The Interpretation of Temporomandibular Joint Radiographs

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SUMMARY

This article is intended as a guide to the investigations, relevant findings and proper interpretation of radiography of the temporomandibular joints.

S. Afr. Med. J., **48**, 1905 (1974).

As most general radiologists see insufficient cases to become proficient in these investigations, close co-operation with the clinician is advocated.[1] The function of the temporomandibular (TM) joints is to allow movement of the mandible, especially during mastication when both joints work in harmony and within the limits dictated by the dental occlusion. The TM joints are hinge and sliding joints, elongated transversely and angled posteriorly, with the long axes forming an angle of approximately 150° to each other. The working surfaces are the articular eminences of the temporal bones and the condyloid processes of the mandible, between which discs are interposed, forming part of the insertions of the lateral pterygoid muscles. The muscles acting on the joints are the masticatory muscles and numerous accessory muscles belonging to the hyoid and cervical kinetic chain of musculature.

The aetiology of TM joint disease may be congenital and developmental anomalies, trauma, degenerative conditions, ankylosis, inflammatory, neoplastic and general disorders of bone, but functional disorders of the joints account for the majority of the problems.

X-ray techniques should include a minimum of two views at right angles projecting through the articular surfaces. Closed, at rest and open jaw positions should be included. Routine views should be the standard transcranial oblique views, lateral tomographs, occipitomental and Townes's projections. Other techniques may be employed to deal with specific conditions.

ANATOMY AND FUNCTION OF THE TM JOINT

The main function of the joint is to allow movement of the mandible during mastication but movement also occurs during deglutition, speech, coughing and with facial expression. The left and right mandibular condyles, rigidly connected by the body of the mandible, articulate with the cranial base. Both joints must be considered simultaneously since their excursions and limitations affect one another. A third component affecting articulation is dental occlusion. As the lower teeth make contact with their maxillary antagonists, the mandibular condyles will be forced to assume a relationship with the glenoid fossae, determined not by the components of the joints but by the cusps of the teeth and by muscle pull.

The articular component of the temporal bone is called the glenoid fossa, and is situated immediately anterior to the external auditory canal. It resembles a trough whose long axis is angled posteriorly so that a line extended medially will meet a similar line projected from the opposite fossa at an angle of between 145° and 160° at the anterior edge of the foramen magnum. The mandibular condyle resembles a cylinder whose long axis should coincide with the axis of the glenoid fossa. The condyle is attached to the mandible by a neck, which is narrowed anteroposteriorly with a depression on its anterior surface for the attachment of the lateral pterygoid muscle.

Two further structures should be mentioned: the articular tubercle and the postglenoid process.[2] The articular tubercle is a bony knob at the root of the zygomatic arch at the insertion of the temporomandibular ligament. It is lateral to and not part of the articular eminence which is the convex articular surface of the joint covered by cartilage.

The postglenoid process is formed by a ridge projecting as a cone-shaped prominence lateral to the posterior part of the glenoid fossa and immediately anterior to the external auditory meatus. The articular tubercle and the postglenoid process are directed laterally but may cast superimposed shadows on the anterior and posterior parts of the glenoid fossa respectively on radiographs.

The joint is the hinge and sliding type, divided into two completely separate joints by a fibrous disc or meniscus. The upper joint cavity is larger than the lower. In normal occlusion of the teeth, the head of the condyle (with the disc interposed) articulates against the fibrocartilage-covered posterior slope of the articular eminence and *not* the depths of the glenoid fossa. The thin translucent bone seen in the apex of the fossa when the dried skull is held up to a strong light confirms this. The mandibular disc is an elliptical cap fitting tightly over the condylar head. The anterior edge of the disc ends at the lowest point of the curve of the inferior surface of the articular eminence, and there blends with the tendinous attachment of the upper head of the lateral pterygoid muscle. This is of importance, because the lateral pterygoid muscle inserts into the mandibular disc, condylar head and neck, and thus the disc is moved forward with the condylar head when the mouth is opened. The disc changes shape

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and moves in relation to all the bony structures. It is thinnest in its centre and thickest at its posterior end. It is avascular and has little capacity for repair.

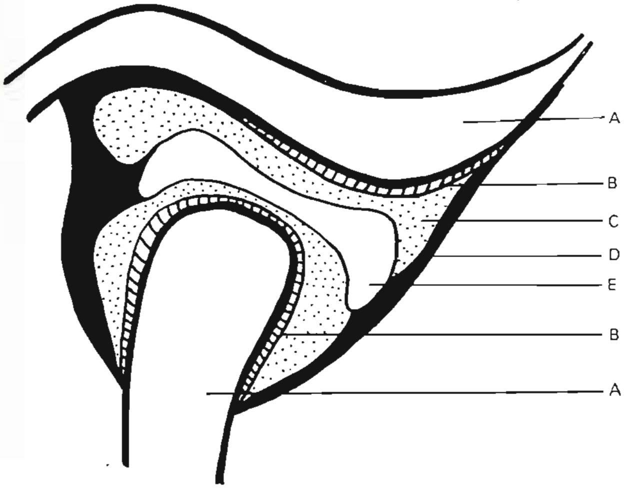

Fig 1. Anatomy of the temporomandibular joint. A = bone; B = articular fibrocartilage; C = joint space; D = joint capsule; E = fibrous disc.

GENERAL PATHOLOGY

The radiologist, after consultation with the clinician, should be able to decide which of the following entities he may be dealing with.

1. Congenital or acquired developmental anomalies of the jaws and facial bones.
2. Acute trauma. Is there a history of recent injury or surgery to the jaw or facial bones?
3. Non-traumatic and degenerative arthritides. Acute pyogenic infections are uncommon, but rheumatoid and osteo-arthritic conditions produce radiological signs and damage to the menisci. This group includes metabolic, atypical rheumatoid and rheumatoid-like conditions.
4. Ankylosis of the joint. This may be fibrous or bony, and follows on previous trauma or infection. It may be due to intra- or extracapsular conditions.
5. Local inflammatory, traumatic or neoplastic conditions of the mouth, antra, fauces or face.
6. Diseases of bone or cartilage, which will include a primary neoplasm, metastatic deposit, the reticuloses, avitaminoses, hormone disorders, e.g. acromegaly or hyperparathyroidism, Paget's disease and fibrous dysplasia.
7. Abnormalities of function due to adaptation to skeletal or dental abnormalities, or secondary to neurological diseases, e.g. in strokes or muscular dystrophies. Adaptation to skeletal or dental abnormalities will include internal derangements of the TM joints and the pain-dysfunction syndrome.

X-RAY TECHNIQUE

The basic principle is the same as applies to any joint, i.e. a minimum of two views at right angles to one another with the beam directed through the articulating surfaces. It is astonishing, however, how often one is presented only with the lateral oblique views by a radiographer who is unaware of any additional projections.

The choice of techniques will depend on the clinical problem. The first four procedures to be described should be routine, but some people will use the lateral tomograms only, in preference to transcranio-oblique views.

Dentures should not be removed.

25°-Angled Transcranio-oblique View of Each Side

The head is placed in the true lateral position with the side to be examined in contact with the cassette. Views are taken with the mouth open and closed. A small localising cone is used and directed 25° caudally. A wedge of 2,5 cm is useful to keep the mouth open. The normal mouth can open up to 3,8 cm between the incisor tips. For the closed position the patient clenches the molar teeth together. Modifications may include an additional film at rest, with the lips together but the incisor teeth separated by 2 - 3 mm; and an extra film with the jaw protruded, i.e. the lower teeth in front of the upper.

Short-distance techniques using a special cephalostat have also been devised with the film focus distance at 30 cm. The advantage is the erect position simulating natural posture and the blurring of overlying structures.

There are gravitational effects on the mandible with the head in a lateral position and this explains the necessity of the patient's being erect in order to record accurate rest films.

These films show the normal bone structure of the mandible and temporal bones and their articulating surfaces, the position and anatomy of the molar teeth, the laminae durae of the mandible, the pituitary fossa, the mastoids and soft tissue of the neck.

Lateral Tomograms

The head is again in a true lateral position and sagittal cuts are taken in the open- and closed-mouth positions or the additional positions mentioned above. The middle of the joint is approximately 2,5 cm deep to the skin surface, but this varies from 1,5 to 3 cm depending on the shape of the condyles. These films show the form and function of the joint and an abnormal mandibular condyle may be detected only in the tomograms. Erect lateral tomograms with an arc of approximately 11°, i.e. the rest position, can be taken if the apparatus is available, for the reasons given above.

Postero-anterior Projection

An erect occipitomental view (baseline 45°), with a 10° angulation of the tube to the feet, is taken. The mouth is kept closed and the central ray should emerge through the infra-orbital margin as for a standard sinus examination. This will show the normal anatomy and configuration of the articulating surfaces of both joints and the condyles. The films may be disappointing, however, when the condyles are obscured by prominent coronoid processes or zygomatic arches. An additional open-mouth view can be employed when ankylosis or limitation of movement of one side is suspected, and the discrepancy in movement between the two sides must be shown. Additional fractures of the facial bones or mandible, particularly of the anterior parts after a fall on the chin, may be seen.

Townes's Anteroposterior Projections

This is another method of showing both joints simultaneously. A 30° Townes's projection of the skull is taken, centring between the TM joints with the patient supine. Films are taken with the jaw open, using the mouth prop. This projection can also be combined with an anteroposterior tomogram, but here the mouth should be closed and at rest. Large mastoid tips may sometimes obscure the joints in this view. If the patient has trismus or limitation of opening, the Townes's projection may still be of value to show the necks of the condyles.

Submentovertical Projection

This should preferably be taken with a film focus distance of 1,8 m to avoid magnification, but 1 m FFD is still acceptable. The posterior rami of the mandible should be perpendicular to the film. Differences of symmetry of the mandible, additional fractures, and the anatomy of both condyles will be demonstrated.

Correction Angles

In this connection Yale[3] has described a technique for taking undistorted lateral tomograms by positioning the patient's head so that the central X-ray beam transverses the fossae in the same axes as the mandibular condyles. To take undistorted films, a preliminary anteroposterior laminogram should be done with opaque ear markers in the external auditory meatuses. From this film a transmeatal line is drawn by connecting both external auditory meatuses. The long axis of each condyle is determined and lines are drawn to cross the transmeatal line. This is called the vertical angle and may be positive, negative or zero. It is positive when the medial pole of the condyle is directed superiorly and negative when it is directed inferiorly.

On the submentovertex radiograph a transmeatal line is again drawn connecting the ear markers, and the horizontal angle of each condyle is measured by drawing lines through each condyle. These lines should meet at the anterior part of the foramen magnum.

From these measurements corrected tomograms can be taken in the erect lateral position with the mouth open and closed or at rest. If correctly done, a vertical radio-opaque band, caused by the continuation of the anterior ridge of the condyle, will be seen.

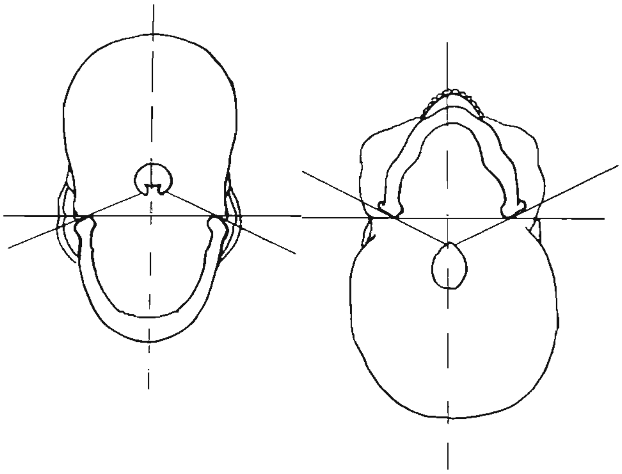

Fig. 2. Correction angles for lateral tomography (after Yale[3]). Left: **vertical correction.** Right: **horizontal correction.**

Anteroposterior Transorbital Technique[4,5] (Fig. 3)

This is valuable if the patient can open his mouth and if fractures of the necks of the condyles are suspected. The patient is examined while erect, with a wedge in position to open the mouth widely. The base line is parallel to the floor and the head is rotated 20° towards the side being examined. The chin is tucked well in. With a long cone the beam is directed 35° towards the feet through the orbit and perpendicular to the film on the horizontal plane. The examination is then repeated on the opposite side.

Cephalometrics

Lateral cephalograms are used for anthropometric evaluations of growth, both directional and quantitative, of the developing child. Its chief clinical application is the assessment of the interrelationship of dental occlusion to the jaws and other hard and soft tissues of the face. It is a useful tool in the prediction of profile after orthodontics or surgical correction of maxillary/mandibular relationships. In this article, lateral cephalometric study mainly deals with the anteroposterior maxillomandibular relationship, and has to be considered with the condyle/fossa relationship during normal mandibular posture (the so-called rest position); active closure of the mandible where the teeth determine the final condyle/fossa relationship; and habitual posturing as occurs in underdevelopment of the mandible when the patient may hold the mandible in an unnatural forward position for various reasons. These may be psychological because the individual is conscious of his shrew appearance and holds the mandible forward to disguise the deformity (the mandible may have to be protruded 5 times the normal distance to allow the incisors to meet), and to allow for articulation of the incisor teeth and the tongue during pronunciation of certain consonants (e.g. 'd', 't').

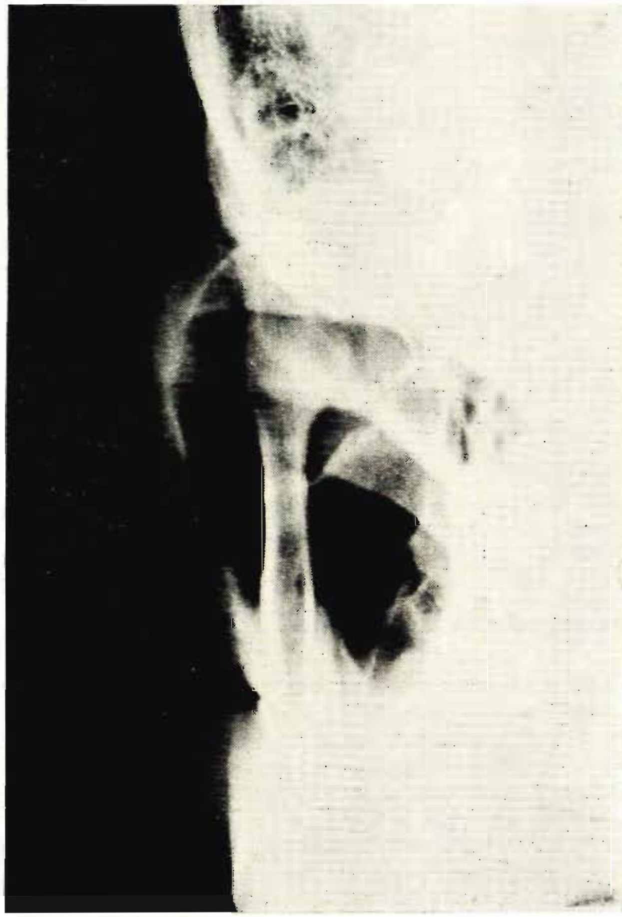

Fig. 3. Anteroposterior radiograph of transorbital view of condylar neck.

The lateral cephalogram is a true lateral skull radiograph, taken normally in a head frame with ear guides to position the patient in a true lateral position as close to the film as possible, i.e. with a fixed midsagittal plane/film distance. The tube is at 1,8 m to reduce distortion by enlargement. Ideally, exposures are taken to produce a soft and hard tissue outline, including the intracranial structures, with the mandible at rest and occluded. Various filters can be made to obviate the necessity for two sets of exposures and the necessity to mate the hard and soft films during tracing. A 1-mm copper filter cut to correspond to the soft tissues of the anterior part of the face can be placed on the cassette and has been successfully used to take hard and soft tissue films simultaneously. A true lateral skull X-ray film can be used if the necessary head clamps are not available. Here it is advisable to use markers in both external auditory meatuses, and to use a 1,8-m tube-to-cassette distance as before, to reduce error.

Ideally, the joint tomography and the cephalometric X-ray examination should be carried out simultaneously in the erect position.

The important landmarks in the cephalometric analysis are the centre of the pituitary fossa or sella turcica marked S (Fig. 4), the nasion (N), the most posterior point on the concave anterior surface of the maxilla (A), and a similar point on the mandible (B). By joining the points S and N, and N and B, and N and A, the anteroposterior jaw relationship can be judged by the difference in angles SNA and SNB. This normally falls within the range of SNB = SNA − 2° within the range of 1° difference. Average angles for adult Caucasoids are SNA = 82° and SNB = 80°. In a mandibular overgrowth there is an increased SNB angle and in a maxillary deficiency there is a reduced SNA angle. These measurements are of no significance unless the condyles are in a central situation in the glenoid fossa at the time of exposing the lateral head plate. This should be the rest position. Orthodontists use several other points of reference on the skull and measure angles between the molar teeth and the incisor teeth, but this information can be obtained from more specialised works.[5] From the measurements obtained, the degree of under- or overdevelopment of the maxilla and mandible relative to each other can be assessed. A cosmetic profile of the patient's appearance is obtained, and the trained orthodontist can obtain measurements which are a guide to the degree of malocclusion of the molar or incisor teeth.

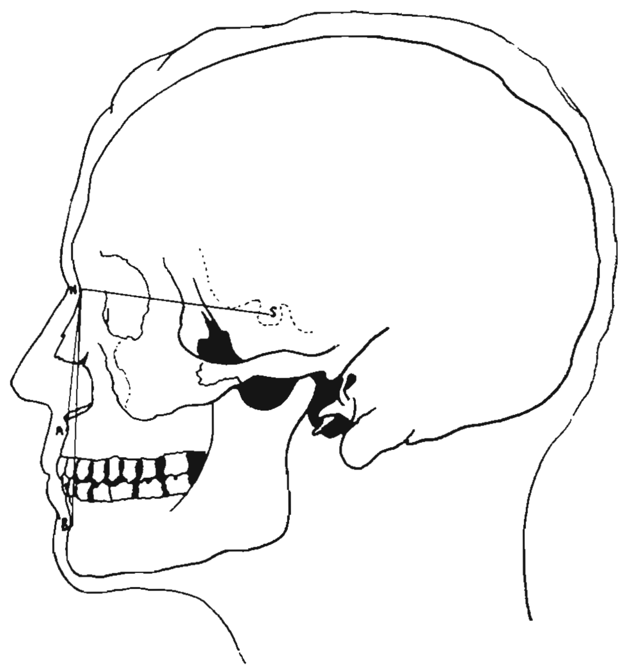

Fig. 4. Lateral cephalogram at rest. S = centre of pituitary fossa; N = nasion; A = maxilla; B = mandible (see text).

Panoramic Radiography[7-10]

This shows the entire maxillomandibular region on a single film, gives a very good view of the ascending rami with their condyloid and coronoid processes, and is of particular value in fractures of the condylar necks and for showing cysts and osteomas of the mandible and maxilla, as well as generalised disorders of bone and malformation of teeth. Units available are the Panorex, GE 3000 and the Orthopantomograph. The disadvantages are high cost and greater space requirements, and the unit must be purchased in addition to existing equipment.

A big advantage is that tomography is carried out with the patient relaxed and in an erect position. The tomographic principle is either fixing the tube and turning the patient's head around a vertical axis with the film moving in another rotational axis or, as is more common now, the patient remains stationary while the tube head and film holder assembly move. In the GE 3000 model the tube axis follows a semi-elliptical path, since the mandible and maxilla do not form a true circle but follow varying degrees of parabaloid curvature.

Arthrography

This procedure is well documented by Campbell.[11] He is of the opinion that the technique is hazardous, with dangers of infection, haemorrhage from the superficial temporal vessels and aggravation of the patient's disability, and that it is painful. He has come to the conclusion that there is no further justification for the procedure with the successful advent of condylotomy (not to be confused with condylectomy, removal of the head and neck). Briefly, the technique consists of injecting 30% Pyelosil (Glaxo) into each joint cavity, starting with the lower because the upper joint cavity covers it like an umbrella, and obscures the detail. Films are then taken in the open- and closed-mouth positions, using lateral tomography and lateral oblique projections, as described above.

Screening, Cine Films, Kymography, Stereo Techniques or Dental Films

These methods are not often used, but are useful for assessment of function and the range of movement. Dental films may be indicated for specific dental problems, e.g. periodontal conditions associated with functional malocclusions, or to show the loss of lamina dura in hyperparathyroidism.

INTERPRETATION OF RADIOGRAPHS

The interpretation of radiographs is difficult because of the wide variation in the normal anatomy as well as in the width of the normal joint space. There is also considerable asymmetry and variation in the broad functional range of normal joints. One must guard against tailoring the radiographic evidence to fit the clinical symptoms. Women normally have shallower joints than men. The fossa deepens with age and then becomes shallower again with senility (regressive remodelling). The condyle at rest is located in a well-centred position in the fossa and the articular surfaces are smooth. The normal head is well mineralised with a continuous white cortical line. Ricketts[12] has given average dimensions of the temporomandibular joint space, based on an analysis of laminograms of normal subjects, as follows: anterior surface of condyle to articular eminence: 1,5 mm; top of condyle to floor of fossa: 2,5 mm; and posterior surface of condyle to a vertical line through the middle of the external auditory canal: 7,5 mm.

There is a great variation in the shape of the condyles in the inferosuperior and anteroposterior planes. Yale[13] has classified basic mandibular shapes as convex, angled, flat or round (Fig. 5).

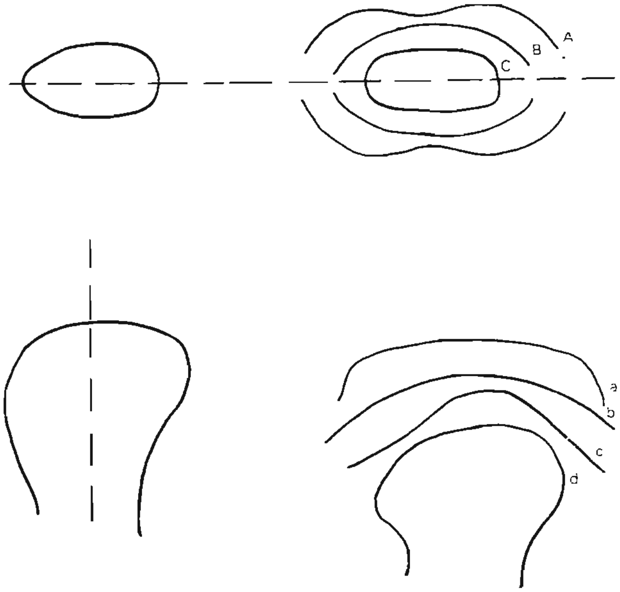

Fig. 5. Basic mandibular shapes. Superior view: A = **concave;** B = **convex;** C = **flat.** Posterior view: a = **flat;** b = **convex;** c = **angled;** d = **round.**

SPECIFIC FEATURES OF DIFFERENT PATHOLOGICAL ENTITIES

Congenital and Acquired Developmental Conditions

Sarnat[14] has produced tables which give the causes of underdevelopment and overdevelopment of the TM joint and mandible, either unilaterally or bilaterally. Osteoma is said to be the commonest neoplastic condition of the coronoid or condyloid processes.

Acute Trauma

Fractures may involve the condylar head within or outside the capsule, and they may be open, closed, greenstick, comminuted, complicated or impacted. Rarely do vertical fractures occur. Intracapsular fractures (involving the head only) may progress to either fibrous or bony ankylosis. A common finding is the fracture dislocation of the condyle, where the lateral pterygoid muscle pulls the condyle anteriorly and medially into the pterygoid fossa. Contra-coup fractures involving the opposite condyle or the horizontal rami in the canine or symphyseal regions may be present.

Tears of the meniscus may be classified into two types:

1. Anterior capsular tears will result in the meniscus slipping backwards and blocking closing movements of the mandible. This injury can be produced when trauma

is anticipated and a direct blow displaces the mandible posteriorly. The tense, contracted lateral pterygoid muscle tears the anterior wall of the capsule from the meniscus.

2. In posterior capsular tears the meniscus is torn from the capsular attachment as the capsule is carried posteriorly by a blow. Posterior tears of the capsule can result in an anterior dislocation of the meniscus, with blockage of both opening and closing. Tearing of the posterior attachment of the disc can also be due to repeated compression of the retrodiscal tissues by the retruded condyle.

In cases of traumatic arthritis the trauma must be severe enough to cause synovitis with pain, swelling, effusion and dysfunction in order to produce symptoms. The injured joint must be the only one affected, with normal joint function before the injury to substantiate the diagnosis. The signs may be negative. Effusion into the upper joint cavity may produce widening of the joint space posteriorly. In severe trauma, articular changes may develop progressively over 3 - 6 months (see under Degenerative Arthritis). Concomitant injuries may be present, e.g. to cervical spine or cranium.

The commonest operations undertaken in this region are meniscectomy with or without paring of the condylar surfaces, condylotomy, split condylotomy or condylectomy, in addition to specific therapy directed towards fracture correction. Routine views may have to be restricted because of splinting of the jaws or limitation of movement, but the first four routine views should be attempted.

Acute dislocation with displacement of the condylar heads anteriorly is a clinical diagnosis, but usually requires radiographic confirmation. Recurrent dislocation may be associated with disc and capsular injuries as described above. Superior dislocation into the middle cranial fossa can occur.

In the normal joint the disc changes shape during translation, and translatory movements occur in both compartments (a) and (b) in Fig. 6. Depending on the relative positions of the condylar head and the disc, the circumstances depicted in Fig. 6 (c-g) may arise.

Non-Traumatic and Degenerative Arthritis

Osteo-arthritis: This occurs mainly in subjects over the age of 40 years, and can be the end-result of a pain-dysfunction syndrome. The TM joint is not a weight-bearing joint, and if dental occlusion is satisfactory should not be liable to trauma resulting from thrust on the articulating surfaces of the joints. The X-ray findings may be negative but may show evidence of disc narrowing with some secondary bone sclerosis and loss of the smooth contour of the condylar head. Perforation of the disc is a common sequel and in advanced cases may lead to ankylosis. Osteo-arthritis can be asymptomatic even with extensive joint damage.

Rheumatoid arthritis: The incidence of TM joint involvement in several series varies from 51% to 4,5%.[16,17] Early cases show negative findings. A characteristic feature of the disease, particularly in juvenile chronic polyarthritis, is juxta-articular resorption of bone. This can cause shortening of the ascending rami, limitation of movement and, depending on therapy and duration of the illness, ankylosis. The resorption of bone causes the condylar head to be repositioned posteriorly and superiorly and can cause secondary premature contact of the posterior teeth with an anterior open bite. A recent study[18] showed 79% of rheumatoid arthritic cases to have surface and pocket erosions, flattening of the

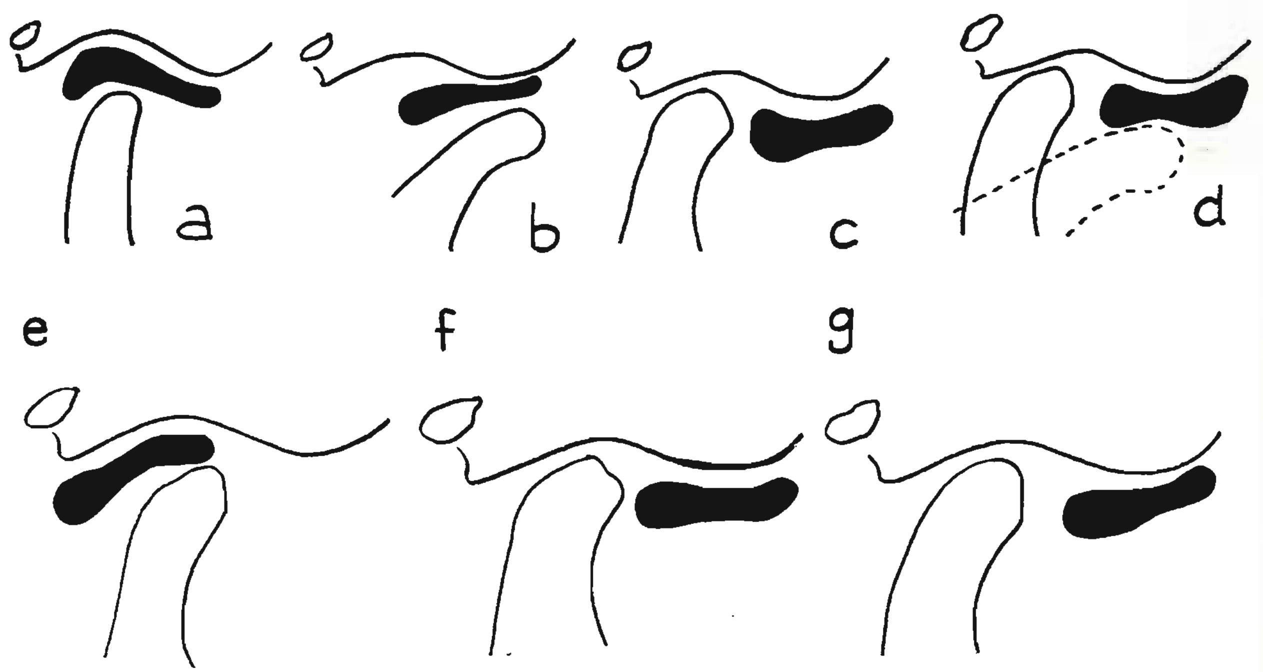

Fig. 6. Disc changes in a normal joint: (a) the normal joint with the mouth closed; (b) the normal joint with the mouth open; (c) posterior displacement of the mandibular condyle; (d) excessive forward movement occasionally associated with this displacement; (e) forward displacement of the mandibular condyle associated with complete backward dislocation of the mandibular disc; (f) anterior dislocation of the mandibular disc; (g) the failure of translation of the mandibular condyle when the mouth is opened in anterior dislocation of the mandibular disc.

condyles and marginal proliferations. An osteo-arthrosis that mimics rheumatoid arthritis has been described in middle-aged women, but is usually self-limiting and regresses over 1 - 3 years.[19]

The rheumatoid-like conditions include ankylosing spondylitis, psoriatic arthritis, systemic lupus erythematosus and Reiter's syndrome, where the joint changes begin in the synovial membrane. Metabolic conditions are best typified by gout, pseudogout and ochronosis.

Ankylosis of the Joint

This can be intra- or extracapsular. In intracapsular ankylosis there will be loss of joint space, sclerosis of the adjacent bony surfaces, or limitation of movement. Extracapsular ankylosis is most commonly due to disturbance of the coronoid-zygomatic arch relationship, e.g. enlargement of the coronoid process or a depressed fracture of the zygomatic arch.

Generalised Disorders of Bone

The findings will depend on the nature of the bone lesion. Dick and Jones[20] have reported TM joint changes in 6 patients undergoing haemodialysis for chronic renal disease. The changes are accepted as being due to secondary hyperparathyroidism and show various features of bone loss of the condylar heads and necks, subarticular cysts or generalised bone demineralisation.

Abnormalities of Function

This may be a normal variant or secondary to facial or dental abnormalities, e.g. a malocclusion or repeated protrusion of the mandible to compensate for a receding chin. Dysfunction may be associated with muscle diseases, e.g. progressive muscular dystrophy, myotonic muscular dystrophy and myasthenia gravis; degenerative diseases, e.g. motor neuronic disease, syringomyelia, dyskinesia, Parkinson's disease, central nervous system neoplasms, cerebrovascular disease or inflammatory diseases such as encephalitis.

The TM joint dysfunction syndrome was first described by Costen[21] in 1934 and was known as Costen's syndrome until the term 'pain-dysfunction syndrome' was coined by Schwartz[22] in 1956. This condition, implying facial pain and TM joint dysfunction, accounts for the majority of these joint problems. It occurs predominantly in females, and stress and tensional factors seem to play a great role. Most symptoms would appear to arise from muscle spasm due to morphofunctional dysharmony, and this in turn may cause meniscal injuries or TM arthritic changes. Malocclusion is certainly a factor.

X-ray findings are negative in the vast majority of cases, but a full investigation is required to exclude the other pathological entities, and there may be radiological evidence of disc damage in some cases.

As previously described, each TM joint forms one point of the functional masticatory triangle, consisting of the two TM joints and the dental occlusion. Each one of these points affects the other two.

The final intercuspal occlusion of the upper and lower teeth (centric occlusion) may displace one or both condyles in the following ways: (*a*) forced posteriorly—distal thrust; (*b*) forced anteriorly—mesial thrust; (*c*) forced superiorly, as in loss of the posterior teeth owing to the fact that the main elevators of the mandible pull directly over the molar area; and (*d*) lateral thrust may occur but can only be detected clinically.

The disc moves relative to both condyle and fossa, so that when the condyle is thus displaced it may trip over the disc with a snapping sensation. These changes in the condyle/fossa relationship are readily demonstrated if X-ray films are taken at rest (in the erect posture) and in the closed and open positions.

The posterior (molar) cusps may provoke interference during functional movement. These upset the normal mechanical rhythm of the condyles and muscular action during chewing. These interferences are particularly damaging to the articular surfaces of the temporomandibular joint and to the periodontium as shown in alveolar recession, pocketing or funnelling at the coronal end of the periodontal space. No radiographically demonstrable changes occur in the joint until the degenerative process results in pitting and sclerosis of the articular surfaces.

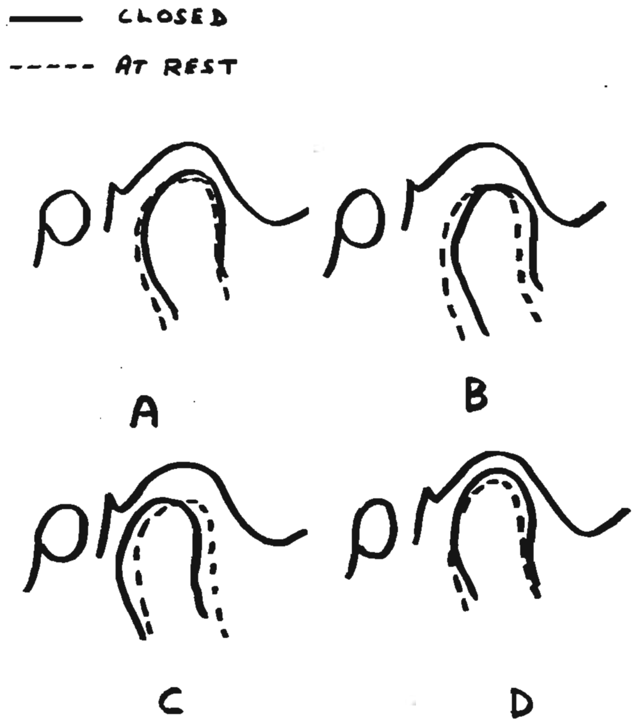

Fig. 7. Relative positions of the condyle in the fossa. A: normal articulation. B: condyle anterior—(*i*) forward jaw posture in compensated retrognathia or micrognathia; with normal occlusion or at rest the condyle may move posteriorly; (*ii*) forward thrust from cusp interference; (*iii*) anterior rupture of the capsule with posterior retraction of the disc. C: condyle posterior—(*i*) distal thrust from tooth/cusp interference; (*ii*) posterior rupture of the capsule; forward movement of the condyle not possible if due to interferences from the disc anteriorly. D: condyle superior. Loss of posterior teeth and muscle action elevates the condyle.

TABLE I. POSSIBLE RADIOLOGICAL FINDINGS IN DISTURBED CONDYLE/FOSSA RELATIONSHIP
(Using lateral tomograms occluded and at rest)

Condyle position	Joint space	Possible diagnosis	Additional investigations
1. Condyle central	Joint space normal	Normal joint	Depend on clinical problem
2. (a) Condyle central	Joint space normal	Interferences during function	1. Check cephalogram for (i) flat occlusal plane; (ii) class III malocclusion (prognathia), and (iii) incisal relationships (particularly retroclination of maxillary incisors) 2. Do dentals for pocketing and widening of periodontal space (which occurs in lateral cuspal interference)
(b) Condyle central	Joint space narrowed superiorly	Loss of posterior support to occlusion	Check cephalogram for loss of molar teeth
(c) Condyle central	Joint space widened generally	Effusion, trauma and sepsis	Check history for trauma, sepsis of adjacent structures or blood spread
3. (a) Condyle anterior	Joint space wide posteriorly	Limitation of disc translation on this side on opening. Exclude anterior capsular rupture with posterior disc displacement	History of trauma
(b) Condyle posterior anterior	Joint space normal or wide posteriorly in occlusion	Limitation of opening, marked or slight — could be forward thrust	1. Do erect tomograms at rest. The condyle should move posteriorly 2. Check cephalogram for loss and tilting of posterior teeth and over-eruption of opposing teeth 3. Check cephalogram for maxillomandibular relationships
(c) Condyle markedly anterior	Joint space wide posteriorly in occlusion	Gross micrognathia and forward posturing of the mandible	1. The condyle is low down on the articular eminence in the closed tomogram 2. The condyle is central in the erect tomogram at rest or shows an improved relationship of condyle in the joint 3. Pressure over the point of the chin (retrusion) allows it to assume a normal position 4. Marked cephalometric difference in occluded and rest positions
4. Condyle posterior	Joint space widened anteriorly	Limitation on this side on opening: exclude posterior capsular rupture with anterior displacement of the disc	History of trauma
		Distal thrust from dental occlusion	1. Do rest erect tomography. If the condyle is central this confirms the diagnosis 2. Check cephalograms. Posterior inclination of the maxillary incisors will confirm. Look for missing teeth and over-eruption of the opposing teeth

Postural Derangements

These occur when the condyle is habitually postured in a forward situation along the articular eminence. This occurs in retrognathic or shrew mouth, and may be adopted by the patient to achieve correct cuspal interdigitation for mastication. It is also used to maintain the pharyngeal airway and to assist in the pronunciation of consonants, 's', 'd' and 't', and for psycho-aesthetic reasons where forward posturing of the jaw disguises the weak or shrew chin. Ligament stretching results and subluxation and later recurrent dislocation may occur.

Sometimes there is limitation of movement of one joint resulting from trauma, sepsis, surgery, dysfunction or degenerative changes, which leads to hypermotility in the other joint in order to maintain function. During the growing period deformity of the occlusion may result from forward growth of the one side of the mandible. Any of these situations may in turn lead to internal derangement. The key to diagnosis is limited movement in the symptomless joint. The X-ray findings are best illustrated in a diagram showing the relative positions of the condyle in the fossa (Fig. 7). When the condyle is forced anteriorly or posteriorly by the dental occlusion, the disc may be displaced, allowing the condyle to ride over the anterior or posterior edge with resultant changes in both the arthrographic and tomographic appearance. Table I lists the various findings in disturbed condyle/fossa relationship.

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