THE INTERVERTEBRAL JOINTS

II : THE FACET JOINTS

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Summary
The anatomy of the facet joints, also known as the zygapophyseal, apophyseal or lateral intervertebral joints, is described in detail. Particular reference is made to the changing orientation of the articular facets in the cervical, thoracic and lumbar parts of the spine, allowing different ranges of movement in these regions. Possible causes for back pain are explained as a function of the biomechanics of the vertebral column.

Opsomming
Die anatomie van die faset gewrigte, ook genoem die "zygapophyseal", "apophyseal" of sy-intervertebrale gewrigte, word in detail beskryf. Besondere verwysing is gemaak na die veranderende oriëntering van die artikulerende fasette in die servikale, thorasiese en lumbale dele van die werwelkolom, wat verskillende bewegingsomvange in hierdie areas toelaat. Moontlike oorsake van rugpyn, as 'n funksie van die biomeganika van die werwelkolom, word beskryf.

INTRODUCTION

The vertebral column is unique in being a rigid yet flexible structure, allowing movement to occur at the intervertebral joints[24,36]. As physiotherapists appreciate, a knowledge and understanding of spinal anatomy and biomechanics is basic to the successful treatment of patients with disorders of the joints of the vertebral column.

The joints of the spine can be classified as the intervertebral discs and the facet joints. The intervertebral discs, described by the author previously[22], are the joints of the vertebral bodies[23,34,36], while the facet joints are the joints of the vertebral arches[23,34,36]. This paper gives a detailed account of the structure and functioning of the facet joints of the spine, known also as the zygapophyseal joints, the apophyseal joints or the lateral intervertebral joints. In this description, they will be referred to by the simpler term "facet joints", denoting articulations between opposing facets on the articular processes of adjacent vertebral arches.

Anatomical structure of the facet joints

The facet joints are present between the vertebrae from occiput to sacrum. They are typical synovial joints of the plane type[7,23,24,26,33,34,36] and, as such, are multiaxial as regards planes of movement possible[23]. They are the posterior[24], paired joints of the vertebral column[23,34,36].

The articular processes which bear the articular facets arise near the junction of the pedicles and laminae of each vertebra[23,34,36]. Each facet joint is enclosed by a fibrous capsule (Fig.1). This is reinforced posteriorly by fibres of the multifidus muscle inserting into the capsule, and adjacent mammillary process in the lumbar vertebrae, and antero-medially by the elastic ligamentum flavum[2,23,33]. The articular capsule is generally lax, particularly in the cervical spine where a greater range of movement is evident[7,23,31]. This is of particular relevance in the treatment of conditions in which the manifested signs and symptoms are related to movements of these cervical joints.

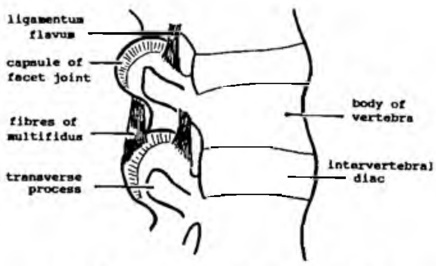

Fig 1: The facet joint (lateral view)

In the lumbar spine, the facet joint intracapsular spaces, lined with synovial membrane, have been shown to extend beyond the superior and inferior articular processes and under the ligamenta flava[32,38]. These polar recesses may be filled with fat pads or have fat-filled synovial folds projecting from them into the joint spaces[14] for two to four millimetres[32]. The intra-articular fat may become enlarged, extending from the polar recesses into the joint cavity[32,38], and may cause reduced movements at the particular joint involved. This may be associated with increased mechanical stresses on the joint and, eventually, joint degenerative changes[5,14,32].

These intracapsular folds have been described also as meniscoid-like in nature[7,28], giving the impression of the presence of discs in the facet joints. In the facet joints of the cervical spine, Yu, Sether and Haughton (1987)[39] demonstrated four types of menisci, composed of dense connective tissue in children but collagen and fat in adults and diseased or damaged joints.

These rudimentary folds of synovial membrane within each facet joint move freely during movement of the joint[5,14,32] and can become entrapped between the moving joint surfaces. This may be the cause of the "locked" joint seen by physiotherapists, an advocated treatment being manipulation to free the entrapped tissue and hence the joint. These intracapsular folds contain blood vessels[14] and nerves[7,14,15,27]. The nerve supply is from the medial branches of the posterior primary rami of the spinal nerves[8,13,23,27,34,36], and is thought to have a nociceptive function[15], relaying the sensation of pain from the particular facet joint/s involved[8,27].

The orientation of the articular facets of the facet joints differs in the various regions of the vertebral column[23,26,36] (Fig.2), and is central to the type of movement/s which can take place at the joints[23,26,33]. An appreciation of this influences the choice of the movements used by manipulative therapists in the treatment of spinal problems. Considering the superior articular facets, for example, these are generally orientated superiorly and slightly posteriorly in the cervical spine; posteriorly and slightly laterally in the thoracic spine; and medially and posteriorly in the lumbar spine[23,26,33,36]. The specific orientation of the articular surfaces of the facet joints (Fig.2) allows the greatest range of motion of rotation and flexion/ extension in the cervical spine; of rotation in the thoracic spine, and of flexion/extension in the lumbar spine[9,23,36]. Despite the fact that there

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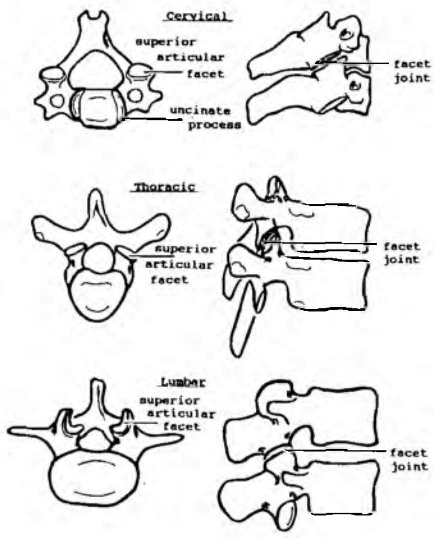

Fig 2: Facet joint orientation (superior and lateral views). (After Williams et al [36])

is very little rotation possible between each vertebra in the lumbar spine, rotation mobilisation is considered by many physiotherapists to be a most effective technique for the treatment of low back pain. This may be more because of the hysteresis effect of such mobilisations on the soft tissues involved rather than the movement of the facet joints themselves.

At the junctions between these regions, the orientation of the articular facets of the last vertebra of the region above will closely resemble that of the first vertebra of the region below rather than that which is typical of the particular region[23,36]. For example, the superior articular facets of the twelfth thoracic vertebra face posteriorly, as do those of the vertebrae above. The inferior articular facets, however, are orientated laterally, which is more typical of those of the lumbar vertebrae and which will effectively reduce the degree of rotation and increase the flexion/extension possible at this joint. This changing orientation of the articular facets will influence the stress patterns experienced in these regions of the spine. For example, many patients present with spinal pain in the thoracolumbar area, where degenerative patterns of these facet joints seen radiologically are typical of the particular stresses experienced here. These joints may become "locked" in flexion/extension, giving rise to pain and stiffness. These factors must be considered for the effective treatment of thoracolumbar dysfunction.

In the cervical spine, the paired intervertebral joints between the occiput and the first vertebrae (the atlas), known as the craniovertebral joints, are atypical in that they are not true facet joints[23]. These joints are paired synovial joints, but are of the condylar type[23,34,36]. The superior articular facets of the atlas, which articulate with the articular facets of the occiput, are larger than those of the vertebrae below, kidney-shaped and face anteriorly and medially. The inferior articular facets of the atlas are orientated inferiorly, medially and slightly posteriorly[23,34,36].

The equivalent joints between the atlas and axis (the second vertebra) are synovial joints of the plane type. A third joint exists between the atlas and axis where most rotation occurs. This is a synovial joint of the pivot type, between the dens or odontoid peg of the axis and the inner surface of the anterior arch of the atlas[23,34,36].

The third to seventh cervical vertebrae also have a second set of plane-type synovial joints, known as the uncovertebral joints[23,36]. These appear as a lateral lipping (the uncinate processes) along the lateral edges of the superior margins of the vertebral bodies, articulating with the inferior margins of the bodies of the vertebrae above[23,36] (Fig.2). The orientation of these small joints again play a role in determining the degree and direction of movements occurring in the cervical spine.

Clinically relevant biomechanics of the facet joints

Normal functional spinal movements, such as flexion, extension, lateral-flexion or side-bending and axial rotation[16,17,19,23,25,27,34,36], involving translation and rotation, can occur in any of the three fundamental planes (horizontal, sagittal and coronal), or a combination of these planes[19,23]. For example, flexion and extension occur in the sagittal plane, and lateral-flexion in the coronal plane, both movements involving gliding movements of the facet joints. Axial rotation occurs in a horizontal plane, around a vertical axis. It is restricted by the facet joints, particularly in the lumbar spine. This movement can be increased by a coupling of movements (e.g. lateral-flexion and flexion/extension) and a combination of the respective planes[2,19,23,27,35].

The range of movements possible between vertebrae in each of the cervical, thoracic and lumbar spinal regions is small, but the sum of the individual movements gives a considerable range of motion over the length of the vertebral column[19,23,27]. In the cervical spine, there is little measurable axial rotation between the occiput and the first vertebra[19,27], and no lateral flexion between the atlas and axis[3]5. Lateral-flexion is controlled between each of the remaining cervical vertebrae by the uncovertebral joints[23,27]. In the thoracic spine, the ribs limit this movement, while rotation is restricted to one to two degrees between any two vertebrae in the lumbar spine by the facet joints[19,23,27].

The forces which are exerted on the vertebral column during these normal functional movements of the spine are a result of compression (approximation), distraction (traction), shearing (translation/gliding), bending and twisting (rotation)[16,19,23]. Loading of the spine involves an increase in compression forces, absorbed mainly by the intervertebral discs and an increase in shearing forces at the facet joints[16,17], which are ideally situated in the individual vertebrae to absorb and support these shear forces[10,11].

The greater percentage of the compression forces are borne by the intervertebral discs[16,19,23]. The facet joints, however, play a major role in the control of these forces. That is, these joints provide stability to the spine, particularly in the cervical and lumbar regions[5,9,23,31], by restricting excessive movements of the vertebral column, which will damage the intervertebral discs[2,5,9,23,31,33], and, in the cervical spine, the vertebral arteries too, ultimately[31].

However, as with all synovial joints, the facet joints too can be deformed and damaged when overloaded. In order to minimise this, the forces on the spine are spread throughout the length of the vertebral column[17], and the activity of the paravertebral muscles, particularly, play a role in decreasing stress on the intervertebral joints. This helps to ensure the preservation of the spine as a stable yet functional unit[17]. The facet joints, therefore, allow mobility yet give stability to the vertebral column[23].

Nevertheless, abnormally excessive forces through these joints will result in trauma to both the facet joints and the intervertebral discs, leading to the signs and symptoms typically found by practising physiotherapists and other clinicians. The lumbar spine facet joints[18], for example, as well as the related soft tissues[18,20] have been implicated as a significant source in low back pain. Therefore, some knowledge of spinal kinematics is essential in an appreciation of normal movements and in the understanding and management of spinal problems[35].

Spinal biomechanics are studied in the neutral upright position when the normal spinal curvatures are taken into account. For instance, in erect standing, the majority of the compression forces pass through the intervertebral discs[16,19,24,25], particularly in the lumbar spine. Such compression forces, acting over a period of hours, cause a narrowing of the intervertebral disc spaces, an increase in pressure between the articular surfaces of the facet joints, and, if sustained, an increase in the normal lumbar spinal curvature[6,19,37]. These factors, and an increase in extension of the lower spine, lead to an increase in the impingement or degree of impaction of the inferior articular processes onto the superior articular processes and laminae of the vertebrae below[2,6,29,30]. This is because the facet joints cannot sustain vertically applied loads[6]. This may lead to the "locked" joint with associated pain and decreased movement, in the lower back, for example. Reversing the stresses on the joints by the use of traction and mobilisation of the joints, for instance, helps to relieve these symptoms.

Further studies of the lumbar facet joints[6,29,30,33] have shown that the anteromedial/coronal part (one third) of the facet joints (Fig.2) restrict excessive flexion of the spine by restraining the forward translational component of flexion; whereas the posterior/sagittal part (two-thirds) of the facet joints restrict excessive axial rotation. The axial rotation which occurs in the lumbar spine before impaction of the articular processes is, therefore, small[1,4,6]. An understanding of this is of particular relevance when using rotational movements of the lumbar spine in the treatment of low back pain, for example.

In this way, although the facet joints resist most of the intervertebral shearing forces in the lumbar spine, they share the compression load in the more lordotic postures[2]. In rotation, the facet joints protect the posterior part of the intervertebral disc by the facet surfaces taking up the forces due to the torsion. In flexion, the capsules of the facet joints further serve to protect the intervertebral discs by restricting excessive movements. However, the facet joints enhance the coupling motion of the vertebral column[2,19,23,27,35]. The facet joints and intervertebral discs, therefore, have distinct roles in the absorption and transfer of energy due to forces on the spine, both in maintaining postures and in locomotion, involving normal functional movements of the spine[17].

Sustained postures, particularly at the extremes of any range of motion, in any of the planes of motion, result in strain of the capsules, the ligamenta flava and the multifidus attachments, possibly leading to the symptoms of low back pain[2,21] experienced by many patients. Furthermore, sustained excessive compression forces, causing loss of vertebral height of the intervertebral discs if continued over time, will eventually lead to subluxation of the facet joints[12]. This, in turn, results in arthritic changes and pain.

Flexibility of the spine also depends, to some degree, on the elasticity in spinal ligaments, which decreases with age, thus making the vertebral column appear to be more stable[3].

In conclusion, a knowledge of the anatomy and an understanding of the biomechanics of the facet joints give an appreciation of the different spinal movements possible. However, there is still a great deal to be learnt about the efficient control of the forces acting on the vertebral column, and particularly at the extremes of the ranges of motion. This is evidenced by the on-going problem of spinal pain seen daily by many physiotherapists and other clinicians.

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