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Age-Related Changes in the Cervical Facet Joints: Studies with Cryomicrotomy, MR, and CT

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The cervical facet joints of 20 cadavers were studied systematically with MR, CT, cryomicrotomy, and histologic sections to determine the anatomic changes that occur with age. Uniform layers of cartilage and subarticular cortical bone characterize the cervical facet joints in cadavers under 20 years of age. Most adult cervical facet joints have only a discolored or microscopically thin layer of cartilage and have irregularly thickened subarticular cortical bone. The appearance of the cervical facet joints changes significantly with aging.

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Anatomic criteria to distinguish normal from abnormal cervical facet joints have not been defined. We noted that many adult cervical facet joints lacked the uniform layer of cartilage and the meniscus that has been described in the normal cervical facet joints [1–3]. We therefore studied the age-related changes of the cervical facet joints with MR, CT, and cryomicrotomy.

Materials and Methods

Twenty cadavers (12 male, eight female) with no recorded spinal symptoms or disease were selected from the cadavers donated to the Medical College of Wisconsin. The cervical spines in these cadavers were imaged with a 1.5-T cryogenic imager (Signa, General Electric, Milwaukee) and a 3-in. "butterfly" surface coil (Medical Advances, Milwaukee) placed behind the neck. Contiguous 3-mm-thick images in the sagittal plane were obtained with a 256 × 256 matrix and two excitations. Long and short TR images (600–1000/20, 2000/20, 2000/80) were acquired. Image acquisition time was between 30 and 43 min. CT was performed with a GE CT 9800 scanner in the same plane as the MR images. A 1.5- or 3-mm-thick slice was used with a 512 × 512 matrix, 120 kV, 200 mA, 4 sec scan time, 1.5–2.0 magnification factor, and bone windows. After CT and MR imaging the cadavers were frozen and a block of tissue that included the entire cervical spine was removed with a bandsaw. The block was placed on the stage of a planing cryomicrotome (LKB, Gaithersburg, MD). Anatomic sections were obtained in the same plane as the MR and CT images. As 1-mm-thick sections were removed, the surface of the specimen was photographed. The photographs and MR and CT images were compared. In three specimens the cryomicrotome sectioning was terminated when the midpoint of the facet joints was reached. The remaining tissue was placed in formalin and then decalcified, embedded, sectioned, stained with hematoxylin and eosin, and examined with light microscopy. In four cases, the cervical facet joints on one side were unavailable for this study. The case material was divided into two groups: under 20 years old (two cadavers ages 10 and 19) and over 35 years old (18 cadavers ages 37–86).

Results

The facet joints in the cadavers under 20 years of age conformed to the conventional anatomic depiction [3] (Fig. 1A). In these facet joints, a layer of glistening homogeneous ivory-white cartilage, measuring 1–1.3 mm in thickness,

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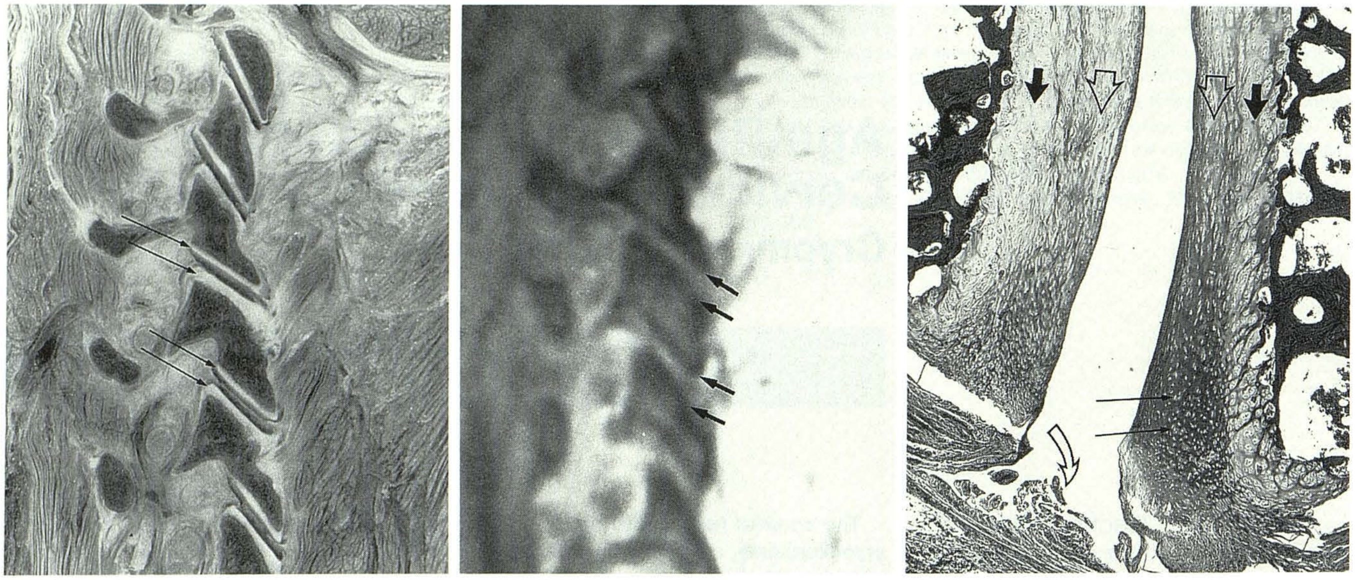
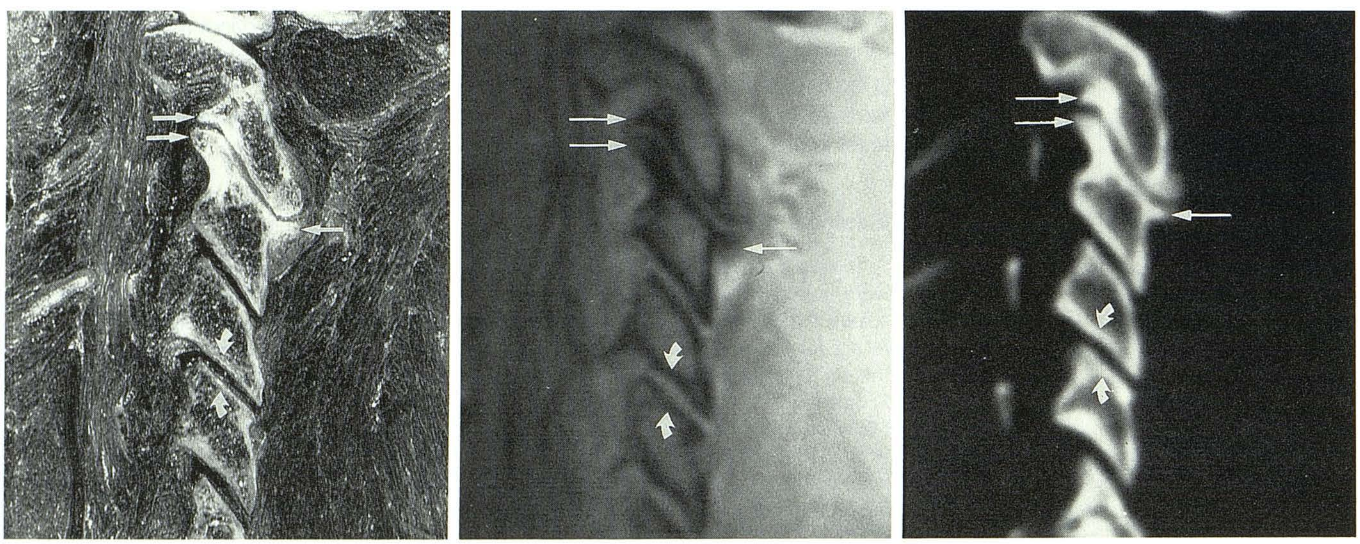


A B C

Fig. 1.—*A–C*, Anatomic section (*A*), MR image (*B*), and histologic section (*C*) in parasagittal plane through cervical facet joints in a 10-year-old. Note uniform layers of cartilage (*arrows* in *A*) on superior and inferior articular facets, which are not effectively shown in MR image. The thin layer of cortical bone underneath cartilage (*arrows* in *B*) is seen in the MR image (TR = 800, TE = 20). The anatomic section (stained with hematoxylin and eosin) shows a superficial layer of cartilage (*open arrows*), which stains darkly, and a deep layer of cartilage (*wide solid arrows*), which stains lightly. Numerous chondrocytes are evident (*long thin arrows*). Only a small portion of a meniscus (*curved arrow*) is evident.



A B C

Fig. 2.—*A–C*, Anatomic section (*A*), MR image (*B*), and CT scan (*C*) of cervical facet joints in a 37-year-old. Note that no cartilage is evident on superior or inferior articular processes of cervical facet joints (*A*). Normal cortical bone (*curved arrows* in *A*) in articular processes of C4–C5 is labeled in *A*, *B*, and *C*. A narrowed joint space, osteophytes, and thickened cortical bone are present at C2–C3 joint (*A*) and evident on the MR (*B*) and CT (*C*) images (*straight arrows*). The destruction of cartilage, which was shown histologically, is not identified on MR or CT images.

lined the articular surfaces of each articular process. Histologic examination of the cartilage showed chondrocytes in small groups within lacunae, surrounded by large regions of homogeneous basophilic matrix (Fig. 1C). In the cryomicrotome sections, a thin dull-gray layer of cortical bone adjacent to the cartilage was distinguished from the medullary bone in each articular process. In the younger cadavers, large tapering menisci of dense connective tissue were evident in the cervical facet joints. The 19-year-old had significantly thinner cartilage and smaller menisci than the 10-year-old. Neither of these cases had osteophytes or sclerosis of the medullary bone adjacent to the joint.

The cadavers 37 years of age and older had less articular cartilage, less regular cortical margins, and no grossly evident

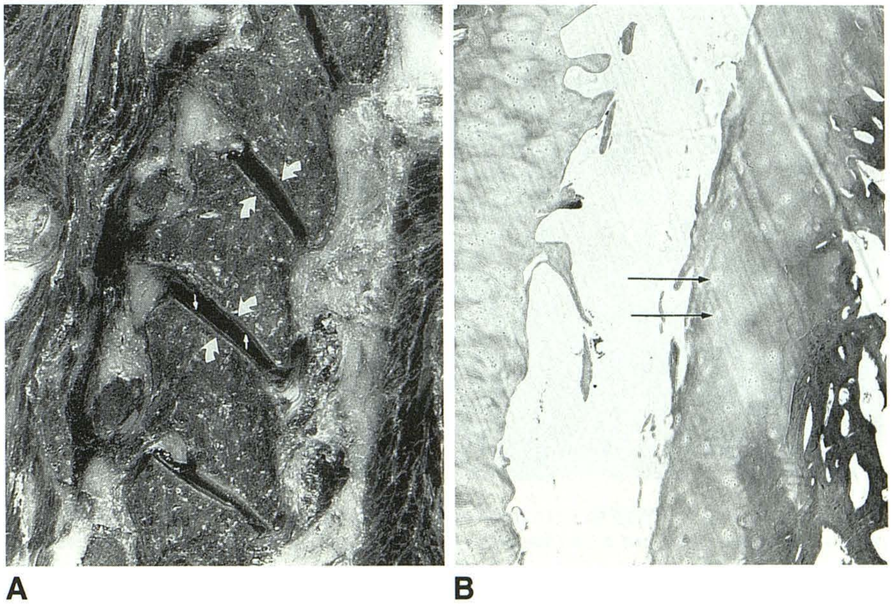


Fig. 3.—*A* and *B*, Anatomic (*A*) and histologic (*B*) sections through cervical facet joints in a 46-year-old. A thin band of dark-gray cartilage (*small straight arrows*) lines cortical bone on superior and inferior articular processes (*curved arrows*). Histologic section of C3–C4 facet joint shows irregular and degenerated cartilage with faint staining and scattered chondrocytes (*long thin arrows*).

meniscus in the cervical facet joints. Except at the C1–C2 level (which is not a true facet joint), 70% of the cervical facet joints in the older cadavers had no cartilage evident on gross inspection of the cryomicrotome sections (Fig. 2); the remaining 30% had a layer of dull-gray cartilage less than 1 mm thick (Fig. 3A). Microscopic examination of the histologic sections disclosed a thin layer of cartilage on the articular surfaces even when cartilage was not grossly evident on the cryomicrotome sections. The cartilage was characterized by a sparse matrix that was less densely basophilic than in the younger cadavers and by degenerated chondrocytes (Fig. 3B). A meniscus was not detected on inspection of the cryomicrotomic section but connective tissue bands of a rudimentary meniscus were demonstrated in the joint by microscopic examination. In most of the cases with cartilage abnormalities, osteophytes and/or a sclerotic change in the adjacent medullary cavity were evident. In some of these cases, medullary bone was totally replaced by dense sclerotic bone.

MR images, obtained in 11 of the 19 cases, demonstrated the articular cartilage imperfectly, even in the 10-year-old cadaver (Fig. 1B). The absence of cartilage in the majority of the adults was not readily identified on the MR images (Fig. 2B). The subchondral bone adjacent to the joint was represented as a thin rim of very low signal intensity. Osteophytes and sclerotic bone in the medullary cavity were readily demonstrated by MR (Figs. 2 and 4). In most cases, sclerotic bone appeared as a region of diminished signal intensity. In one case the high signal intensity characteristic of fatty bone marrow was conspicuous, despite densely sclerotic medullary bone evident on the anatomic sections (Fig. 5). Direct sagittal CT, obtained in nine cases, revealed the more severe degrees of joint space narrowing (Fig. 2C). It also reliably demonstrated osteophytes and sclerotic bone (Fig. 2C).

Discussion

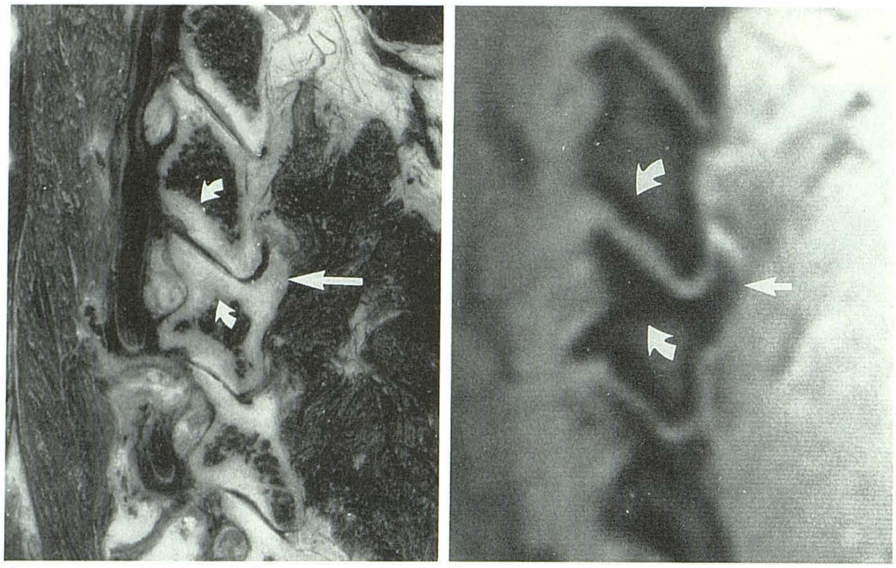
This study shows that the majority of adult cervical facet joints do not have the appearance described as normal [3]. In cadavers 37 years of age and older, articular cartilage is reduced to a thin, discolored or microscopic layer; the meniscus is nonexistent. About one half of the cervical facet joints in adults have thickening of subchondral bone or osteophytes as well as cartilage loss. These changes, although they are consistent with the description of osteoarthritis [4–8], should probably not be considered pathologic since they are seen in the majority of adults. We found the lower and middle cervical levels are usually more severely affected, as others have [4], although painful arthropathies are said to be more common in the upper than lower cervical spine [6].

The study suggests that MR and CT do not effectively detect age-related changes in the cervical facet joints. Both MR and CT demonstrated osteophytes and hyperostosis but not the changes in the articular cartilage and the meniscus.

The study suggests that osteophytes or sclerosis that MR or CT commonly demonstrates in the cervical spine in symptomatic adults may be incidental findings in some cases, notwithstanding the fact that they are commonly seen in patients with pain referrals to the cervical spine [1, 9]. Therapeutic trials of intraarticular steroids and local anesthetics have also suggested a role of the cervical facet joints in neck pain [10].

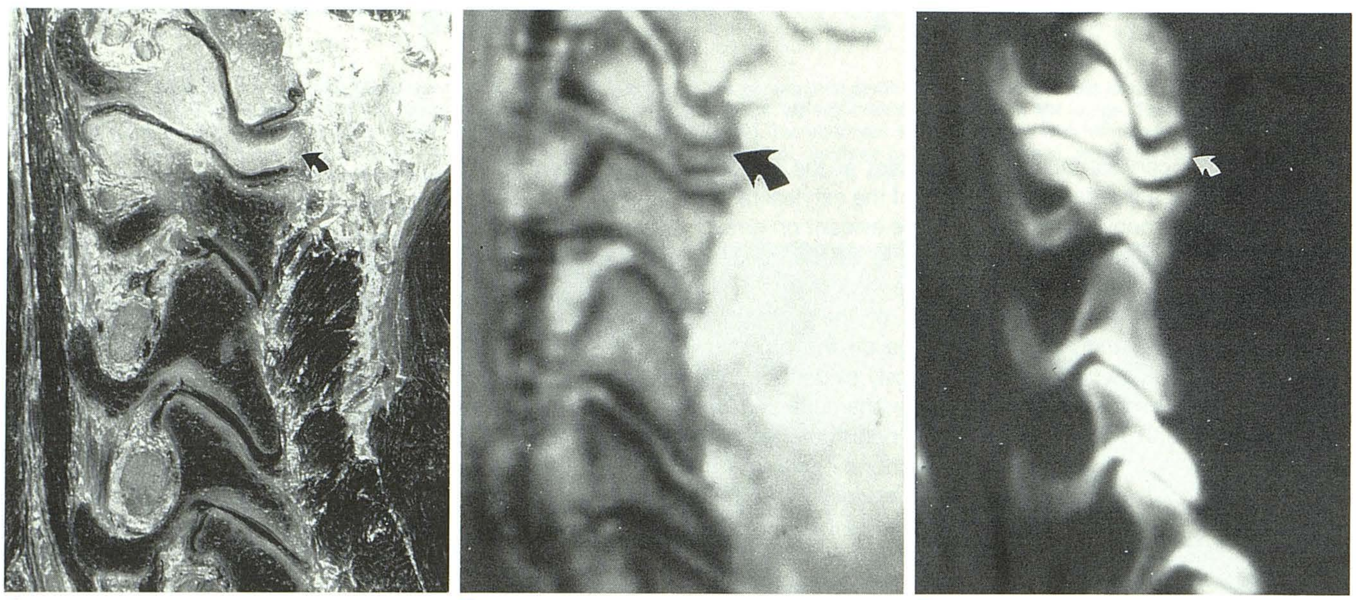
Symptomatic and incidental changes in the cervical facet joints are not easily differentiated by CT or MR, at least with the present criteria; therefore, additional studies are needed to distinguish symptomatic and age-related changes in these structures.

We conclude that only in the first two decades of life do the cervical facet joints normally have a macroscopic layer of articular cartilage, a meniscus, and a uniform layer of subar-



A B

Fig. 4.—*A* and *B*, Anatomic section (*A*) and MR image (*B*) show degenerated C3–C4 facet joint with thinned articular cartilage, thickened articular cortical bone (*curved arrows*), and an osteophyte (*straight arrow*). Osseous changes are shown effectively in MR image (*B*). None of the facet joints have evident cartilage or regular cortical bone on the anatomic sections.



A B C

Fig. 5.—*A–C*, Degenerative changes in upper cervical facet joints. The cryomicrotome section (*A*) shows destruction of articular cartilage at C2–C3 and C3–C4 and deformity and sclerosis of the intervening articular pillar (*curved arrow* in *A*). MR image (*B*) shows a bright signal from the sclerotic marrow cavity (*curved arrow*) suggesting fatty degeneration of bone marrow in medullary space. CT scan (*C*) shows a density consistent with sclerotic bone (*curved arrow*).

ticular bone. Normal findings in adult cervical facet joints are usually characterized by a thin layer of abnormally staining cartilage containing degenerated chondrocytes, and thickening of the adjacent bone.

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