Role of Synovial Pain Fibres in Osteoarthritis

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ABSTRACT : In the course of routine total knee replacement operations, synovectomies are performed as a part of the operations. It is commonly observed that patients who have synovectomies performed as a part of the total knee replacement operations have much less pain post-operatively in the long term.

The synovial specimens from ten total knee replacements were subjected to histological examination for nerve endings. Seven were stained positive and three were negative.

The role of these nerve endings in pain production in osteoarthritis is postulated.

INTRODUCTION

Osteoarthritis being a degenerative disease is often looked upon as the end result of an altered joint structure with pain result from direct mechanical irritation of sensory nerve endings. It ;however, is not as simple as it may seem because of the discordance of clinical symptoms with radiologic findings. The articular cartilage which is the main site of pathology is in itself devoid of neural elements and thus pain in osteoarthritis is thought to originate from non cartilagenous articular as well as para articular structures[1]. Kellergen and Samuel[2] have found that pain in the osteoarthritis originates primarily from the ligamentous structures of the joints and that the synovial membrane is relatively insensitive to pain. Kennedy[3] on the other hand,found the synovial membrane to be richly innervated. Other authors have suggested that no pain receptors are presented in the synovium[4]. A more recent study, however, of Gronbald et al[5] has shown that the neural elements are presented in the synovium and that neuropeptides may contribute to pain in joint disease.

The disagreement in the actual presence of neural elements prompted us to study the synovial tissue sample taken from 10 patients with osteoarthritis who underwent total knee replacement.

MATERIALS AND METHODS

The synovial tissue samples were obtained from the total knee operations from 10 knee joints. Eight patients fulfilled the clinical and radiographic criteria for primary osteoarthritis. One patient who underwent bilateral total knee replacement had secondary osteoarthritis from long standing rheumatoid arthritis. The synovium was taken from the suprapatellar recess and medial and lateral gutters following synovectomy which was a part of the operation of the total knee replacement. All cryostat sections were stained using the Palmgram Axon Stain method.

RESULTS

Using the Palmgram Axon Stain method, 7 synovial samples demonstrated nerve structures (Fig.1,2,3). All were simple free fibres endings with a predominant perivascular location. Three synovial samples proved to be negative for any nerve structure.

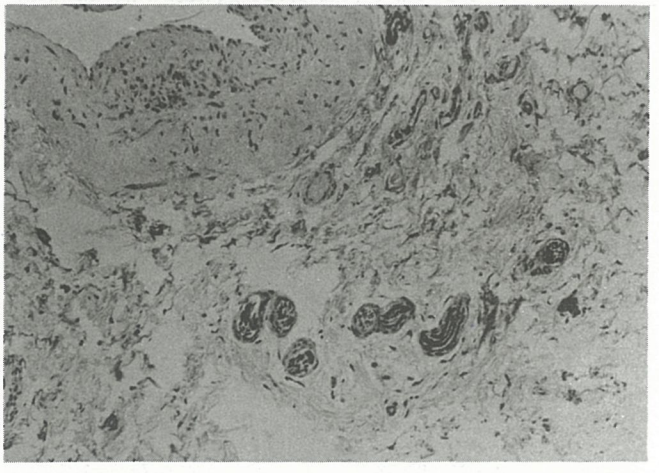

Figure 1. Photo micrograph of the synovium of the left knee of a 70 year old lady showing the nerve endings using immuno enzymatic stain for enolase. Magnification x 100.

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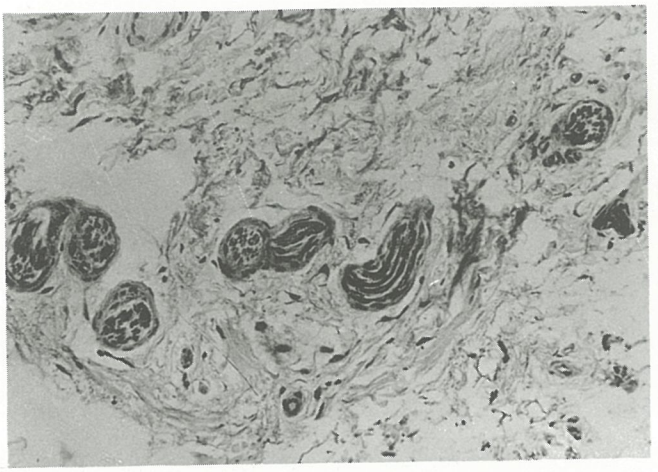

Figure 2. As same as in figure 1, magnification x 200.

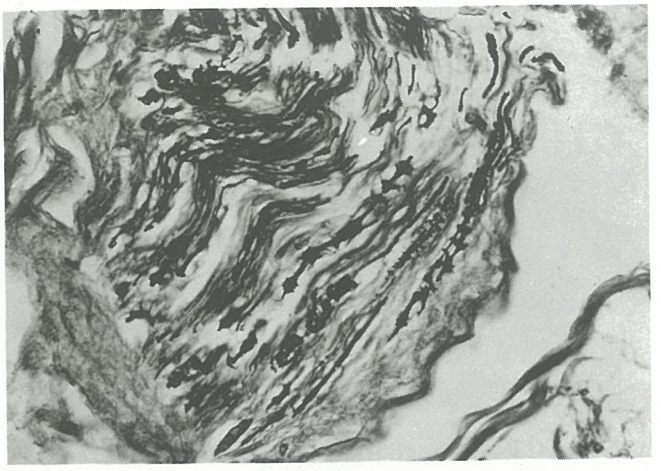

Figure 3. Nerve endings in the synovium using Palmgram Axon stain. Magnification x 200.

DISCUSSION

The preceding data establishes the definite presence of the neural elements in the synovial membrane. Its noted absence in the 3 synovial samples could preclude the possibility that they have a specific pattern of location and that the synovial tissue taken from these areas were aneural. The pattern of the nerve endings noted in our specimen were similar to Ralston's studies[6] which showed the synovial neural elements to be free fiber endings. There is a general hypothesis that such nerve endings are associated with reception of painful stimuli. The presence of neuropeptides like substance P in the neural elements gives credence to its possible contribution to pain in the osteoarthritis[5]. Zimmerman[7] mentions two mechanisms of chemical activation of the synovial and periarticular nociceptors is either due to inflammatory response and ischaemia or "neurogenic inflammation" mediated by nociceptors. The common denominator in these suggested processes is an inflammatory state which we feel is the final pathway of pain in the osteoarthritis.

The role of the synovial membrane in the osteoarthritic pain is now of greater importance as arthroscopic correlates would show that the synovial inflammation was most intense in the vicinity of the synovial cartilage junction[8].

The arthroscopic as well as the histologic studies have shown normal synovium in areas farther than this location[8]. If we were then to correlate this data with our findings that the neural elements were not uniformly distributed in the synovial membrane, we could then hypothesize that the posssible location of such receptors to be in these synovial-cartilage junctions. The anatomical proximity of the synovial membrane to cartilage is in itself evidence that it will be the first to be exposed to articular degenerative changes. The meniscus, cruciate ligaments and other periarticular structures are thought to function mainly as mechanoreceptors[6,9]. These mechanoreceptors therefore, would respond only to an altered biomechanical state which usually sould not manifest in the early osteoarthritis.

The pain in the osteoarthritis therefore, could be divided into two main groups. The first being early osteoarthritis which would manifest clinically with joint pain, without radiologic changes, with positive arthroscopic corrlators, but with no gross altered biomechanical state. Pain mechanism is mainly due to the chemical activation of the synovial receptors from the articular changes. The second is advanced osteoarthritis wherein clinical signs of joint pain are presented with definite radiologic changes, and parallel arthroscopic findings of degeneration. The altered biomechanical state is more pronounced, and thus the pain mechanism would come from two sources as followings:

1. Direct chemical activation of receptors from joint debris.

2. Afferent feedback mechanism from mechanoreceptors of ligaments and other periarticular structures, is due to the altered biomechanical state[6,9,10]. The therapeutic approach therefore, in the early osteoarthritis would be directed towards control of the inflammation explaining the rationale of arthroscopic joint debridement. Advance osteoarthritis on the other hand, would primarily be directed towards correction of the altered biomechanical state, diffusing the feedback mechanism.

CONCLUSION

The role of the synovial membrane in etiopathogenesis of pain in the osteoarthritis has a neuroanatomical basis. Further study is needed to define the actual function of the different neuropeptides in relation to pain mechanism. It is suggested that a bigger sample size of the synovial specimens be undertaken to correlate the receptor patterns. It is an interesting thought to consider systematic arthroscopic or chemical synovectomy of these receptor sites in the hope of reversing the inflammatory stage of the osteoarthritis, alleviating the pain symptoms, and possibly give time for the cartilage repair.

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