffin sections. Med Lab Tech 1975, 32: 203-213

3 Tripp EJ, MacKay EH. Silver staining of bone prior to decalcification for quantitative determination of osteoid in sections. Stain Tech 1972; 47: 129-136.

4 Aegerter E, Kirkpatrick JA. Degenerative joint disease. In-Orthopedic diseases, 2nd ed., Philadelpha: Saunders CO., 1964.

5 Ham AW, Cormack DH. In Histophysiology of cartilage, bone, and joints. Philadelphia: Lippincott CO., 1979.

6 Buckwalter J, Rosenberg L, Coutts R, Hunziker E, Reddi AH, Mow V. Articular cartilage: injury and repair. In Woo S L-Y, Buckwalter JA (eds). Injury and repair of the musculoskeletal soft tissues. Illinois: AAOS, 1988

7 Buckwalter JA, Mow VC, Ratcliffe A. Restriction of injured or degenerated articular cartilage. J Amer Acad Orthop Surg 1994; 2: 192-201.

8 Mitchell N, Lee ER, Shepard N. The clones of osteoarthritic cartilage. J Bone Joint Surg 1992; 74B: 33-38.

9 Archer CW. Skeletal development and osteoarthritis. Ann Rheum Dis 1994; 53: 624-630.

10. Collins DH. In the pathology of articular and spinal diseases, London: Arnold, 1949.

11. Bennett GA, Bauer W. Joint changes resulting from patellar displacement and their relation to degenerating joint disease. J Bone Joint Surg 1937; 19: 667.

12. Arnoldi CC: Vascular aspects of degenerative joint disease. A synthesis. Acta Orthop Scand Suppl 261, 1994.

13. Chrisman OD, Fessel JM, Southwick WO. Experimental production of synovitis and marginal exostosis in the knee joint of dogs. Yale J Biol Med 1965; 27: 409-412.

14. Christensen SB. Osteoarthrosis. Changes of bone, cartilage and synovial membrane in relation to bone scintigraphy. Acta Orthop Scand Suppl. 214, 1985.

15. Marshall JL. Periarticular osteophytes. Initiation and formation in the knee of the dog. Clin Orthop 1969; 62: 37-47.

16. Gilbertson EMM. Development of periarticular osteophytes in experimentally induced osteoarthritis in the dog. Ann Rheum Dis 1975; 34: 12-25.