

A CLINICAL INVESTIGATION OF REMOVABLE PARTIAL DENTURES.

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Summary of the Literature in Relation
to Removable Partial Dentures

Consequences of Tooth Loss

Tooth loss may cause phonetic and aesthetic disturbances and progressive changes in the whole masticatory apparatus. (1)

Speech may be impaired by the loss of upper or lower anterior teeth, the labio-dental and dental sounds being affected. The labio-dental sounds such as F, V or PH require a contact between the lower lip and the incisal edges of the upper teeth. Similarly, dental sounds such as TH, Ch, J, S or Z require intact upper and lower anterior arches; loss or wrong position of anterior teeth can result in phonetic impairment. (2)

The aesthetic factor caused by tooth loss has been shown as the major driving force in patients seeking partial denture service, reduced masticatory function being a secondary consideration. (3)

The loss of one or more teeth has been shown to have a destructive effect on the periodontium of the remaining teeth through their over-eruption, drifting and tipping, with consequent creation of masticatory stress and food impaction. (4)

Teeth adjacent to the extracted tooth tend to move towards the resultant space causing a loss of contact points and food impaction. (5)

Teeth in normal masticatory function are surrounded by strong connective tissue fibres. (6) The tooth without occlusal contacts tends to erupt or elongate, has few periodontal fibres, and is loosely attached to the alveolus which shows signs of resorption.

Migration and elongation of the teeth often causes occlusal disharmonies. (7)

Tooth drift occurs towards the edentulous space quite often by a tilting action, cuspal inclines become relatively increased and out of harmony with the remaining dentition. As occlusal disharmony develops, an effect can be felt during contact in the masticatory action, or in an eccentric glide which can be annoying, irritating or painful. The individual reduces the scope of the masticatory movement to avoid the interferences. These inclinations can continue to change and interfere to such an extent, that ultimately open and close movements only are performed. Overeruption and elongation of the tooth or teeth opposing an edentulous space can cause interference with normal movements as a result of the change of the relationship of the erupting tooth to the occlusal plane. Slight overeruption can place some restriction on the masticatory function of that side.

Further eruption produces an increased restriction on the working side, but when mastication is performed on the opposite side of the mouth, the interference is more severe by comparison, because the balancing side exhibits more lateral and forward movement than does the working side. Should function be limited by further eruption, normal closure may become difficult. The patient then will attempt to find a closed position which is more comfortable by deviation in any direction.

Early construction of a partial prosthesis can prevent such disharmony in the masticatory mechanism or can help maintain occlusal balance after occlusal correction has been initiated. Masticatory function is reduced by tooth loss from the dental arches. The loss of the first molar from every half of the jaws reduced masticatory efficiency by 30% when compared with a full dentition. (8)

Patients with reduced masticatory efficiency swallow food in large portions, so that the food is in a coarse form poorly mixed with saliva. (9)

Farrel⁽¹⁰⁾ demonstrated that the degree of mastication of food has very little effect on the digestion of most foods. However, one of the pleasures of life include the ability to masticate thoroughly and efficiently in order to enjoy fully ones daily dietary intake. Loss of masticatory function cannot be accepted as being unimportant to the patient's general well being. Restoration of masticatory efficiency and prevention of developing occlusal imbalance and its possible sequelae can be attained in many instances by the construction of suitably designed removable partial dentures.

Tooth Replacement

There are many methods of prosthetic replacement for unavoidable natural tooth loss. The choice of method must be assessed for the individual case.

Important factors are the condition of the remaining teeth, the number of the remaining teeth and the condition of the gingivae, periodontal membrane and alveolar bone. Economic considerations may dictate other than an ideal form of treatment. Personal factors, namely oral hygiene, intelligence, motivation for wearing the prosthesis, and general health are of paramount importance for a favourable prognosis.⁽³⁾

The choice after careful assessment may be -

1. Fixed bridge.
2. Partial denture incorporating precision attachments.
3. Partial denture cast metal skeleton of cobalt-chromium alloy or gold.
4. Partial denture of acrylic resin base with wrought or cast connectors and metal components.
5. Training denture of acrylic resin as a prelude to future full denture construction.
6. No partial prosthesis.

Before initiating action for any of the above prostheses, the treatment should be considered necessary. The patient must be taught adequate oral hygiene, and be examined frequently so that the standard is maintained. ⁽¹¹⁾

Many investigators have shown improved masticatory efficiency can be considerably enhanced by partial dentures, maximum efficiency being attained approximately one month after denture insertion. ⁽⁸⁾ The fit of the dentures must be good to provide their practical efficiency during mastication. ⁽¹²⁾⁽¹³⁾ The partial denture can assist to preserve the remaining dentition when used as a unit to re-unite and stabilize the entire arch. ⁽¹⁴⁾⁽¹⁵⁾⁽¹⁶⁾ The denture in this instance helps to preserve the remaining dentition by its splinting action, maintains continuity of contact points between the teeth, and at the same time stimulates the periodontal tissues.

Some authors consider the partial denture as a foreign body which may cause damage to the wearer's mouth. ⁽¹⁾ Gingival coverage and inadequate oral hygiene are significant factors in promoting gingival inflammation. Where a tooth is involved in denture design, the periodontal condition often deteriorates. The possibility of periodontal damage can be minimised by adequate design of the partial denture. The denture should have minimal bulk, involving the minimal number of teeth in the design consistent with attaining adequate lateral and vertical support. ⁽¹⁷⁾ Oral hygiene must be excellent and maintained including thorough and frequent cleansing of the denture base.

Periodontology and Partial Denture Prosthesis

Koivumaa ⁽¹⁾ noted differing views on the nature of the gingival pocket, and demonstrated estimates of normal pocket depth vary from 0mm upwards. Clinically, a depth of 2-3mm is accepted for a normal pocket. The normal pocket may become pathological either by inflammation or trauma which produces deepening of the pocket. ⁽¹⁸⁾

Plaque⁽¹¹⁾ is a community of living organisms glued to the tooth in maximum concentration by the cementing substance. The inhabitants of the plaque produce enzymes and endotoxins which are responsible for the inflammatory reaction in the soft tissues.

A. Steps to reduce gingival inflammation

Plaque elimination should include adequate mouth preparation prior to taking impressions.⁽¹¹⁾ Adequate oral hygiene must be taught including cleansing of the partial denture to prevent plaque adherence to the components. The design of the cobalt chrome denture skeleton should avoid the free gingiva where possible.⁽¹⁷⁾ The patient should be instructed not to wear the denture at night.⁽⁴⁾

B. Factors affecting thickness of periodontal membrane

Periodontal membrane thickness varies with age, the aged having a thinner membrane than the young. Teeth in heavy function have a thicker periodontal membrane than teeth without an antagonist; unerupted teeth have thinner membranes than either of the above.

Loose mobile teeth have thickening of the periodontal membrane. Malposed drifting teeth have a thinner periodontal membrane towards the side where the tooth is moving (pressure) and a correspondingly wider membrane on the opposite side (tension).⁽¹⁹⁾

C. The effects of force on periodontal membrane

De Van⁽²⁰⁾ experimentally demonstrated that a large axial force was required to move a tooth 1/1000th of an inch, but a small transverse force accomplished similar movement. The teeth were invested in rubber, simulating the periodontal membrane. Teeth can withstand approximately eighteen times the load vertically as against when the load is applied laterally.⁽²¹⁾ When horizontal force affects a tooth, the result is a combined one of pressure, pull and torque. Accordingly, lateral stresses should be avoided in partial denture prosthesis.

D. Tooth Mobility

Increasing mobility of the teeth is considered an early symptom in periodontosis and various attempts have been made to measure tooth mobility.

Muhlemann⁽²²⁾ by means of a calibrated dynamometer was able to determine tooth mobility within an accuracy of .005mms with a range of 0-1.5mms. He set the limit of physiological mobility at .25-.30mms for adults and maintained movement in excess of this figure indicates pathological changes have occurred.

Changes in the Mucosa of the Edentulous Parts of the Alveolar Ridges and the Palate.

Mechanical trauma is the most important factor producing chronic inflammation in mucous membranes underneath dentures.⁽²³⁾ Mechanical trauma may arise from instability, traumatizing centric occlusion and traumatizing articulation. A factor responsible for the mucosal changes arising in connection with dentures is evidently the absence of the stimulating and cleaning action of the tongue and the muscles at sites covered by the dentures.⁽²⁾

Carlsson⁽⁴⁾ emphasises the severity of damage to the underlying mucosa in partial denture wearers, when trauma caused by fracture of occlusal rests or non-compensated alveolar resorption allows saddles or components of the denture to bear unduly on the underlying tissues. The denture base (saddles) should be extended over as wide an area as possible to distribute pressure evenly to as large an area of tissue and alveolar ridge that is available.⁽²⁴⁾

Changes in the Alveolar Process

Lytle⁽²⁵⁾ states -

"Often the first sign of destruction of the residual ridges under ill-fitting dentures is the deformed and traumatized condition of the soft tissues where there has been excessive pressure."

He demonstrates reparative processes when the traumatic condition is removed. Local resorption of bone and inflammatory osseous changes occur when a load exceeding physiological tolerance limits must be borne by abutment teeth,⁽¹⁴⁾ but continuous resorption may also occur in areas where teeth have been lost and which bear the denture saddles.^{(14) (26) (27) (28)}

Applegate⁽²⁹⁾ uses "Bone Index Areas" to assess alveolar bone, and when there is doubtful alveolar support he advocates splinting of abutments, reduce the occlusal table and use of a conditioning therapy to reverse disuse atrophy. He suggests using dentures with very narrow molars and possibly using soft lining materials within the base.

McKevitt⁽³⁰⁾ described the following types of alveolar bone using a constant radiographic technique.

1. Hypercalcaemic
2. Normal
3. Hypocalcaemic

He postulates some resorption is to be expected in groups 2 and 3 with denture prosthesis since these groups have a greater tendency to atrophy.

He describes three types of bone atrophy.

1. Uniform alveolar atrophy, where uniform rapid resorption occurs throughout the ridges. The bone is hypocalcaemic, resorption is quicker than bone apposition and equilibrium is unattainable.
2. Serrated Mandibular Atrophy. The end result is a thin, high ridge, the bone is hypercalcaemic.
3. Mixed Alveolar Atrophy and Hypertrophy. The end result is a flabby ridge, because here the soft tissues are not atrophied, but remain in position.

Systemic diseases such as carcinoma, diabetes and nephritides produce more severe alveolar resorption.⁽³¹⁾ Disturbance in protein metabolism is thought to interfere with osteogenic activity. Calcium deficiencies are evidenced in the frequent finding of osteoporosis and a negative calcium balance in the aged.⁽³²⁾ These are especially prevalent in the post-menopausal female. Diminished gastric acidity greatly reduces calcium absorption. Decreased activity, especially if abrupt (as after accidents or ailments), results in negative calcium balance evidenced as osteoporosis, especially prevalent in post-menopausal women. Dietary intake of milk and milk products plus vitamin D (400-1000 units daily) is prescribed. Milk in acidulated form is especially valuable to compensate for low gastric acidity, to soften the curd, promote digestion and to increase solubility of calcium salts.

Some essential factors for ridge preservation include ⁽³³⁾

1. Adequate denture base coverage.
2. Diminish the occlusal table.
3. Exactness of occlusal equilibration.
4. Relining, rebasing of saddles as required.

Principles and Concepts in Modern Partial Denture Prosthesis.

Occlusion

There can be changes in the occlusion due to tooth loss, tooth wear and tooth movement.⁽³⁴⁾ During partial denture construction, the artificial teeth must be brought into physiological harmony with the remaining dentition. The tooth form of the remaining dentition may require modification.

Where there is excessive inter-occlusal distance, an occlusal splint produces marked improvement in muscle function, the construction of a prosthesis to maintain the corrected vertical dimension maintains this functional improvement.

Points to consider for the occlusion are -

1. Equilibration prior to constructing the prosthesis.
2. Correcting occlusion with the dentures.
3. Maintenance of the occlusion during subsequent wear.

Gilson⁽³⁵⁾ states it is rare to have centric occlusion (maximal intercuspation) coinciding with centric relation. He designates centric occlusion "the median contact position" and centric relation "retruded contact position". The occlusion should be adjusted to provide freedom of movement from median contact position to retruded contact position and establish maximum contact in retruded position.

Mandibular movements should be studied on an adjustable articulator.⁽³⁶⁾ Quite often lateral and protrusive excursions can be greatly improved by slight occlusal adjustment. Traumatic contacts can produce alveolar resorption under saddles and excessive stress on abutment teeth.

Beyron⁽³⁷⁾ comments on Functional Optimal Occlusion:

"The load should be distributed through interproximal contact in centric position among all teeth and in eccentric position primarily among the teeth in the engaged tooth segment. The mandible on closing into the intercuspal position should close without interference. Rest position and intercuspal position interval must be maintained.

A form of occlusion in excursive movements permitting multi-directional gliding movements is best. Balancing side contacts are not necessary, in fact should excessive balancing side contacts exist they may obstruct free-gliding movement."

Functional occlusal harmony of the masticatory system should include -

1. Axial stress parallel to the long axis of the teeth (physiological requirement).

2. Stress should be distributed over the entire arch.
3. Closure into the intercuspal position without interference.
4. Proper occlusal vertical dimension.
5. Free gliding movements eccentrically without interference.

Occlusal imbalance can arise from -

1. Tooth drift.
2. Over-eruption.
3. Loss of tooth contacts.
4. Under-contouring of restorations accompanied by steep enamel walls.
5. Cross-bite relationship.

Degrees of occlusal imbalance may be summarised by -

1. Restriction of masticatory performance.
2. Deviation in opening or closing.
3. Deviations in contact position.
4. Restricted occlusal contact (posterior tooth loss). The condylar head moves superiorly in the glenoid fossa.
5. Restricted occlusal contact and deflecting inclines.

Occlusal imbalance may affect either the teeth, muscles of mastication or the temporo-mandibular joints, or all three of these structures.

The degree of severity of signs and symptoms include -

1. Radiographically a thickened periodontal membrane with maximum thickness towards the dento-enamel junction in the affected teeth.
2. Restriction of scope of masticatory cycle.
3. Deviation in opening and closing. Lateral deviation may be observed visually, forward and backward deviation are difficult to observe.
4. Deviation from the normal closure changing the position of centric occlusion.

The most frequent symptoms are -

1. Pain, stiffness and restriction of opening movements (masseter, temporalis).
2. Clicking or pain in the temporo-mandibular joints. Lack of posterior support can cause condyle displacement affecting the lateral pterygoid muscle fibres.

Treatment procedures⁽³⁸⁾ for occlusal imbalance include -

1. Observation of jaw movements, deviation right or left mandible.
The degree of pain, deviation of opening and maximum opening should be recorded each visit.
2. Study of the occlusion. Study casts should be mounted on an adjustable articulator with a centric record of the jaws slightly apart and completely relaxed. An evaluation should be made of the stability of the occlusion and observe the distribution and angulation of the teeth and the type of occlusion.
3. The temporo-mandibular joint mechanism.

Occlusal imbalance causes changes in muscle action producing deviations in function and may produce clicking joints. Palpation suggests areas for referred pain, e.g. masseter, temporalis, lateral pterygoid.

The dental examination may demonstrate -

- (a) Occlusal prematurity.
- (b) Limited unilateral support.
- (c) Lack of posterior support.
- (d) Overclosure.

(a) When the surgeon taps the teeth together in centric relaxed position, there is a characteristic contact sound, which is greatly reduced if premature contacts exist. Occlusal indicator wax can be used to determine the existence of premature contacts or to determine whether contacts are adequate for function and stability. Articulating paper shows distribution of contact markings in relaxed centric relation and one can determine stability or deflection in the position.

(b) Limited unilateral support. Muscle hyperfunction may accomplish jaw repositioning to restore tooth contact to the detriment of the temporo-mandibular joint.

(c) Lack of posterior support. Function may be attained by muscle action moving the mandible forward which may create possible temporo-mandibular joint disturbance.

(d) Overclosure caused by tooth loss and drifting can cause the condylar head to rotate distally producing possible temporo-mandibular joint disturbance.

Treatment procedure may be -

1. Sedation
2. Immobilisation
3. Tooth extraction
4. Use of a biteplane or occlusal splint
5. Occlusal adjustment.

After evaluating the centric recording, grinding procedures are introduced to enable a stable relaxed closing position to be established. For eccentric movements the patient is instructed to slide a short distance to right and left and the contacts are marked. Limited contacts in lateral excursion places excessive loading on isolated teeth especially if the patient tends to bruxism or otherwise the scope of movement is limited. Isolated steep cusps out of harmony with the remaining dentition are adjusted to the "BULL" rule, hence vertical dimension is not reduced.

The occlusion should then be adjusted for the masticatory stroke, which normally operates in front of the slide pathways. With articulating paper in place, the patient is instructed to chew imaginary food on each side of the mouth. Should isolated heavy masticatory contacts be found, these are reduced to widen the distribution of contacts. A review of patients treated for occlusal imbalance shows that adjustment of the occlusion to permit a stable relaxed closing position is the most important phase in the correction procedure, only a minor number of conditions are attributed to faulty eccentric function.

Where there has been lack of posterior support, overclosure or lack of unilateral support, a removable part denture can often be used to help restore, stabilise and maintain a sound functional occlusion.

Considerations for the Periodontal Membrane and the Mucosa.

Where there are sufficient teeth present, tooth borne dentures are indicated. ⁽³⁴⁾ Stresses must be applied axially, not horizontally and must be well distributed. The major connectors must be rigid.

Where it is desired to control the load to tooth and mucosa in free-end saddles (Kennedy I and II), the load is reduced by reducing the area and the length of the occlusal table, or by using stress-breaking with flexible connectors or movable joint between retainer and saddles.

There are two basic types of stress breakers ⁽²⁾ -

- (1) Those having a movable joint between the direct retainer and the saddle. Some of these allow up and down and side to side movements, others also permit a vertical hinge action.
- (2) Those having a flexible connector between the direct retainer and the saddle. The connector may be wrought gold wire or a bar of cast metal of thinner section than the lingual bar.

Advantages of Wrought wire connectors.

1. A more flexible union between retainer unit and saddle.
2. The round section of the wire connector allows equal freedom of movements in all directions radial to its section, whereas the often flatter cast connector allows movement best where the stress acts across the thinner section.
3. The metallurgical condition of the wrought wire makes it less liable to fracture as a result of intermittent stressing than the cast connector which tends to crystallise and fatigue.

Disadvantages of Wrought wire connectors

1. Soldered joints to saddles or retainers may fracture as a result of fatigue.
2. Wrought connectors are usually limited to gold dentures (soldering to cobalt chrome alloy is difficult).
3. The gold wires are more liable to be deformed accidentally than the thicker cast connectors.
4. Accurate relationship between saddles and retainer unit is liable to be lost when soldering.

Flexibility of Stress breaker depends on -

1. Cast or wrought.
2. Length and position of connector.
3. Cross sectional dimensions and shape of the connector.

Advantages of Stress breaking are -

1. Horizontal forces on abutment teeth are diminished.
2. Careful choice of a flexible connector allows balance of stress between the alveolus and abutment teeth.
3. The abutment teeth are not necessarily damaged should necessary rebasing be delayed.
4. Splinting of standing teeth is facilitated.
5. Since the retentive unit remains passive, there is a feeling of security for the patient when a stress-broken denture is worn.

Disadvantages of Stress breakers are-

1. Technically more difficult to construct, added expense.
2. The vertical and horizontal force components are increased for the alveolar bone and may increase resorption.
3. Indirect retention effectiveness is reduced.
4. The more complicated appliance is sometimes not will tolerated by the patient.
5. When light flexible connectors are used, these can easily be bent or distorted during cleaning or as the result of an accident to the detriment of the abutment teeth.

6. Repair of a hinge type stress breaker or flexible connector is difficult.
7. When necessary rebasing is delayed there can be marked alveolar resorption.

Factors to consider in deciding whether to use stress breaking or rigid connectors will also include -

1. The length of the edentulous saddle.
2. Condition of the abutment teeth.
3. Condition of the alveolar ridge.
4. Compressibility of the mucous membrane covering the alveolar ridge.
5. Economics.

Advantages of Rigid connector between clasp and saddle are -

1. Relative ease of construction.
2. Desirable distribution of stress between abutment teeth and the alveolus with a wise choice of clasping.
3. Continuous clasps can act as an efficient indirect retainer and distribute the lateral load to the standing teeth of the balancing side.
4. Less likely to damage during cleansing or by accident.
5. Rebasing is not required as frequently since there is less load distributed to the alveolar bone than in stress breaking.

Disadvantages of Rigid connectors are -

1. Torque that may exceed physiological limits may be thrust upon abutment teeth.
2. Immobilisation of the teeth can't be as effective as when using stress breaking.
3. Danger of crystallisation and fracture of clasps.
4. Should a large range of clasp movement be allowed, the patient feels insecure.
5. Rebasing of saddles when required must be done promptly to preserve the abutment teeth and their supporting tissues.

Krogh-Poulsen⁽²⁴⁾ emphasises the importance of full diagnosis and treatment of the mouth, including periodontal treatment, elimination of caries and occlusal equilibration prior to constructing the partial prosthesis.

He suggests omission of non-essential dentures and free-end saddles, and prefers a fixed prosthesis where possible. Possibilities for the omission or increased distribution of traumatic forces include splinting of the remaining teeth, shortening tooth crowns, or covering teeth with onlays.

Where there are free-end saddles, maximum extension over the available denture bearing area is essential.⁽¹⁴⁾⁽²⁴⁾ Simple robust designs are often preferred, provided there is adequate vertical and horizontal support. Skeleton metal castings are preferred because of better fit and rigidity and they offer more scope in design.⁽²⁴⁾⁽³⁹⁾

The fulcrum line should pass through the middle of the supporting area of the denture. Indirect retention, if necessary, is provided by occlusal rests or incisal hooks, as far removed from the fulcrum as possible. Where biting force is excessive, the occlusal table must be reduced in both breadth and length.

Patients must be given careful instruction in correct oral hygiene and frequently recalled to assess oral hygiene and to rebase or reline saddles as required. Steffel⁽³⁹⁾ advocates a preference for precious metal restorations for selected abutment teeth should restorative dentistry be a requirement. The surveyor is essential to arrive at a considered treatment plan and adequate mouth preparation.

A rigid, stable, well-fitting base is essential for registering centric relation. Bilateral rigidity between free-end saddles is lost if stress breakers are used.⁽²⁴⁾⁽³⁹⁾

Elastic clasp arms are less traumatizing than rigid arms, and should occupy the same relative height on opposing tooth surfaces. Positive support, including stability is more important for partial dentures than active retention. (24)(39)(44)

Proper stress distribution enhances the stability of partial dentures. All partial dentures move in function, hence rounded occlusal rests in saucer shaped seats in conjunction with elastic clasp arms permit hinge-like movement of free-end saddles without using stress breakers.

A secondary impression technique for the free-end saddle area enhances stability and equalises support provided by teeth and tissues.

Isolated bicuspid are weak primary abutments and often should be splinted if used in this respect. Periodontally involved teeth should be splinted if used in partial denture anchorage. Partial dentures should not be worn at night.

Applegate⁽¹⁴⁾ and McCracken⁽⁴⁰⁾ stress the importance of accomplishing occlusal harmony. The occlusion is analysed and any existing occlusal disharmony corrected in mouth preparation for partial dentures. A dynamic record of the opposing dentition is then made in a special relatively hard wax on a stable metal base, which is worn by the patient for twenty-four hours and during sleep. The record includes all voluntary excursive movements plus involuntary movements such as nervous habit patterns and changes in jaw movement caused by changes in posture. This record eliminates the problem of trying to reproduce mandibular movement on an articulator.

An occlusal template is poured up in a very hard stone, stone stops are used to maintain vertical dimension and the casts mounted on a plane line articulator. The occlusal template can be electroplated with silver if so desired. (40)

Torque to abutments in Kennedy Class II maxillary dentures can be decreased by having a major terminal connector (palatal bar) placed as remotely as possible posteriorly from the fulcrum line.⁽¹⁴⁾

Kaires⁽⁴¹⁾⁽⁴²⁾ demonstrates that reduction in the size of the occlusal table reduces vertical and horizontal forces acting in partial dentures and lessens the stresses in the abutment teeth and supporting structures. Masticatory performance is reduced by an estimated 3-12%.

The effect of design on force distribution is inconclusive; however, rigid design is more desirable in withstanding horizontal stresses than a flexible bar. McCracken⁽⁴³⁾ stresses the function of the occlusal rest is the division of loads coming upon the partial denture so as to provide for greatest efficiency with the least damaging effect to the abutment teeth.

The occlusal rest must be able to transmit occlusal forces to the abutment teeth in an occlusal direction only, thereby diminishing lateral stress transmission to the abutment tooth. For this reason, the floor of the occlusal rest should incline toward the centre of the tooth so that the occlusal forces are centred over the root area. The floor of the rest should form an angle of something less than 90 degrees with the vertical minor connector. Judicious diskling on the tooth proximal surface parallel to the path of insertion establishes a guiding plane for denture insertion. Box-like occlusal rests preparations and those with vertical walls are to be avoided.

A ball and socket type of relationship between occlusal rest and abutment tooth is more desirable.

Kabcenell⁽⁴⁴⁾ maintains that clasps serve three purposes -

1. Stabilisation of the abutments and of the denture.
2. Transmission of lateral forces.
3. Retention.

Interproximal diskings of abutments parallel to the path of insertion provides stability.

Rigidity is required for stabilisation and transmission of lateral forces. The rigid element of the clasp rests passively against the tooth, occlusal to the height of contour, and encircles more than 180 degrees of the tooth circumference (horizontal reciprocation) to attain the utmost in stability.

The rigid elements must be placed as close to the gingivae as possible so that lateral stresses will have the shortest possible torque fulcrum.

Additional stability is provided by properly placed uprights and rests. The uprights on the proximal surface of abutment teeth should rest upon a straight enamel surface. This provides a truss action over most of the height of the clinical crown, and provides a guiding plane for the path of insertion. Rests which fit precisely into saucer-shaped rest seats also contribute to stability. Force upon a well-placed occlusal rest seats a tooth in its socket without damage. The walls of the rest provide additional surface to reinforce the unity of tooth and denture when lateral stresses are directed against the tooth.

Retention is a factor of horizontal, not vertical undercut. The flexible clasp elements must terminate gingivally to the height of contour. The exact point of termination is related to the retentive needs of the denture, the contour of the abutment, the length and cross sectional area of the clasp, the material from which the clasp is made, and the direction from which the clasp approaches the tooth. When clasp stability can be attained, retention is rarely a problem. When the stabilising elements provide only one path of egress for the denture with a truss-like action, retentive elements need only overcome the forces of gravity and those caused by adhesive foods. The flexibility of a clasp increases as its length increases and as its cross-sectional area decreases. Cast metal

clasps are more rigid than wrought wires, cobalt chromium alloy is more rigid than gold. Clasps of wrought gold have a superior proportional limit and are much less subject to breakage during adjustment.

Teeth frequently do not have contours that allow ideal clasping and should be modified so that they will be more nearly ideal.

The proper placement of rests, rigid clasps, uprights and flexible clasps on properly recontoured teeth provides a specific path of insertion, a stable denture, protection of the abutment teeth and retention which is adequate for the needs of the denture.

Kratochvil⁽⁴⁵⁾ advocates placement of the occlusal rest on the mesial aspect of abutment teeth supporting a free end saddle. (Kennedy I and II). This causes force distribution to be more perpendicular to the alveolar ridge adjacent to the abutment and tends to tip the abutment anteriorly where it is supported by the adjacent tooth.

An "I" Roach bar (infra bulge) is suggested as the retaining element for the abutment tooth placed at its greatest circumference. This in conjunction with a mesial occlusal rest exerts no torque effect on the abutment. The I bar covers very little tooth surface, and allows almost natural tooth contour for natural gingival stimulation.

Wagner⁽⁴⁶⁾ demonstrates the advantages of using gold inlay restorations for abutment teeth in particular circumstances. Where posterior teeth are in mesial version, the mesial undercut can be reduced and by using adequate pin resistance and retentive form, a gold inlay can produce the desired tooth contour. An inlay quite often can be used where a cuspid or bicuspid is an abutment tooth in preference to a full crown; e.g. Bell shaped crowns may be suitably recontoured by using an inlay. It is essential to prepare seats for occlusal rests in the wax patterns when they are necessary.⁽⁴³⁾

Precision attachments in partial denture prosthesis have certain advantages and disadvantages when compared with the more conventional removable partial denture.

Preiskel⁽⁴⁷⁾ lists the following advantages -

1. Elimination of visible retentive components.
2. No food stagnation around clasps.
3. Excellent horizontal stabilisation.
4. Reduced bulk.
5. Attachments are parallel, hence there is no strain on the abutments when inserting or removing the prosthesis.
6. Retention is not effected by the shape of the tooth.
7. Attachments may be adjusted for wear, with no risk of applying horizontal load on the tooth.

Some of the disadvantages are -

1. Abutment teeth require preparation.
2. Length of the clinical crown and size of the pulp tissues can place limitations on the size of the attachment.
3. Clinical and laboratory procedures are exacting, lengthy and expensive.
4. Little possibility of load sharings between the teeth and tissues exists.

Steffel⁽³⁹⁾ commenting on precision attachments says -

"This type of partial denture can be aesthetic, of physiologic value, effectual in mastication and allows the abutments to be relatively caries-free. Horizontal stresses in all directions are distributed evenly to all abutments, and all fibres of the periodontal membrane are used for stabilisation. The male part of the attachment can move occlusally, and when stress is removed the displaced tissues return to rest with neither teeth or soft tissue under constant pressure. This intermittent loading is thought to be of physiological value to the underlying alveolar bone."

Economics, the exacting and lengthy nature of both clinical and laboratory procedure must preclude the widespread use of precision attachments in partial denture prosthesis.

Review of some Clinical Surveys of Partial Denture Prostheses

Anderson and Lammie⁽³⁾ in a survey of 507 patients wearing partial dentures during the period 1947-1952 found that periodontal changes are more common in patients wearing mucosa-borne dentures than in those wearing dento-gingivally supported partial dentures. The depth of gingival pockets of 3mm was quite common in this series of patients. Accurate techniques, adequate treatment planning plus personal factors including good oral hygiene, intelligence, motivation for wearing the denture and good general health, were considered to be the most important criteria in providing an efficient partial denture service.

Koivumaa⁽¹⁾ in 1956 conducted a clinical study on patients who were wearing acrylic partial dentures without occlusal rests. The first group was examined when the dentures were inserted, group two consisted of approximately 60% of the original group who attended a recall 12-15 months later. A third group consisted of patients who had been wearing their dentures 6-6½ years.

In the material studied, inflammation of the mucous membranes was noted in connection with the use of mucosa-borne partial dentures. The commonest sites of inflammation were the palate and the gingival margin underlying the denture. This inflammation was often associated with deepened gingival pockets (greater depth than 2mm) and exposed cemento-enamel junctions. Neither age nor sex were shown as significant factors in the above findings.

Bone resorption occurred underneath the dentures to such an extent that in one year a large part of the material had lost balanced articulation. Centric occlusion was found deficient in 46% of cases within the 12-15 month recall period.

The results of the investigation suggests that injuries and changes are less frequent among those wearing dentures daytime only than among those wearing them regularly day and night. A remarkable feature was

that although the mucous membrane and gingival margins underlying the dentures were inflamed in many cases, the patient made no complaint about it. It was also found that the traumatizing articulation caused no complaints.

Carlsson et al⁽⁴⁾ commencing in 1960 presented a series of studies on the effect of wearing dento-gingivally supported partial dentures.

Study I

There were 99 patients who had worn their dentures 12-15 months. This series consisted of 108 partial dentures in all, of which 21 were not worn. The unworn dentures were 3 maxillary and 18 mandibular Kennedy Class I partials. The incidence of the mobility of abutment teeth had increased.

Exposure of the cemento-enamel junction increases with time, but no correlation with partial dentures could be shown. There was a tendency to deepening of the gingival pockets with a higher incidence in abutment teeth.

The incidence of inflamed gingival margins at abutment teeth is higher with all time denture wearers, than day time only. Similarly, inflammatory reactions of traumatic origin in edentulous areas and the hard palate are seen more frequently in all time wearers rather than those day time only. There was evidence of inflamed gingivae under indirect abutments for denture wearers, whereas this inflammation was negligible in non-denture wearers.

The state of the oral hygiene has a most important role in the incidence of gingival margin inflammation. There was comparative frequency of caries on tooth surfaces in contact with the denture, whilst caries incidence was rare under occlusal rests. Caries incidence is considerably reduced by good oral hygiene.

The retentive effect of the clasps of the dentures tends to deteriorate, however overall denture retention and stability was satisfactory. The occlusal contacts in centric were generally present (18% impairment), but articulation in lateral movements was found to have deteriorated greatly (66%). Subjective opinion of the patients regarding the dentures showed that despite some pathological conditions and minor inadequacies, most were happy and most considered their masticatory function had been improved.

Study II(48)

A group of 54 patients wearing full dentures and lower partial dentures (Kennedy Class I) were recalled. The patients were examined when the dentures were inserted and then 12-15 months later. Forty-eight patients attended, 32 of the 48 lower dentures were Kennedy Class I (34% of these were being worn) and 16 were Kennedy Class I with one or more bounded saddles. These were all being worn.

Marginal gingival inflammation and mobility of the abutment teeth increased. The inflammation was more frequent with deficient oral hygiene and where the abutments were crowned.

The occlusal contacts in centric were deficient in 16% of cases. Articulation contacts were impaired in 70% of cases apparently by alveolar bone resorption under the saddles.

Tissue changes at the abutments were more frequent and severe in Kennedy Class I lower cases than in the more heterogeneous material in Study I. It was decided to follow up this group to determine whether tissue inflammation and tooth mobility would progress further.

Study III⁽⁴⁹⁾ one year later.

The periodontal changes progressed throughout the second year. Two cases of axial mobility had progressed sufficiently to necessitate tooth removal. The high incidence of inflammation in abutment teeth had

persisted. Denture covered mucosa showed no improvement. Carious lesions incidence increased considerably, particularly with patients having poor oral hygiene.

Articulating contacts deteriorated further. The authors conclude good oral hygiene is essential. Partial dentures should only be worn when necessary. The design should be planned to minimise risk of damage to the oral tissues.

Study IV Carlsson. (50) This material consisted of all that was available from Study I, four years after denture insertion. The abutments were radiographed to compare -

1. The level of marginal bone in relation to the length of the tooth.
2. Condition of the alveolar bone margin.
3. Width of the periodontal space in the marginal area.

After four years 37 out of 66 patients did not display severe clinical or radiographic periodontal destruction of the abutments. The gingiva was not severely inflamed and there was no deterioration of the bone radiographically.

Provided the patient has good oral hygiene, partial dentures can usually be tolerated without the risk of pathological alterations. Contacts between the denture and gingival margins should be avoided as far as possible. Inflammation was often severe in connection with lingual coverage and bar, connectors between bar and clasps, and occlusal rests and parts of saddles bearing unduly on periodontal tissues. Such damage is particularly severe when caused by fracture of occlusal supports or non-compensated alveolar ridge resorption.

None of 18 abutment teeth crowned and splinted to adjacent crowned teeth, presented clinical or radiographic evidence of periodontal damage.

Every fourth abutment tooth involved in the survey disclosed well-defined alveolar border bone changes during the four years under review.

Anderson and Bates⁽⁵¹⁾ presented a survey on 327 patients wearing partial dentures where the bases were made in cobalt chrome alloy, white and yellow gold, and acrylic resin. The mucosa and gingival condition under cobalt chrome bases was good, and better if the denture was not worn at night. The cobalt chromium base was superior for cleanliness and fit. There was some distortion in the gold bases and also surface deterioration in the metal.

Seeman⁽¹⁷⁾ conducted a survey on 149 patients between the ages of 16 and 80 years who had worn their partial dentures for periods ranging from 6 months to 20 years.

Both inadequate oral hygiene and gingival coverage were found to be significant factors in the production of periodontal disease.

Derry and Bertram⁽⁵²⁾ in a clinical study of 60 patients wearing 74 partial dentures after 2 years usage, laid down guidelines for the design of biologically acceptable removable partial dentures.

1. Minor connectors should avoid contact with the free gingiva. (51) (3) (4) (11)
2. Interproximally, minor connectors should contact the edentulous ridge approximately 3mm from the tooth surface. (51) (3) (4) (11)
3. Major connectors should be rigid. (14) (42) (4)
4. Occlusal rest seats should be well defined and placed on the surface of an abutment tooth opposite a free-end saddle. (3) (44) (45)
5. Emphasis should be placed on firm lateral support and well designed saddles, rather than increased active retention. (4) (45)

There was great emphasis on oral hygiene instruction. There was no significant change in tooth mobility. Less than 2% of abutments had unaccounted for mobility of less than 1mm horizontally.

The Kennedy Class I denture is usually the least worn, but this was not the case in this investigation. However there were only 26% of Kennedy Class I dentures in this study, whereas in Carlsson's group,⁽⁴⁾ 61% of the total were Class I type. Ninety-one percent of the dentures

in this study were being worn. The favourable results obtained in this study were probably related to good oral hygiene, average number of natural teeth in edentulous jaws was high (8), only 26% of the dentures were Kennedy Class I, and the basic design could be considered adequate.

Own Investigation

AIM

It was decided to conduct a clinical survey of patients wearing removable partial dentures to assess the effects of their design and usage on the health of the oral structures.

MATERIAL

901 patients wearing partial dentures were examined. These came from two sources.

The first group consisted largely of patients wearing partial dentures who presented themselves in the Examinations Department of the Sydney Dental Hospital during the period July to November, 1971. These patients were not necessarily involved in partial denture problems, many presented themselves for routine examination or for relief of pain. Included in this group were patients who had recently received partial dentures, constructed by teaching staff and final year students in the Department of Prosthetic Dentistry, University of Sydney, and members of the staff employed at Sydney Dental Hospital. 606 examinations were completed in this group.

The other group consisted of members of the Army and Air Force, wearing partial dentures and located at Sydney and nearby stations and barracks. A series of visits from July to November to six dental centres provided a further 295 examinations.

The large number of patients examined was considered adequate to eliminate bias due to chance.⁽⁵³⁾ Recall of patients was impracticable.

The two groups do not represent a sufficient cross-section of the community to present a true random representation,⁽⁵³⁾ however the findings were considered significant for the groups selected. All examinations were carried out by the author.

METHOD

A special examination proforma was prepared as illustrated.

Name: Sex: D.D.I.

Reg.No.: Occupation:

Exam.Date: Year of Birth:

Radiograph Date:

Health

1. Reason for Presenting

2. Previous Dental
History

3. Medical History

i. Present complaint
and treatment

ii. Bleeding

iii. Current medication

iv. Drug sensitivity

v. Asthma

vi. Allergy

vii. Diabetes

viii. Heart Disease.

ix. Rheumatic Fever

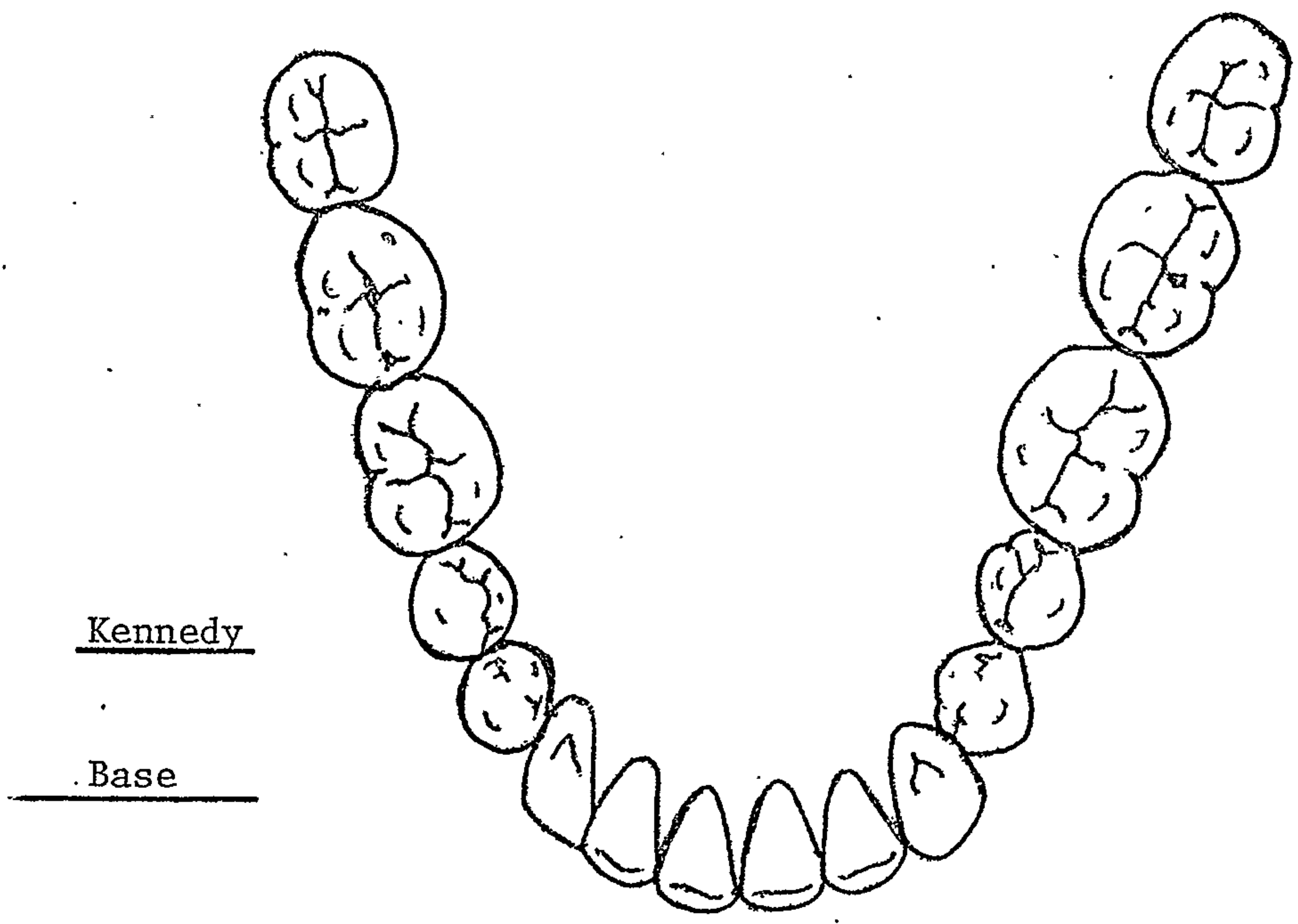
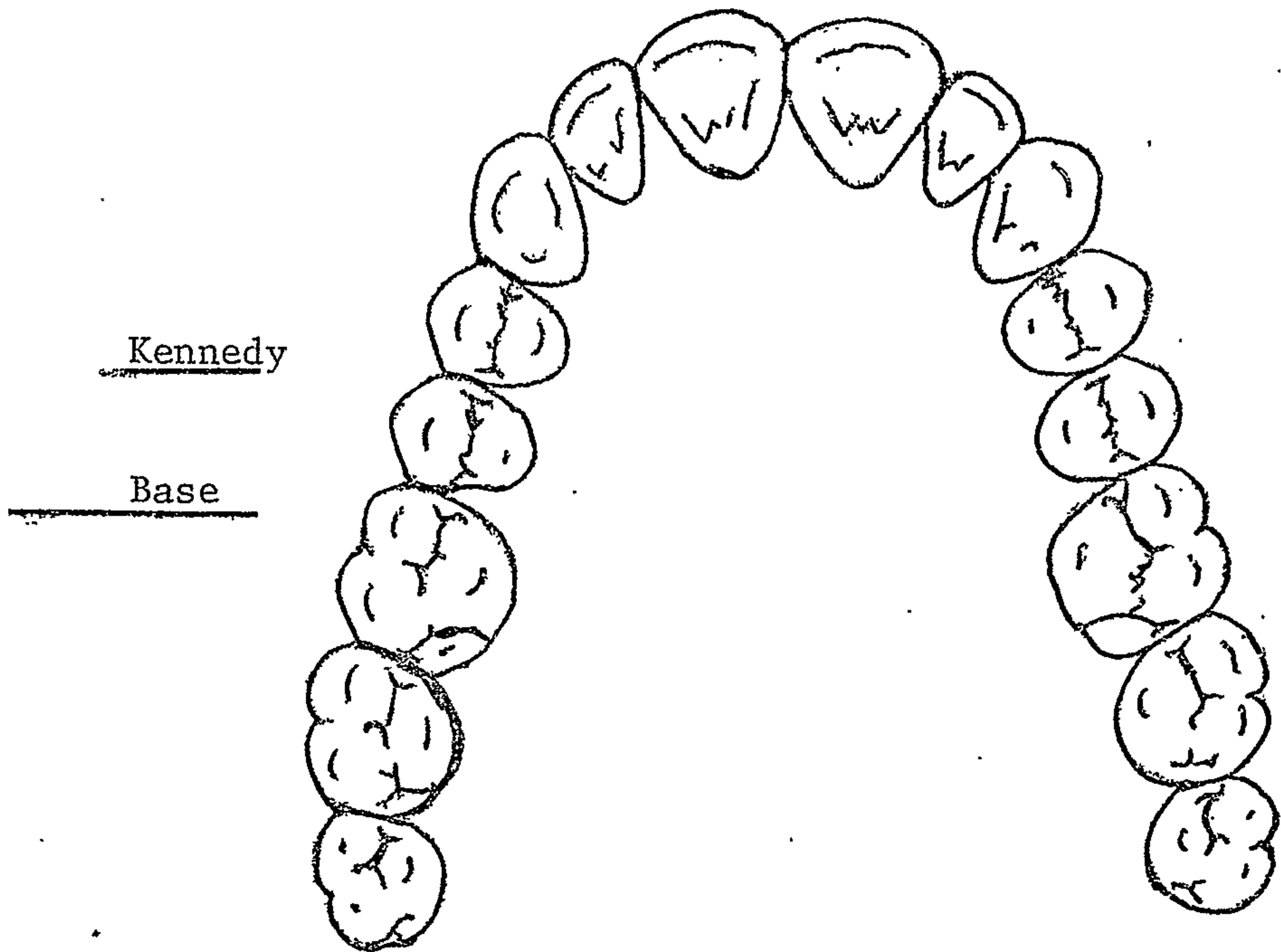
x. ENT Disorders

xi. Disability
(Phys./Neurol.)

xii. Pregnancy

xiii. Other

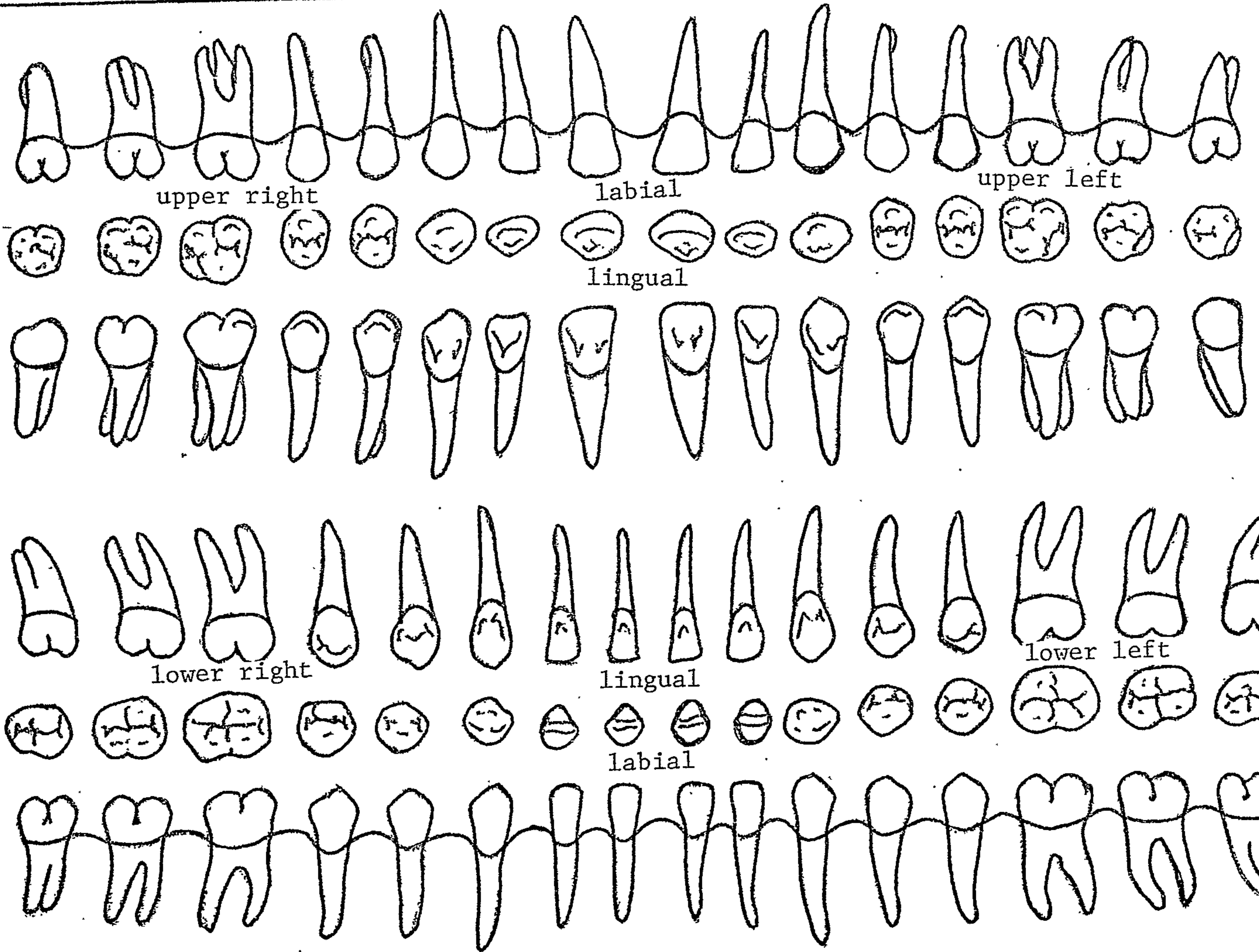
4. General Appraisal



I.

Russel's Index

Mobility



Mobility

Russel's Index

I.

Edentulous Areas - Mucosa in contact with denture base



Occlusion Centric

CR.CO.

BLPC.

ULPC.

ANTC.

Centric Balance

Eccentric Interferences

Denture

Fit

Stability

Retention

Patient Assessment

Function

Comfort

Usage

Wearing

Always

Daytime

Non wearing

Spasmodic

Never

Cleanliness

Breakage or Deformation

Patient reason for

Partial Denture requirement

Treatment completed after
denture insertion

Surgery

Operative

Periodontal

Other

Radiographic Observations

The following information was available in each instance.

1. Type Partial Upper Denture
 Partial Lower Denture
 Part Edentulous mouth
2. Age and Sex of patient.
3. Age of denture (period since insertion)
4. Classification of Partial Dentures -
 - a. Partial upper worn against lower natural antagonist.
 - b. Partial lower worn against upper natural antagonist.
 - c. Partial upper worn against partial lower.
 - d. Full upper worn against lower partial denture.
 - e. Partial upper worn against full lower denture.
5. Kennedy Classification of Partial Dentures.
6. Type of denture base material.
7. Adequate Vertical Support.
8. Number of direct abutment teeth.
9. Number of indirect abutment teeth.
10. Total number of standing teeth in the arch supporting a partial denture.
11. Russel's Periodontal Index for Direct Abutment Teeth.
12. Russel's Periodontal Index for Indirect Abutment Teeth.
13. Russel's Periodontal Index for Other Teeth.
14. Mobility Average for Direct Abutment Teeth.
15. Mobility Average for Indirect Abutment Teeth.
16. Mobility Average for Other Teeth.
17. Inflammatory state of mucosa Edentulous Area and Hard Palate.
18. Occlusion
 Centric Relation, centric Occlusion coincidence.
19. Centric Balance.
20. Eccentric Interferences.
21. Examiner's Assessment of Dentures.
22. Patient's Assessment of Dentures.
23. Denture Usage.
24. Denture Cleanliness.
25. Breakages of denture components.

26. Patient Motivation for Partial Denture requirements.
27. A medical history noting current ailments, current medication, any past serious or chronic illnesses was compiled, and a general assessment of the patient's health made.
28. Where full mouth periapical and bite wing radiographs were available these were studied for general assessment and for Russel's Index. Unfortunately, the majority of examinations was confined to mirror and probe, a graduated millimetre periodontal probe and adequate chairside lighting.
29. A detailed analysis of dental caries incidence was not recorded in this study, however, my impressions would support the findings of Carlsson and Anderson and Bates, namely "Cariou⁽⁴⁾s lesions will develop with comparative frequency on those tooth surfaces which are in contact with the denture. Consequently atypical location of carious defects are common. The development of caries under occlusal rests was rare.⁽⁵¹⁾
With good oral hygiene, the development of caries will be considerably reduced."
30. Each partial denture design was sketched on a diagram of each arch. All metallic components in black textures, whilst the resin components and artificial teeth were sketched in red.

CRITERIA

Kennedy Classification of Partial Dentures⁽⁵⁴⁾

- | | |
|---------------------|---|
| Class I | Bilateral edentulous areas located posterior to the remaining teeth. |
| Class II | A unilateral edentulous area located posterior to the remaining natural teeth. |
| Class III | A unilateral edentulous area with natural teeth remaining anterior and posterior to it. |
| Class IV | A single, but bilateral (crossing the midline) edentulous area located anterior to the remaining natural teeth. |
| Class I, II and III | may have modifications by adding the number of additional bounded saddles. |
| Class IV | has no modifications. |

Adequate Vertical Support

Vertical support was considered adequate where all teeth bearing retentive arms have occlusal rests, preferably in prepared seats, and where all tooth-borne saddles are supported by an occlusal rest at either end of an edentulous space.

Buccal circumferential wrought arms passing through embrasures were not considered to provide sufficient vertical support to withstand functional masticatory forces.

Direct Abutment Teeth. Includes all teeth bearing a retentive arm and/or an occlusal rest supporting an edentulous saddle area.

Indirect Abutment Teeth. Includes teeth involved by denture base extensions or metal aprons on lingual or palatal surfaces, by metal struts or continuous clasps involving teeth with some load from edentulous saddle areas.

Other Teeth. Denotes remaining standing teeth in an arch supporting a partial denture not involved by any denture component.

Russel's Periodontal Index (55)

It was decided to use Russel's Index for the following reasons:-

Scoring is done on a subjective basis, and certain criteria are laid down so that differences in examiners can be minimised and so make results comparable. "The signs of the disease must be clear, obvious and unmistakable". When in doubt assign the lesser score. Inflammation is redness, is it present? Because of an oral hygiene failing or plaque presence, one might expect inflammation, but does it exist? Similarly, calculus may be present without the presence of inflammation. Gingival recession does not matter, if form of the tissues is correct.

Russel's Index does not distinguish between a slight pocket and a deeper pocket. However, Russel's Index does measure destructive periodontal disease.

It is a relatively simple, speedy means of stating prevalence as well as severity of the gingival condition.

Orban⁽⁵⁶⁾ states -

"The fact that plaque exerts a significant effect on tissue health is of great importance not only to the epidemiologist but to the clinician, as periodontal disease appears to be the result of local factors, combined with systemic influences and the host resistance.

Loe⁽⁵⁷⁾ has shown that plaque will cause gingival inflammation in healthy mouths when present in the gingival crevice for 10-21 days. There is no marked difference between jaws, however interproximal areas score higher than buccal or lingual surfaces. When proper cleansing was reintroduced, gingival inflammation resolved in approximately one week.

Untoward inflammatory states in clean mouths should initiate enquiry regarding possible blood dyscrasias, debilitating diseases, current drug medication which may include such drugs as dilantin, steroids and hormonal compounds.

There may be endogenous and exogenous deficiencies in the geriatric and post menopausal female, vitamin C deficiency and hypochromic anaemia are common examples.⁽³²⁾ Calcium imbalance may cause osteoporosis and resultant unexpected alveolar resorption.

RUSSEL'S INDEX (55)

Score	Criteria	Additional X-Ray Criteria
0	There is neither overt inflammation in the investing tissues, nor loss in function due to destruction of supporting tissue.	Radiographic appearance is essentially normal
1	Mild gingivitis: overt area in the free gingiva, but does not circumscribe the tooth	
2	Gingivitis: inflammation circumscribes the tooth, but there is no break in the epithelial attachments.	
4		There is early notchlike resorption of the alveolar crest
6	Gingivitis with pocket formation. The epithelial attachment has broken down. There is a pocket, not merely a deepened cervical gingival crevice due to swelling of the free gingiva.	There is horizontal loss involving the entire alveolar crest, up to half the length of the tooth root.
6	There is no interference with masticatory function, the tooth is firm in its socket.	
8	Advanced destruction with loss of masticatory function. The tooth may be loose, drifted, dull to metallic percussion, may be vertically mobile.	There is advanced bone loss, involving more than half the length of the tooth root, or a definite infrabony pocket with widening of the periodontal membrane. There may be root resorption, or apical rarefaction.

RULE: When in doubt, score the lesser.

Tooth Mobility was measured using Ramjford's criteria. (58)

Grade 0: Physiologic mobility, firm tooth.

1: Slightly increased mobility.

2: Definite to considerable increase in mobility, but no impairment of function.

3: Extreme mobility. A loose tooth that cannot be used for normal function.

Mucosa Edentulous Areas and Hard Palate

Classification described by Koivumaa⁽¹⁾ was used.

0. No change in mucosa.

1. Local patches of deeper red than the surrounding mucosal tissue, sometimes also hyperaemic.

2. Oedematous reddened mucosa with a fairly soft and often granulomatous surface extending over the whole area covered by the denture.

Occlusion

Recording centric relation on wax strips as described by Graham⁽³⁸⁾ was used.

"A series of Kerr occlusal indicator wax strips are placed over the teeth on one arch and the patient is asked to adopt a relaxed state. The operator then lightly taps the teeth together, being sure that the movement is completely under his control. The presence of the wax surface eliminates proprioceptive reaction, and continued tapping will permit the tooth contact to penetrate the wax surface. Removal of the wax strips and examination will show the extent of tooth contacts. This extent will then determine whether the contacts can be considered adequate for jaw function and jaw stability, or whether their position and number would cause a deflection or avoidance and be considered premature contacts."

The wax record was used to determine whether centric relation and centric occlusion coincided (lack of any prematurities). Where there is total absence of prematurity in the wax record, this does not indicate

centric relation and centric occlusion are the exact same position, however it does indicate progress from centric relation to centric occlusion (the long centric) should be unimpeded.

Centric contacts, although not complete over the entire arch (some denture teeth out of contact) might still be considered functionally adequate depending on their nature and distribution.

Eccentric Interferences

Presence or absence of eccentric interferences attributable to the artificial teeth or denture components during latero-protrusive excursions was noted visually, and by the use of fine articulating paper if in doubt.

Whilst it is an ideal to have good articulation for partial denture prosthesis, its practical attainment is rare. Good working side contacts are desirable, without balancing side interferences. However, it is considered important not to introduce interferences to the normal masticatory stroke or in centric relationship by any of the denture components or artificial teeth.

Should these interferences exist, masticatory function is reduced, and abutment teeth may well be subjected to unnecessary torquing forces.

Examiner's Assessment of the Denture

The denture was inserted and with light digital pressure applied towards the denture supporting area, a visual estimation of the fit of the skeleton or base in relation to the teeth, and of the base to the supporting soft tissues was made.

The denture adaptation to the teeth was considered good when obvious spaces were not recorded. Otherwise, the adaptation of the base was considered deficient. The fit of the base of the denture, saddles and connectors, was considered good when without undue pressure on the soft tissues, contact between tissues and the periphery of the base existed.

The fit of the base was otherwise considered deficient. No attempt was made to determine the fit of the denture in relation to the mucosa in non-visible areas.

Stability of the Denture

Stability was assessed by -

- (1) Light digital pressure on saddle areas, bilaterally and unilaterally.
- (2) Repeated closures into centric occlusion.
- (3) Notation whether normal facial musculature movements caused displacement.

When saddles, retentive elements and rests were secure stability was good, otherwise it was considered deficient.

Retention of the Denture

Active retention was assessed by removing the denture directly opposite to the path of insertion. Active retention was present when resistance to removal was felt. Friction alone was not considered as resistance. (59)

Patient's Assessment of the Dentures

The patient's subjective opinion regarding the function and comfort of the dentures was recorded as good or bad in each instance. Short notes concerning details of any dissatisfaction were recorded.

Denture Usage

Denture wearing habits were recorded by the use of 4 groups.

1. Always
2. Daytime only
3. Spasmodic, usually worn for aesthetics only, sometimes worn for mastication only.
4. Never. Dentures had not been worn for months or never.

Denture Cleanliness

The dentures were considered clean when free of materia alba, calculus and easily removable discolouring stain. Otherwise cleanliness was considered deficient.

Patient Motivation for Partial Denture Requirement

The patient was asked why they required partial dentures and the most important factor was recorded in each instance, and interpreted in the following categories -

1. Aesthetics
2. Function
3. Phonetics
4. Negative

Procedure for Data Processing

1. A master sheet for coding was produced to enable examination data to be recorded on an 80 column I.B.M. punch card.
2. The data was recorded by an I.B.M. Printing Card Punch 26, using 40 of the available columns. A separate card was used for each partial denture.
3. The punch cards were processed by a programmer on an I.B.M. 70-40 computer at the Basser Computer Department.

The master sheet for coding was designed as follows.

(1-3)	<u>Identification</u>	
	<u>TYPE</u>	
(4)	Part Upper	1
	Part Lower	2
(5)	<u>SEX</u>	
	Male	1
	Female	2

(6-7)

Age of Denture - Months

At insertion	1	60-72.	1	
0-3	2	72-84	2	
3-12	3	84-96	3	
12-24	4	96-108	4	When coding
24-36	5	108-120	5	3- or -3
36-48	6	> -120	6	
48-60	7			

(8)

Age of Patient

< 20	1
20-29	2
30-39	3
40-49	4
50-59	5
60-69	6
70-79	7
> -79	8

(9)

Classification Partials

Partial Upper/Lower natural antagonists	1
Partial Lower/Upper natural antagonists	2
Partial Upper/Partial lower	3
Full Upper/Lower partial	4
Partial Denture/Full lower	5

(10-11)

Classification Kennedy (2)

Class I	1	Class III	1	
Class I ^I	2	Class III ^I	2	
Class I ^{II}	3	Class III ^{II}	3	When coding
Class I ^{III}	4	Class III ^{III}	4	5- or -6
Class II	5	Class III ^{IV}	5	
Class II ^I	6	Class IV	6	
Class II ^{II}	7			
Class II ^{III}	8			

- (12) Denture Base
Ac/Wt 1
Ac 2
Co/Cr 3
Co/Cr/Wt 4
- (13) Adequate Vertical Support
YES NO
Ac/Wt 1 5
Ac 2 6
Co/Cr 3 7
Co/Cr/Wt 4 8
- (14) Number of Direct Abutment Teeth
Actual Value 1-9
- (15) Number of Indirect Abutment Teeth
Actual Value 1-9
- (16-17) Total Number of Standing Teeth
Actual Value 1-15
- (18-19) Russel's Index Direct Abutments Average (including one decimal)
0 - 0 0 - 0
1 - 1 .1 - 1 ACTUAL VALUE
2 - 2 .2 - 2
- (20-21) Russel's Index Indirect Abutments Average (including one decimal)
0 - 0 0 - 0
1 - 1 .1 - 1 ACTUAL VALUE
- (22-23) Russel's Index Average Other Teeth (including one decimal)
0 - 0 0 - 0
1 - 1 .1 - 1 ACTUAL VALUE
- (24-25) Mobility Average Direct Abutments (including one decimal)
0 - 0 0 - 0
1 - 1 .1 - 1 ACTUAL VALUE
2 - 2
- (26-27) Mobility Average Indirect Abutment (including one decimal)
ACTUAL VALUE

(28-29) Mobility Average Other Teeth (including one decimal)

ACTUAL VALUE

(30) Mucosa Edentulous Area (1)

0 - 1

1 - 2

2 - 3

(31) CR/CO Occlusion (1)

YES 1

NO 2

(32) Centric Balance (1)

YES 1

NO 2

(33) Eccentric Interferences (1)

YES 1

NO 2

(34) Examiner's Assessment of Dentures (1)

	<u>Fit</u>		<u>Stability</u>		<u>Retention</u>	
	Good	Bad	Good	Bad	Good	Bad
1	✓		✓		✓	
2	✓		✓			✓
3	✓			✓	✓	
4	✓			✓		✓
5		✓		✓		✓
6		✓		✓	✓	
7		✓	✓			✓
8		✓	✓		✓	

(35) Patient's Assessment of Denture (1)

	<u>Function</u>		<u>Comfort</u>	
	Good	Bad	Good	Bad
1	✓		✓	
2	✓			✓
3		✓	✓	
4		✓		✓

- (36) Usage (1)
- | | | | |
|---------|---|-----------|---|
| Always | 1 | Spasmodic | 3 |
| Daytime | 2 | Never | 4 |
- (37) Cleanliness (1)
- | | | | |
|-----|---|--|--|
| YES | 1 | | |
| NO | 2 | | |
- (38) Breakages (1)
- | | | | |
|-----------------|---|--|--|
| Wrought Clasp | 1 | | |
| Cast Clasp | 2 | | |
| Cast Connectors | 3 | | |
| Resin Base | 4 | | |
| Teeth | 5 | | |
- (39) Patient Motivation for Partial Denture Wearing
- | | | | |
|------------|---|--|--|
| Aesthetics | 1 | | |
| Function | 2 | | |
| Phonetics | 3 | | |
| Negative | 4 | | |
- (40) Source of Material
1. Dental Hospital
 2. Army and Air Force.

* * * * *

Abbreviations used in Data Presentation.

<u>TITLE</u>	<u>ABBREVIATION</u>
Adequate Vertical Support	ADVS
Direct Abutment Teeth	DAB
Indirect Abutment Teeth	IAB
Other Teeth	OTH
Russel's Index	RI
Tooth Mobility	MOB
Centric Relation	CR
Centric Occlusion	CO
Eccentric Interferences	ECC.INT.

Statistical Treatment of the Observations

The general formulae for the estimation of the Standard Error of the Mean (1) and the Standard Error of Proportions (2) were employed.

$$(1) \text{ S.E. of Mean} = \frac{\text{Standard Deviation}}{\sqrt{N}}$$

$$(2) \text{ S.E. of Proportions} = \sqrt{\frac{\text{Proportion (1 - proportion)}}{N}}$$

S.E. = Standard Error N = Number in Sample

Mean or proportion \pm 2 Standard Errors = approximately 95% confidence level.

Relationship of Data by Correlation

Method 1.

A simple correlation table was produced comparing USAGE, ADVS, RI DAB, RI IAB and RI OTH. These characteristics which were thought to be related to one another were examined by the use of the Pearson product moment correlation coefficient.

Method 2.

A second group of comparisons was made by calculating the standardised difference of the means divided by the standard error of the difference and arriving at valid conclusions from the findings.

$$\frac{\bar{x} - \bar{y}}{S\sqrt{(1/n_1 + 1/n_2)}} = \text{"T"} \text{ is referred to the "T" table, with } n_1 + n_2 - 2 \text{ degrees of freedom.}$$

$$\bar{x} = \text{mean (1)} \quad \bar{y} = \text{mean (2)}$$

$$n_1 = \text{Number of sample (1)} \quad n_2 = \text{Number of sample (2)}$$

S = Sample Standard Deviation

$$S^2 = \frac{SS_1 + SS_2}{n_1 + n_2 - 2} \quad \text{Where } SS_1 = \text{Corrected sum of squares (1)}$$
$$SS_2 = \text{Corrected sum of squares (2)}$$

Method 3.

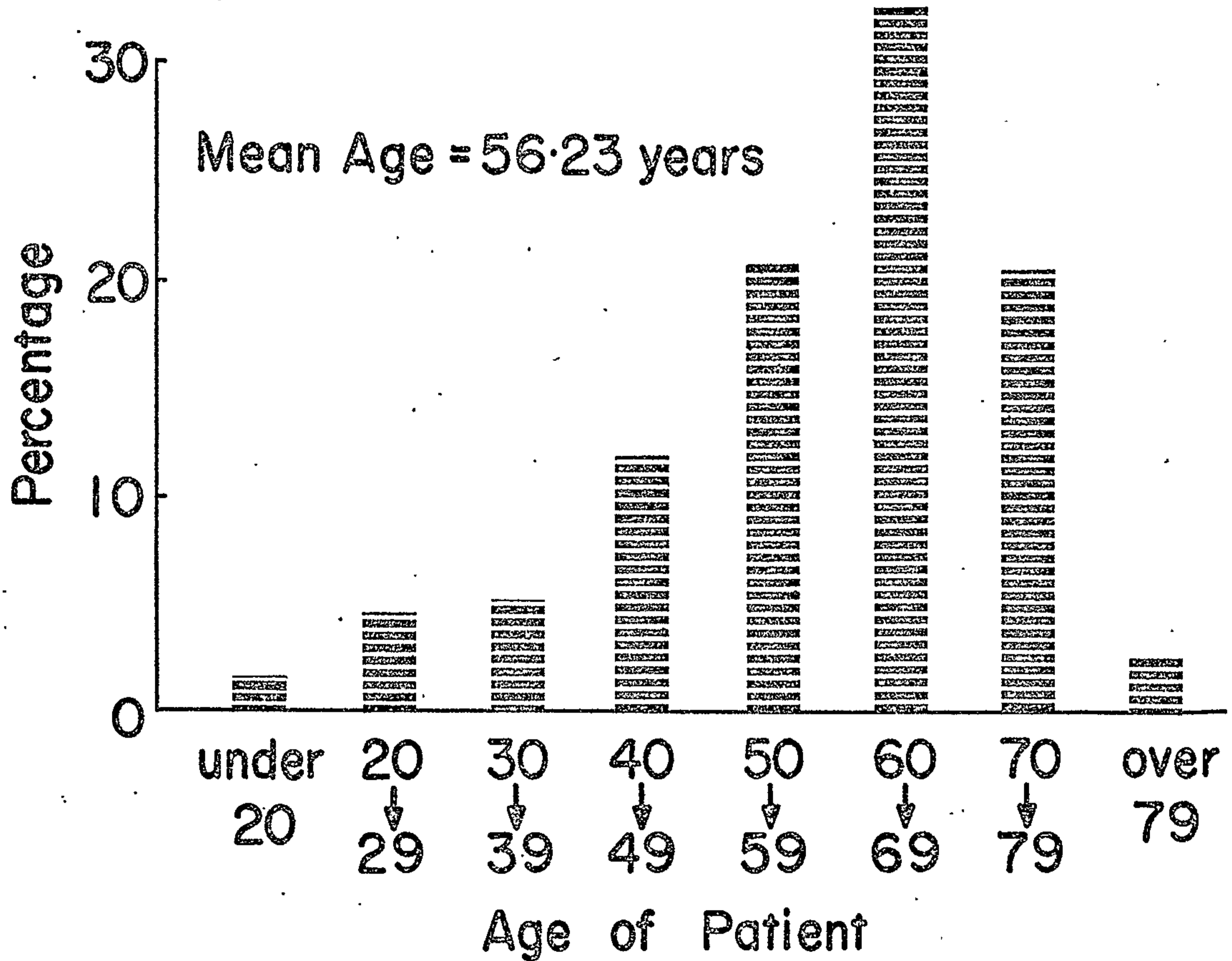
USAGE, ADVS, RI DAB, RI IAB and RI OTH were compared by the use of

2 way tables with Russel's Index values of 0 - 8 grouped by 0.2 intervals.

Data Group 1 (Dental Hospital). 561 Patients wearing 734 Partial Dentures.

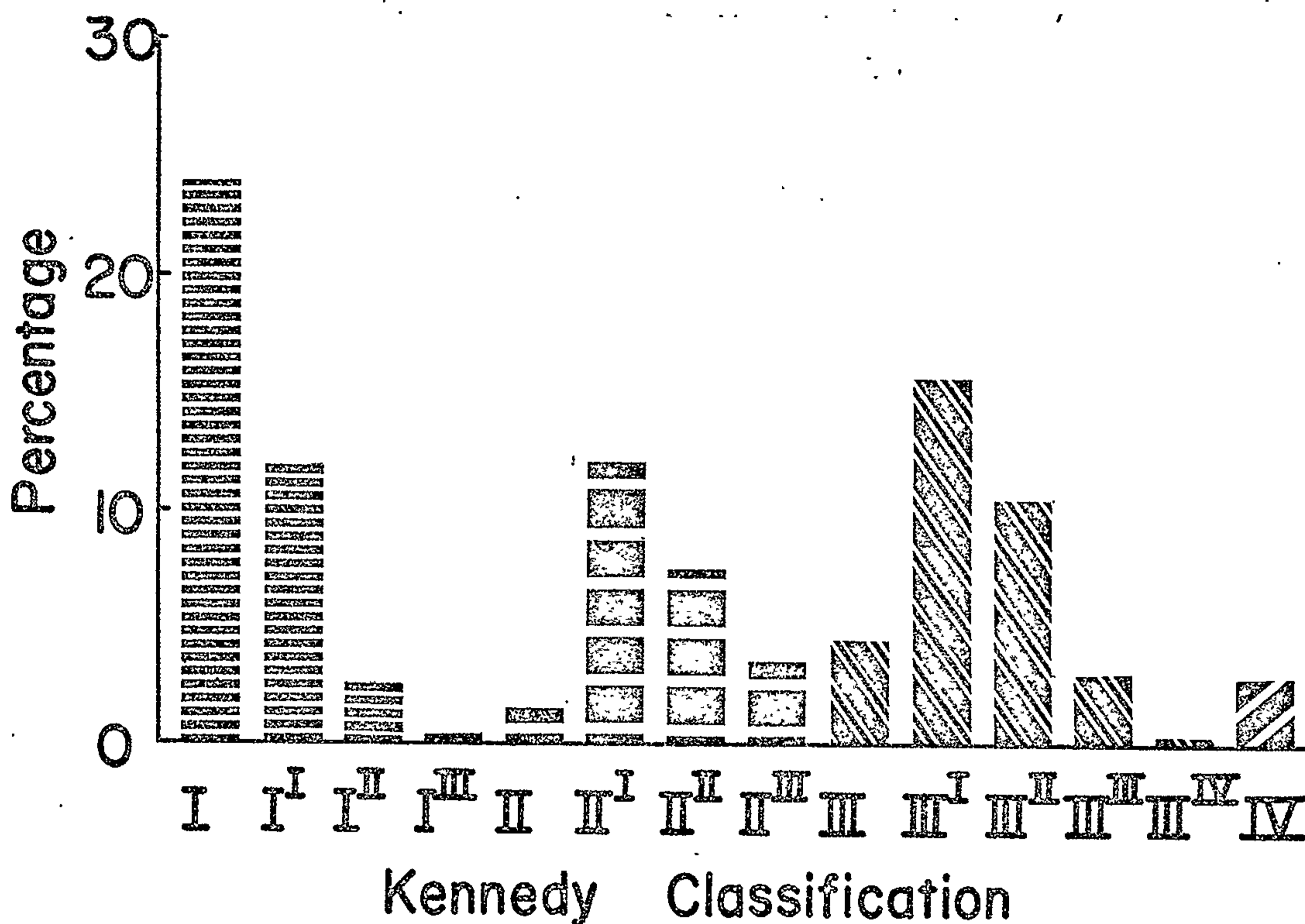
Sex Distribution - Female 72.62%
Male 27.38%

Age of Patient



Denture Classification (1) Partial Upper 51.50%
Partial Lower 48.50%

Denture Classification (2) Kennedy Classification



Denture Classification (3) Classification with Antagonists

Classification of Partial Dentures

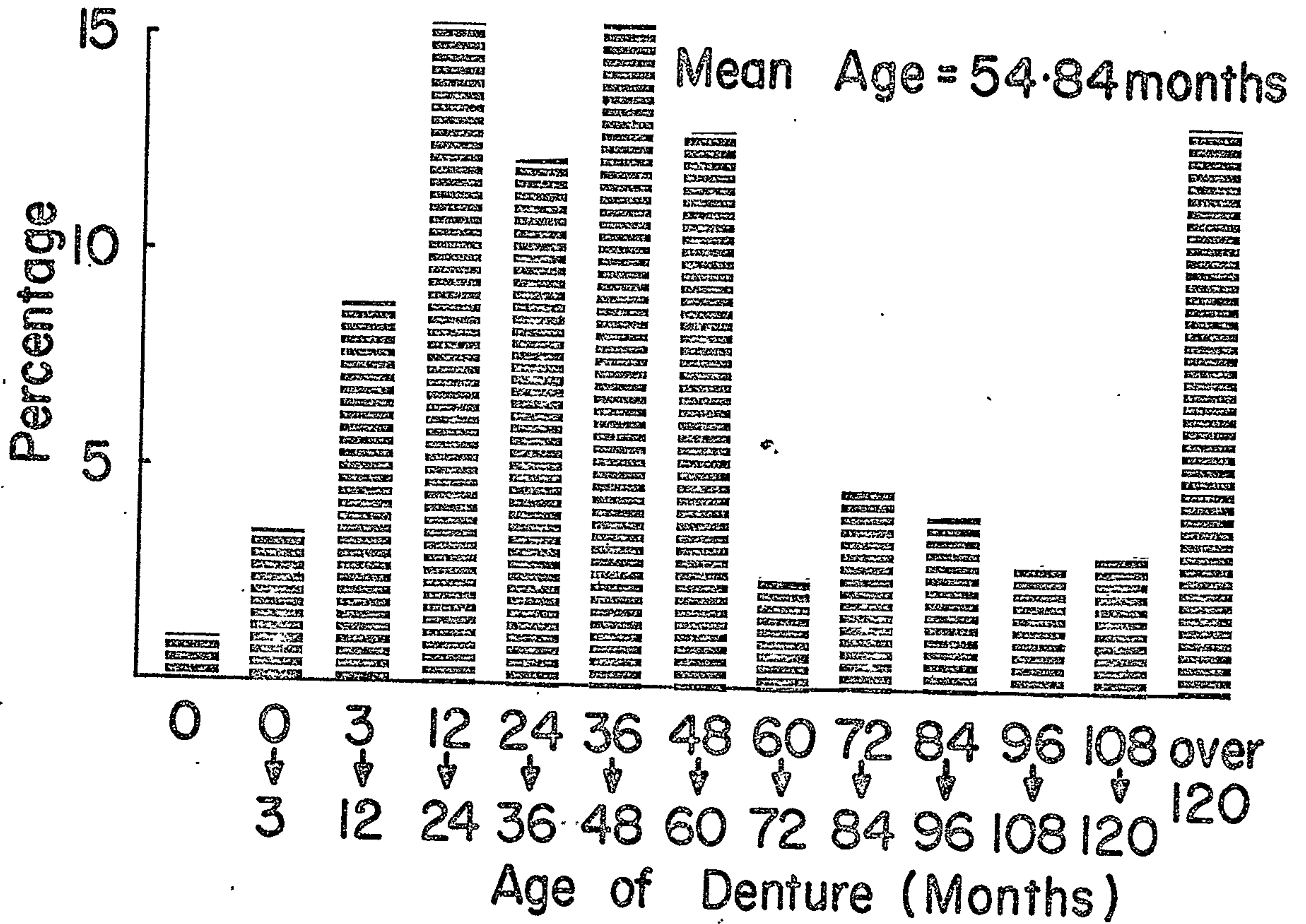
TYPE	%	No. of partial dentures
1 P/N	26.84	197
2 N/P	2.86	21
3 P/P	47.14	346
4 F/P	22.07	162
5 P/F	1.09	8
TOTAL	100	734

P = Partial Dentures

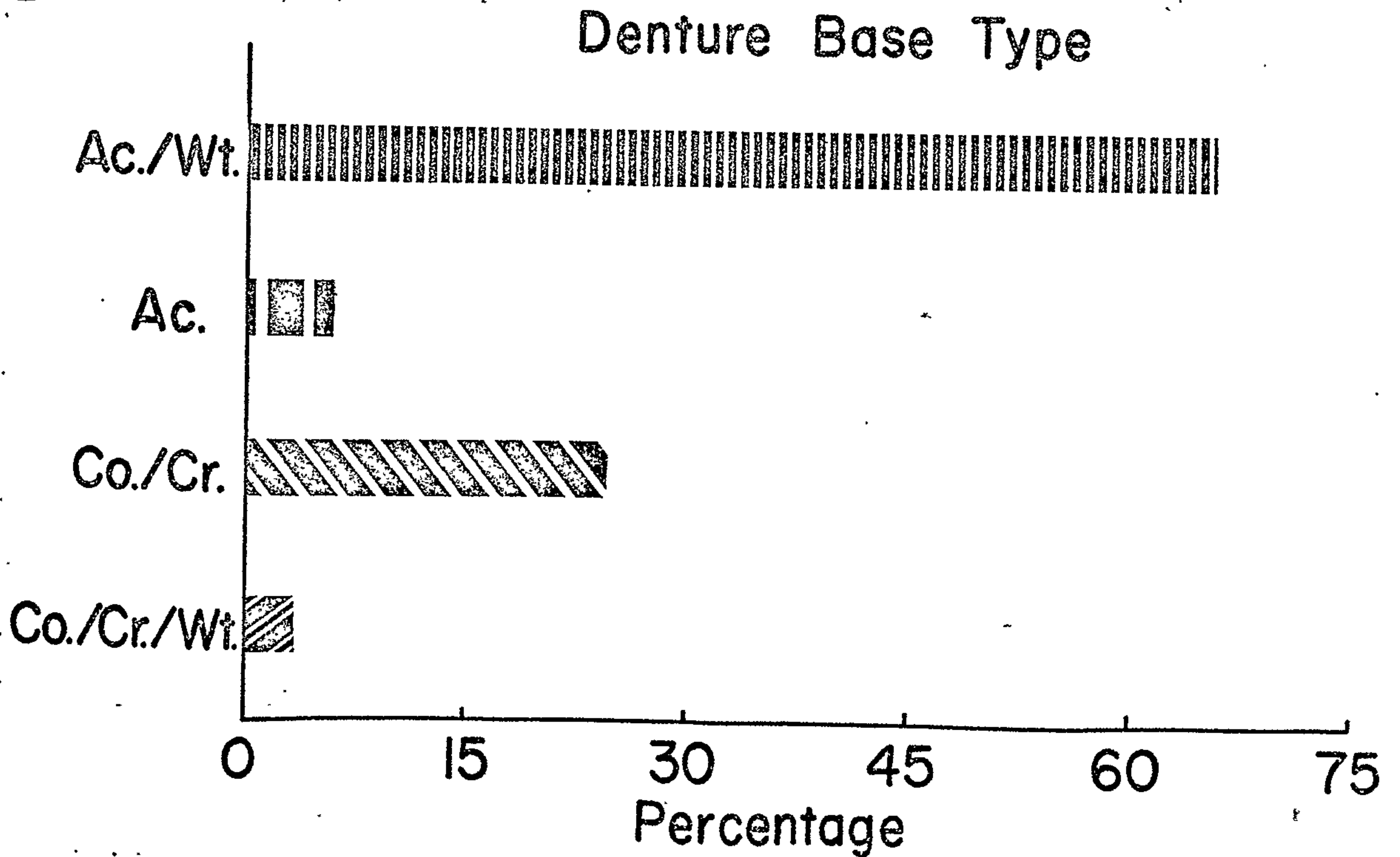
N = Natural Antagonists

F = Full Dentures

Age of Denture



Denture Base Type



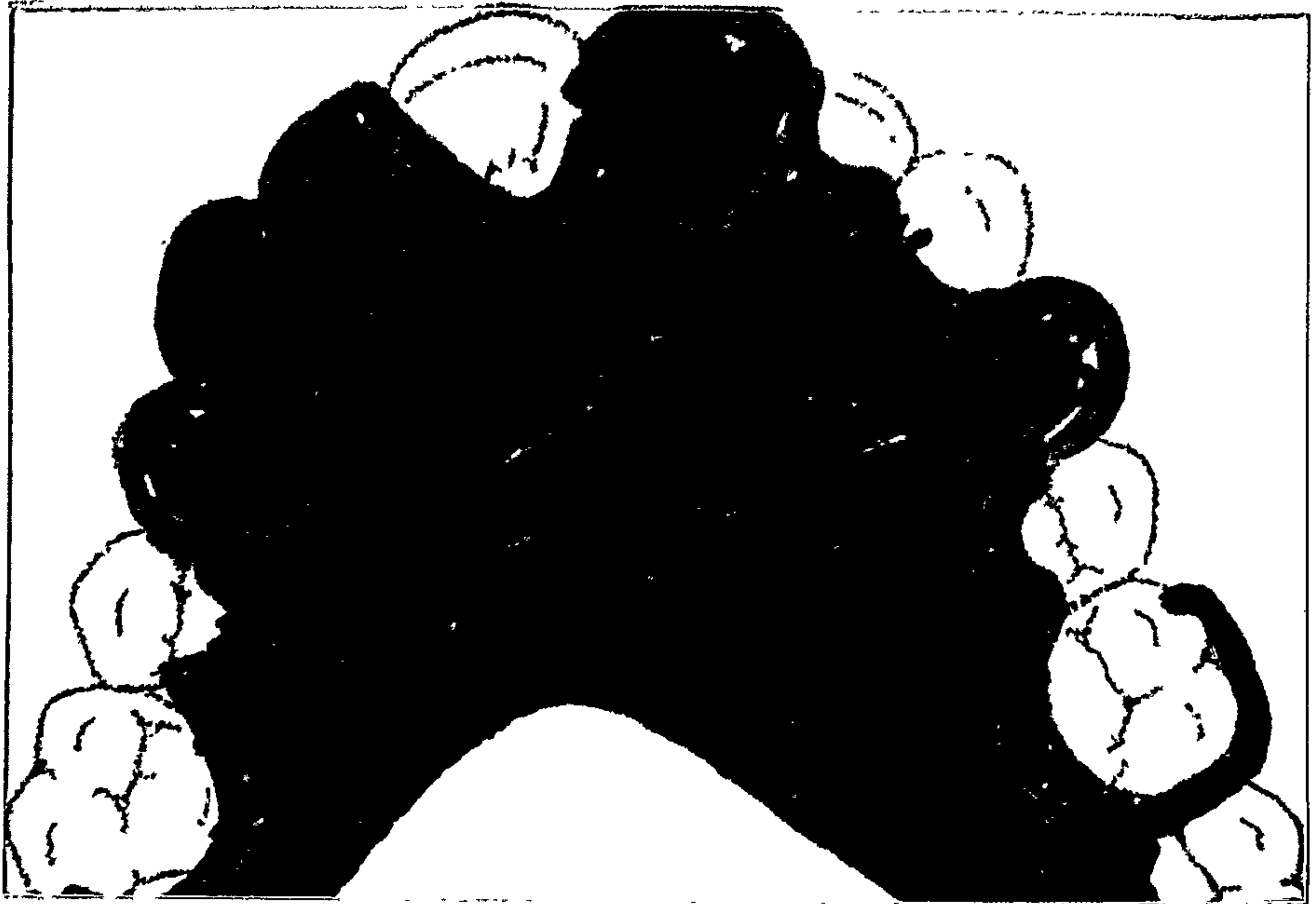


Fig.1. Sketch of acrylic partial upper denture with buccal wrought arm on upper left second molar, and fractured buccal arm upper right first molar. Note absence of occlusal rests.

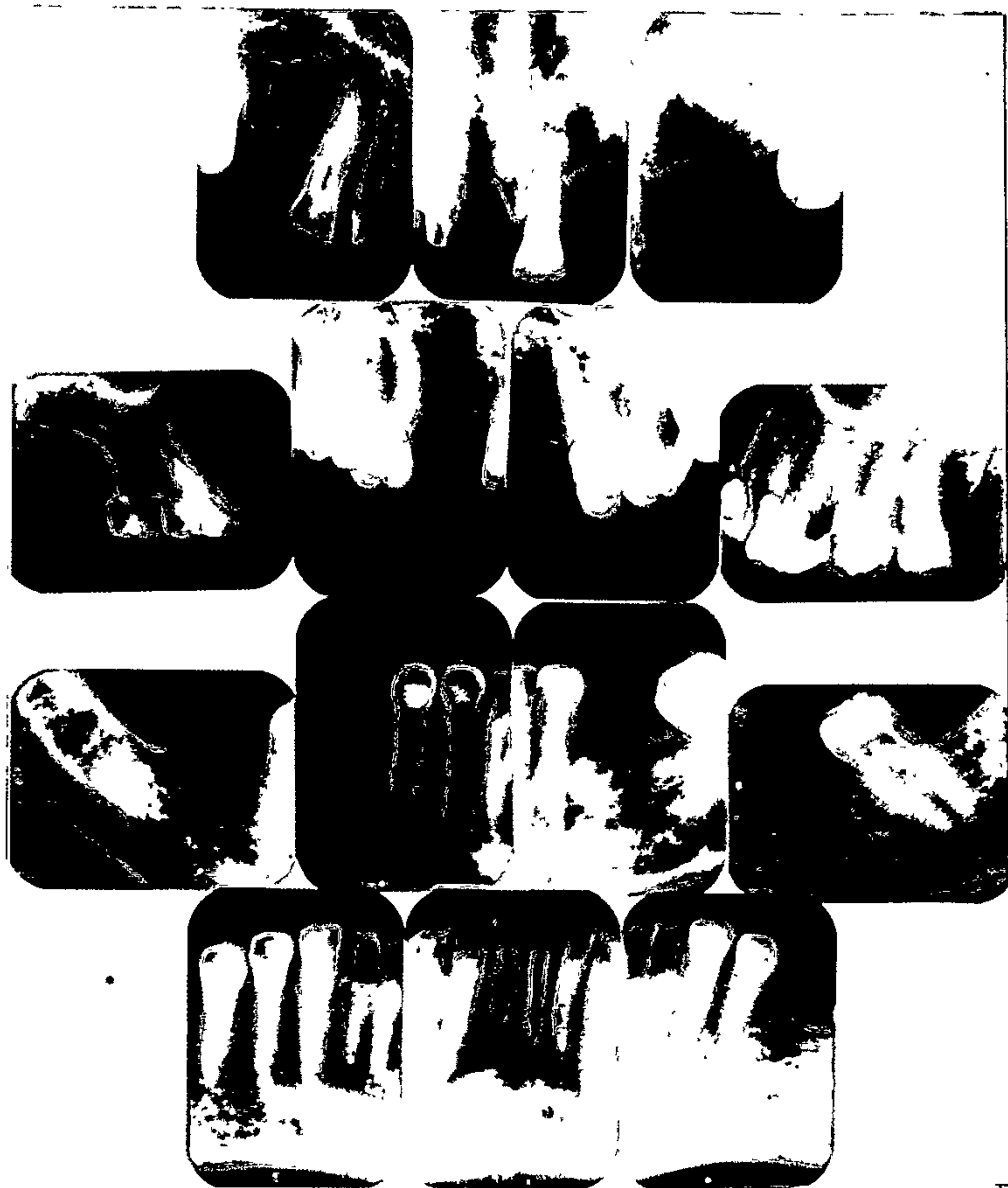


Fig.2. Full mouth periapical radiographs showing marked loss in alveolar bone height in the maxillary teeth when compared with the mandibular antagonists.

Case History 1. (Figs.1 and 2)

The patient was a 64 year old, healthy male, who had been wearing a partial upper acrylic denture since 1964. He presented with a large carious lesion in the upper right first molar.

The denture fit, stability and retention were deficient and the buccal wrought arm on the upper right first molar had fractured. There was a lack of adequate vertical support since there were no occlusal rests. The mouth and denture were clean, the denture was worn always. The patient was quite happy with the denture.

Occlusion was adequate in centric and there were no eccentric interferences.

A paradontal pocket on the upper left lateral incisor existed, otherwise the paradontal index score was nil. Tooth mobility was nil. Full mouth periapical radiographs disclosed excellent alveolar bony support for the mandibular teeth. The alveolar bone for the maxillary teeth was diminished, particularly for the incisors and overall when compared with the mandibular antagonists.

The partial denture would appear to have assisted alveolar resorption in the maxillary arch.

Case History 2. (Figs. 3 and 4)

This patient was a healthy female, 32 years old. She was wearing an acrylic partial lower denture made in Britain in 1964. The denture lacked vertical support, having a buccal wrought arm on the lower left bicuspid and a fractured buccal wrought arm on the lower right first bicuspid.

The Russel's Index and tooth mobility score for the mandibular teeth was zero. The occlusion was deficient with all denture components well free of contacts. There were no eccentric interferences.



Fig.3. Kennedy I mandibular acrylic partial denture without occlusal rests ("gum-stripper").



Fig.4. Healthy mandibular teeth, marginal gingivae and mucosa after wearing "gum-stripper" lower partial denture for 7 years.

The denture fit, stability and retention were deficient and the patient was not happy with the function or comfort of the denture. The denture was worn always. The healthy gingival condition under adverse circumstances could be attributed to meticulous cleansing of the teeth, supporting tissues and of the denture itself.

A total lack of function on the free end saddles and lack of occlusal prematurities may have aided tissue health. The biological factor including host resistance to gingival inflammation was apparently favourable.

Table 2.

Adequate Vertical Support (ADVS)

Ac/wt = Acrylic wrought Co/Cr = Cobalt Chrome

Ac = Acrylic Co/Cr/wt = Cobalt Chrome wrought

ADVS

Base	%	Actual No.	ADVS (YES)	ADVS (NO)
Ac/wt	65.94	484	78	406
Ac	5.72	42	0	42
Co/Cr	24.80	182	171	11
Co/Cr/wt	3.54	26	24	2
Totals	100	734	273	461

Case History 3. (Figs.5 and 6)

The patient was a female, 72 years old, remarkably healthy, and had been wearing a partial upper mesh cobalt-chrome denture constructed in 1958. The denture had not been relined or remodelled since insertion.

The denture fit, stability and retention was good. The design was rigid and lacked tooth-borne vertical support since the upper right second molar was the only abutment tooth provided with an occlusal rest. The denture had full palatal coverage. Russel's Index and tooth mobility scores were nil.

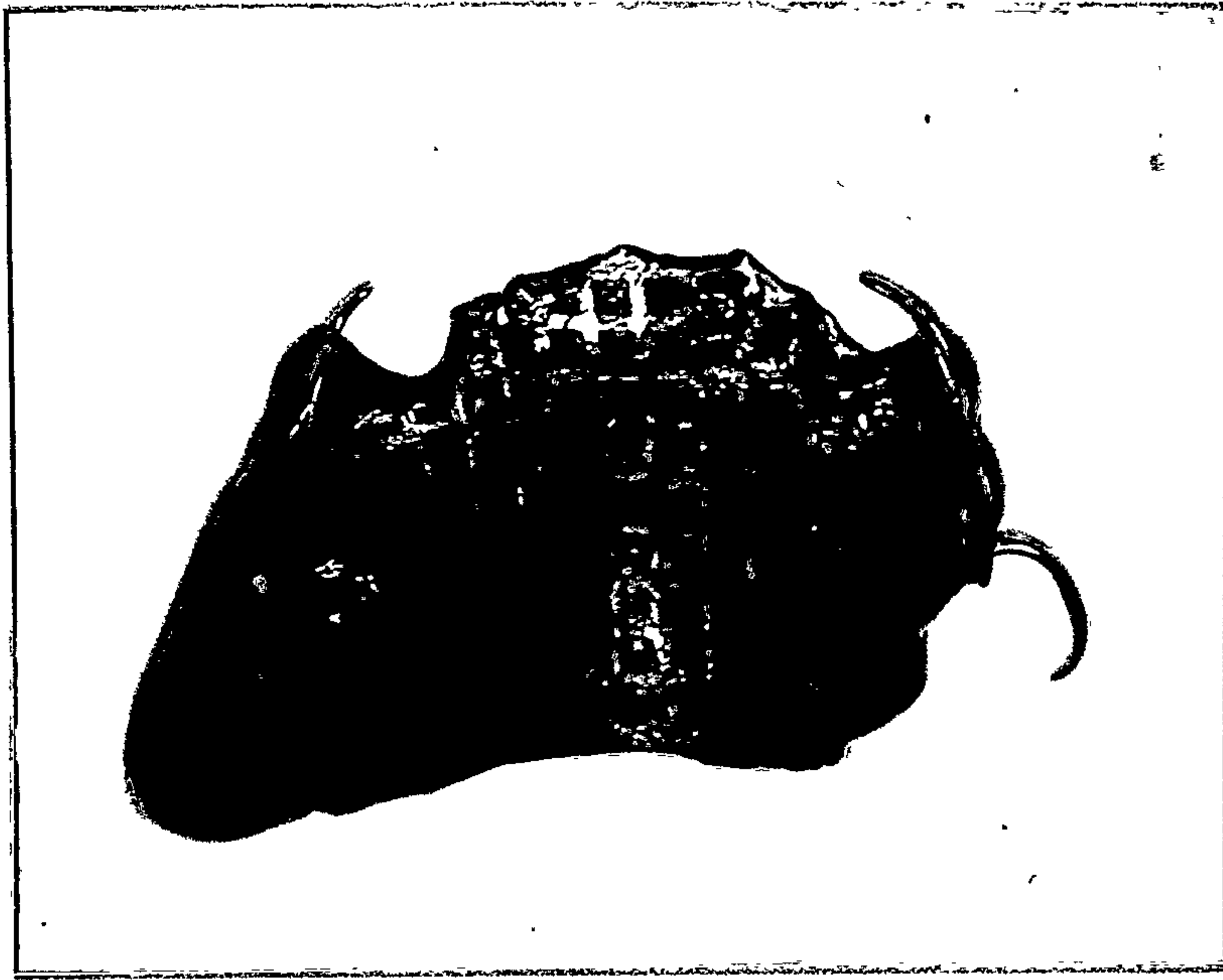


Fig.5. Partial denture of rigid design with full palatal coverage. Upper right second molar was the only abutment tooth provided with an occlusal rest.



Fig.6. Healthy gingivae and mucosa in maxillary arch which has successfully supported a partial denture for 13 years.

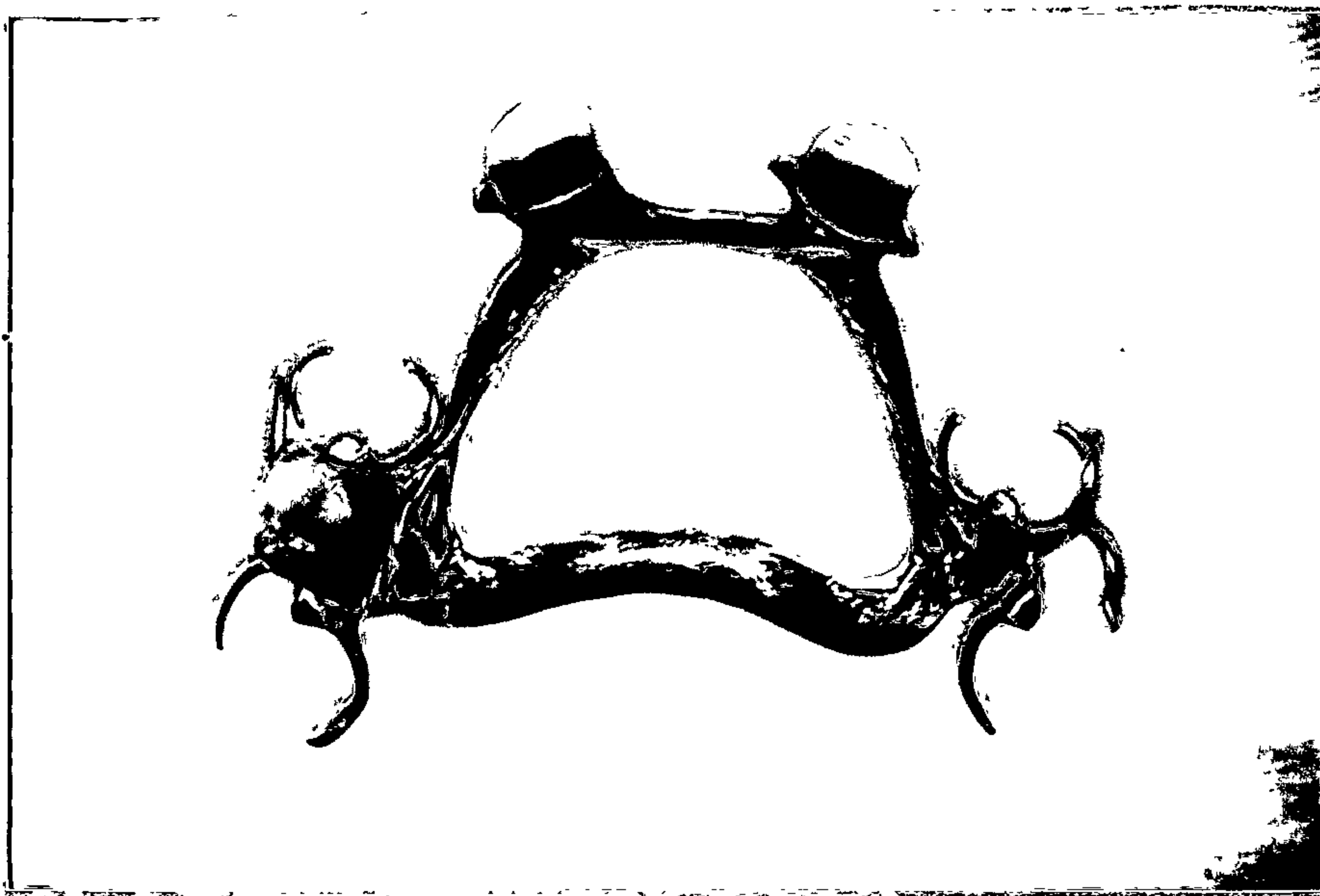


Fig.7. Kennedy Class III^{II} cobalt-chrome denture, casting worn for 15 years.



Fig.8. Healthy mouth demonstrating minor gingival inflammation on proximal of upper left and right canines.

Both denture cleanliness and oral hygiene were excellent, the denture was worn daytime only. Occlusal contacts were evenly distributed in centric relation and centric occlusion without prematurities. There were no eccentric interferences. Posterior contacts were few since there were only 8 standing lower teeth, first bicuspid to first bicuspid, and the patient had never had a partial lower denture constructed.

The absence of any appreciable alveolar resorption might be related to minimal occlusal loading over the posterior saddle areas, and to the presence of a free functioning occlusion.

Case History 4. (Figs. 7 to 10)

This patient was a 41 year old healthy male. He was wearing partial upper and partial lower cobalt-chrome dentures constructed in 1956. The partial upper was remodelled on two occasions, the latter being during 1970. The partial lower denture had not been relined or remodelled.

Fit and stability for the upper denture was good, active retention was deficient. Fit, stability and retention of the lower denture was good. Tooth mobility was zero, whilst there was some minor gingival inflammation associated with some of the abutment teeth. Centric balance was adequate and there were no eccentric interferences present.

The dentures were clean and worn daytime only. The lower partial denture, by means of onlays on the posterior teeth, had been used to improve the occlusion by increasing vertical dimension and providing broad and adequate contacts in centric occlusion.

The entire lower arch had been reunited and stabilised, protecting the mandibular teeth from twisting and torquing effects during function, thus enhancing the healthy preservation of the periodontal ligaments and supporting structures.

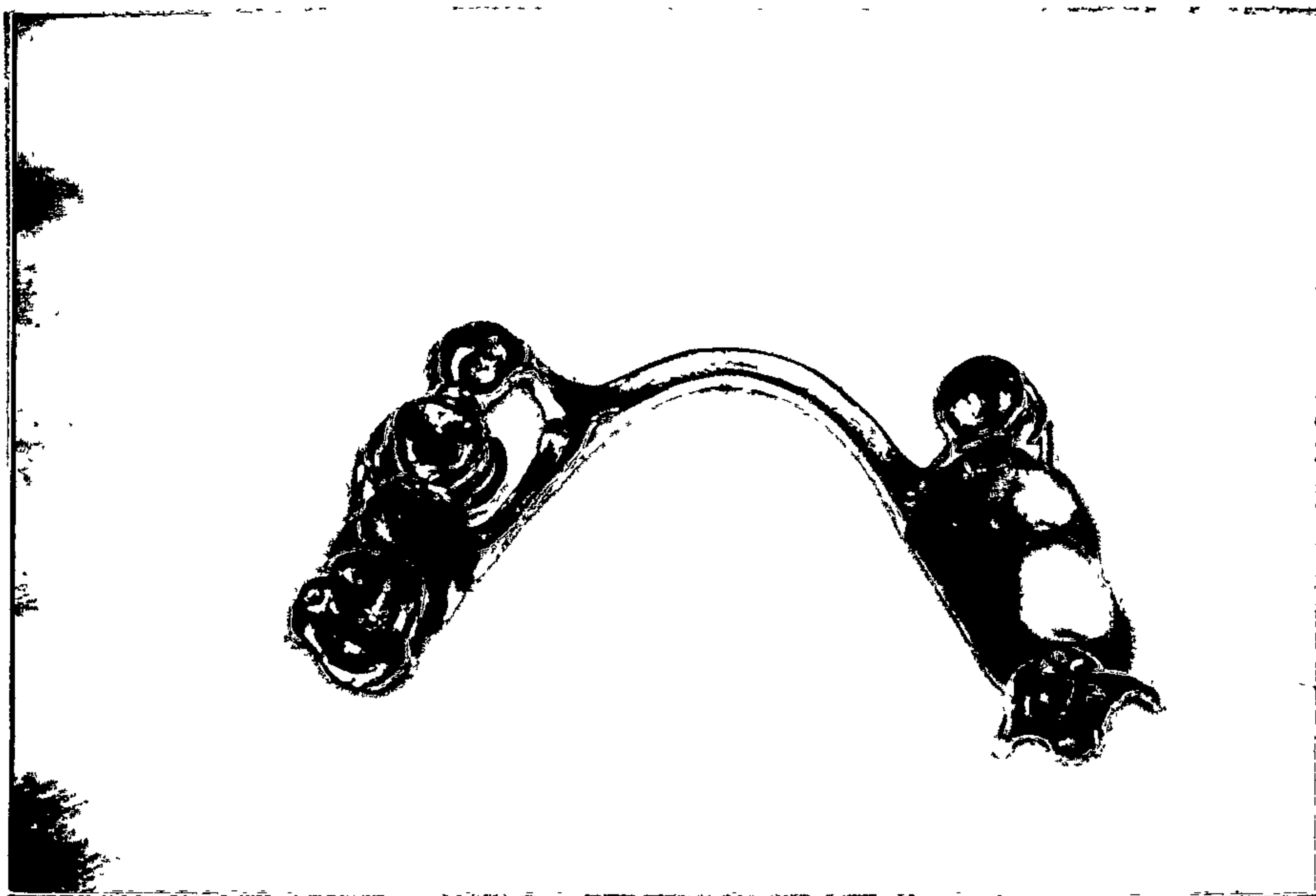


Fig.9. Kennedy Class III^I cobalt-chrome denture using onlays to improve the occlusion, and to stabilize the lower arch. Casting worn for 15 years.



Fig.10. Healthy mouth gingivally and paradontally. There is decalcification of the enamel on the occlusal surfaces of the lower right first bicuspid and the lower left second bicuspid. The right edentulous saddle area shows slight tissue hypertrophy. The denture requires relining or remodelling to provide good fitting surfaces between the denture base and mucosa in the edentulous saddle areas.

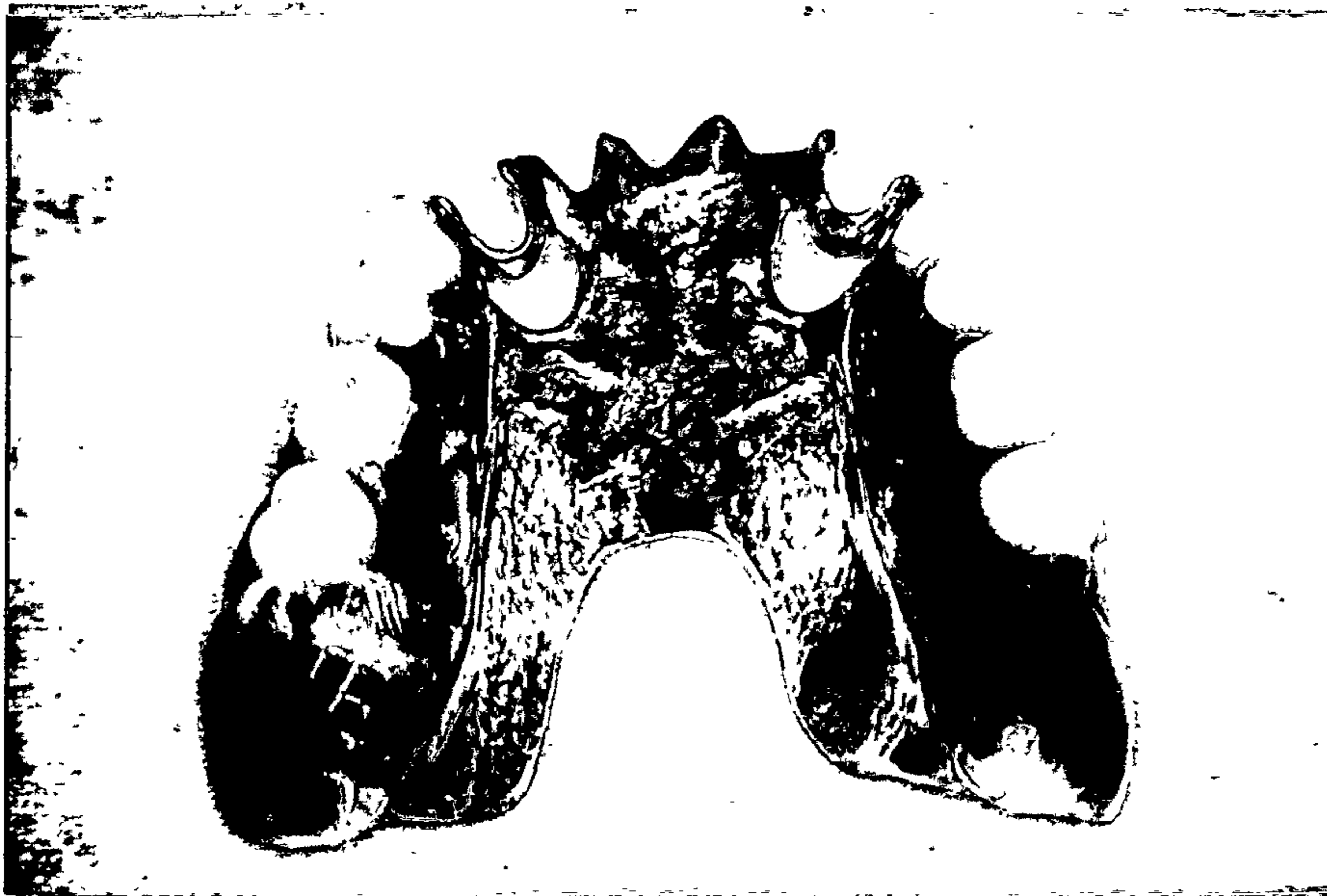


Fig.11. Kennedy I cobalt-chrome partial upper denture using mesio-distal retainers.



Fig.12. Precious metal restorations on all standing maxillary teeth. Note preparation on upper canine castings to receive the mesio-distal retainers. Upper left third molar has been crowned and retained to preserve alveolar bone in this region. Healthy mouth gingivally and paradontally.

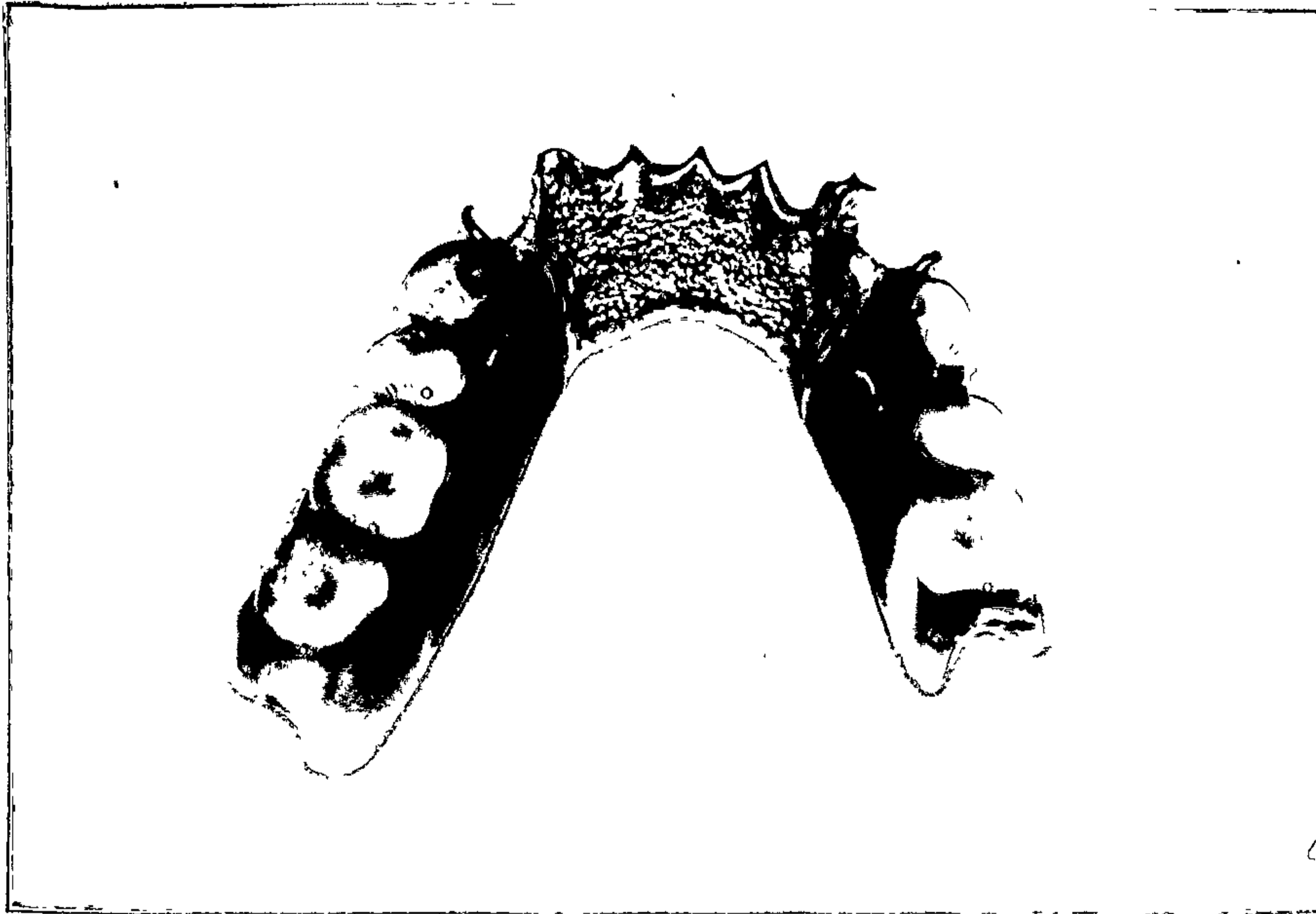


Fig.13. Kennedy II^I cobalt-chrome lower partial denture using wrought gold wire for retainers.



Fig.14. Healthy mouth which has supported a partial lower denture successfully for 6 years.

Case History 5. (Figs.11 to 14)

This patient was a healthy male, 56 years old, wearing partial upper and lower cobalt-chrome dentures. The upper denture had been worn for 18 months, the lower for about 6 years.

All maxillary standing teeth have been crowned using a type C gold, the castings for both canines were prepared to receive mesio-distal retainers. Retention provided by these retainers was acceptable and aesthetically excellent.

Fit and stability of the upper partial was good and similarly with the lower partial, however active retention was deficient in the lower.

Wrought gold arms have been used as retainers for the lower partial denture. Elastic clasps are more efficient for retention and less traumatizing to the abutment teeth than clasps which lack resiliency. The buccal wrought arm for the lower right third molar had fractured.

Tooth mobility was zero. There was mild tissue inflammation on the distal aspect of the upper left canine and the lingual of the lower right third molar. The occlusion was excellent with adequately distributed contacts in centric relation and centric occlusion without prematurities. There were no eccentric interferences present. The dentures were clean and worn daytime only.

Table 3.

561 Patients wearing 734 Partial Dentures

Teeth	No.of teeth		Russel's Index		Mobility	
	Mean	SE	Mean	SE	Mean	SE
DAB	2.46	0.06	0.86	0.02	0.27	0.01
IAB	3.63	0.09	0.74	0.02	0.33	0.01
OTH	7.32	0.07	0.30	0.01	0.07	0.003



Fig.15. Chrome-cobalt partial denture 6 years old, lacking adequate vertical support.



Fig.16. Edentulous saddle areas showing gross inflammation and oedema of mucosa in relation to denture outline.

Case History 6. (Figs.15 and 16)

The patient was a 39 year old healthy female, wearing a partial upper cobalt-chrome denture, constructed in 1965. The denture was ill-fitting, unstable and lacked retention. The upper right second bicuspid had been extracted since denture insertion.

The denture was clean but worn always. A deflective contact on the mesial incline of the upper right first molar in centric relation forced the patient to assume a forward deviation for centric occlusion. The mucosa of the edentulous saddle areas was grossly inflamed, oedematous and swollen. The inflammation was particularly severe in the incisor region where the edentulous saddles were not supported by occlusal rests. Slight mobility was evidenced in the incisors. The patient complained of minor soreness occasionally, but otherwise was happy with the denture.

Mucosa Edentulous Area.

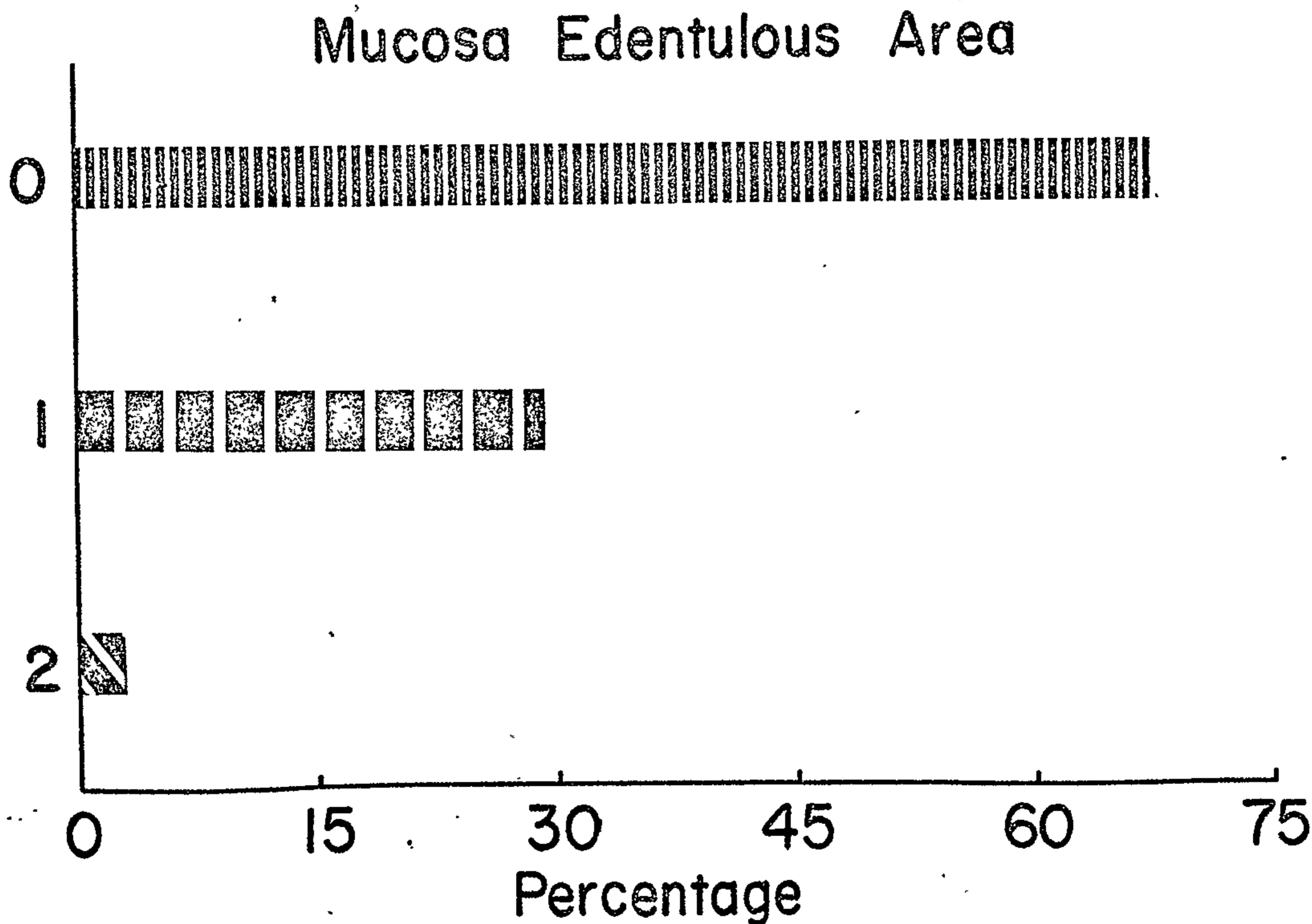




Fig.17. Well fitting lower cobalt-chrome denture.



Fig.18. Gross inflammation of the marginal gingivae and mucosa associated with the lingual bar.

Case History 7. (Figs.17 and 18)

This patient was a 46 year old female, who was taking tranquillisers for emotional stress. Her husband had died 3 months previously. She had worn a full upper and acrylic partial lower denture for many years prior to the construction of the present cobalt-chrome denture which had been worn for 18 months.

Denture fit, stability and retention were good. Her denture was clean, worn always and the patient was happy with the prosthesis. She presented herself for examination complaining of minor discomfort which was arising from a cemental carious lesion on the lingual surface of the lower right second bicuspid. The patient was unaware of the inflamed condition of the marginal gingivae and the mucosa associated with the lingual bar.

Occlusal contacts in centric relation and centric occlusion were adequate and well distributed, however eccentric interferences were present. One would have to consider systemic factors other than local factors as causative agents of the inflammatory state of the gingivae and mucosa. Possibilities include dietary deficiencies since the patient was being treated for nervous disability, was recently widowed and lived alone.

She may have been post-menopausal and deficiency states could include:-

1. Oestrogen deficiency
2. Hypochromic anaemia
3. Calcium imbalance and vitamin C deficiency
4. Protein and vitamin B deficiencies

There may have been an accompanying candida infection. All standing teeth exhibited slight mobility, but the lower right second bicuspid had definite mobility.

Table 4.

Occlusion			
Relationship	%Yes	%No	SE of Proportion
CR/CO	14.44	85.56	.01
CB	69.75	30.25	.02
ECC.INT	53.54	46.40	.02

CR = Centric Relation CO = Centric Occlusion
 CB = Centric Balance ECC.INT = Freedom from eccentric
 interferences associated with denture base or components.
 SE of Proportion = Standard Error of Proportion.

Table 5.

Examiner's Assessment of Dentures
 Fit, Stability, Retention

Group	%	No.Dent.	Group	%	No.Dent.
1	25.89	190	5	31.06	228
2	30.93	227	6	2.18	16
3	0.14	1	7	3.54	26
4	1.91	14	8	4.36	32

Groups 1 - 8, see master sheet for coding. Page 45

By simple calculation

Factor	%	No.Dent.	Factor	%	No.Dent.
Good fit	58.87	432	Bad fit	41.13	302
Good stab.	64.72	475	Bad stab.	35.28	259
Good ret.	32.56	239	Bad ret.	67.44	495

Satisfactory according to examiner's assessment 56.82% (417) dentures.
 Unsatisfactory 43.18% (317) dentures

Group 1 Good fit, Good stability, Good retention
 +
 Group 2 Good fit, Good stability, Bad retention
 = Satisfactory according to examiner's assessment.

Table 6.

Patient's Assessment of Dentures
Comfort, Function

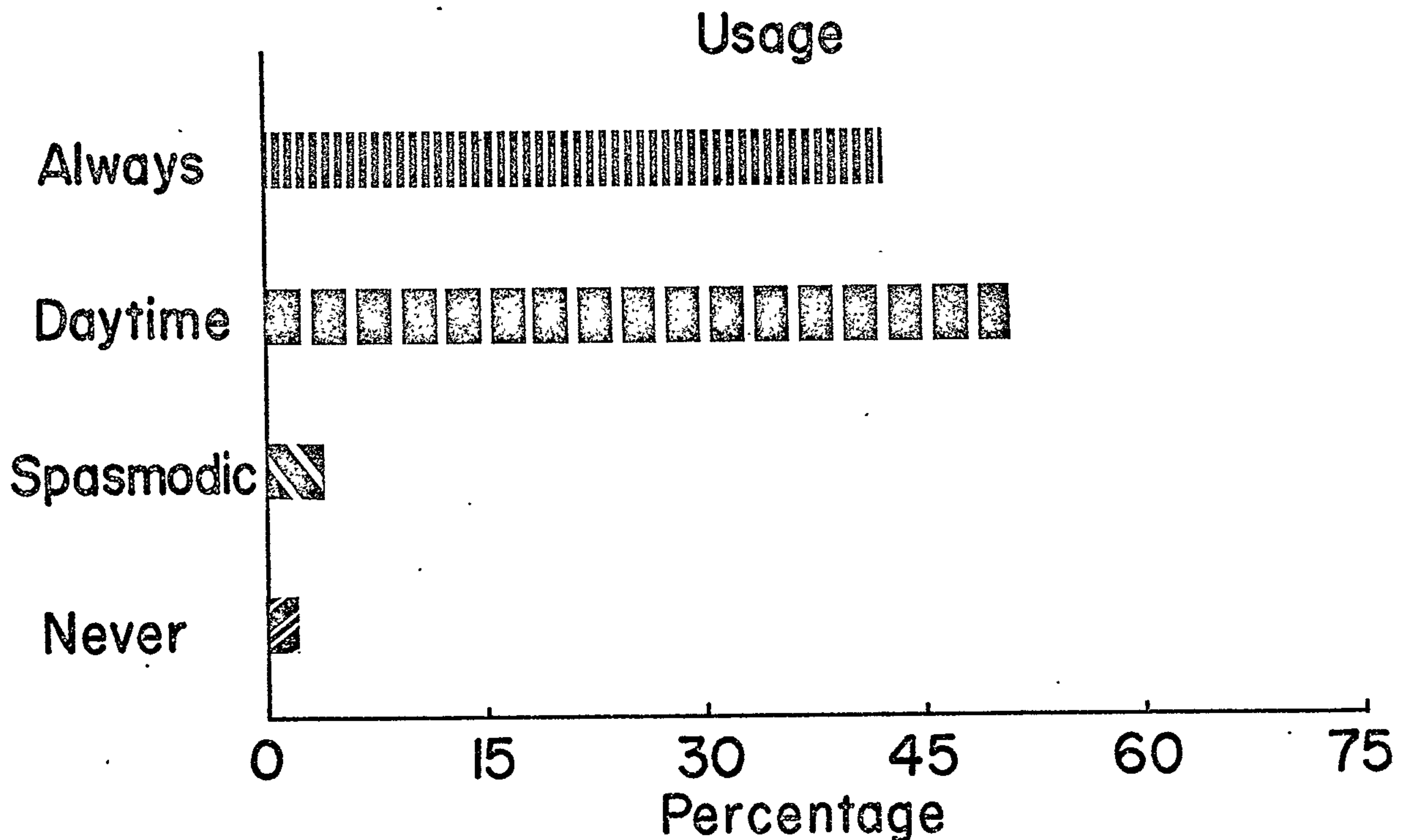
Group	%	No.Dent
1	68.66	504
2	6.68	49
3	6.81	50
4	17.85	131

Groups 1 - 4, see master sheet for coding. Page 45

By simple calculation

Good Function = 75.34% (553) Bad Function = 24.66% (181)
Good Comfort = 75.47% (554) Bad Comfort = 24.53% (180)
Satisfactory according to patient assessment = 68.66% (504)
Unsatisfactory according to patient assessment = 31.34% (230)

USAGE



Denture Cleanliness

Yes = 84.60% S.E. Proportion = .01
No = 15.40%

Table 7. Breakages

Type	Overall %	No. Breakages	Actual No. of dentures
Wt. Clasp	4.50	36	510
Cast Clasp	1.50	11	182
Cast Connect.	0.00	0	0
Resin Base	3.54	26	552
Teeth	3.41	25	734

Patient Motivation for Partial Denture Requirements.

- 63.76% - Aesthetics
- 34.20% - Function
- .41% - Phonetics
- 1.63% - Negative

Relationship of Data by Correlation - Group 1.

Method 1. Pearson product moment correlation coefficient.

Most of these coefficients turned out to be small, rather contrary to the initial expectation which led to their analysis, the exceptions being -

- RI IAB - RI DAB correlation = 0.57
- RI OTH - RI DAB correlation = 0.40
- RI OTH - RI IAB correlation = 0.30

and these were significant at the 1% level. These findings indicate that increases in Russel's Index in DAB, IAB and OTH teeth tend to increase together. In other words RI DAB increases tend not to be isolated but accompanied by an increase in RI IAB and RI OTH which may indicate the inflammation was due to possible lack of preventive care, systemic factors or poor resistance, for example, rather than being entirely due to increased stresses on DAB and IAB teeth involved in partial denture wearing. The correlation coefficients for the remainder of the group were very small, a partial explanation was that data was too heavily grouped

(e.g. ADVS (YES), ADVS (NO)) suggesting the Pearson test was invalid for the other correlations.

Method 2.

Calculation of the standardized difference of two means, dividing by the standard error of the difference.

The following comparisons were of interest.

1. For wrought arms the mean retention factor was .7000 and for cast arms .5330. Therefore the retention factor for wrought arms was superior to cast arms in this group. (Statistically significant at 1%)
2. For the inflammatory condition of mucosa edentulous areas for patients wearing acrylic bases, the mean was 1.3498, and for the inflammatory condition of mucosa edentulous areas for patients wearing cobalt chrome bases, the mean was 1.3510. Therefore inflammation of mucosa edentulous areas was not related to the type of base, i.e. acrylic or cobalt chrome. (Not significant statistically)
3. For the inflammatory condition of mucosa edentulous areas always, the mean was 1.5247, and for the inflammatory mucosa condition of edentulous areas daytime. the mean was 1.5882. The means were fairly close together and therefore usage (always, daytime) does not appear to be a significant factor in inflammation of mucosa edentulous areas. In this test group, in fact, there was slightly more inflammation from the "daytime" group than "always" group. (Not significant statistically)
4. For RI DAB Kennedy Class I and II the mean was .9251 and for RI DAB Kennedy Class III and IV mean was .7199. As expected the RI DAB was greater for Kennedy I and II cases than for Kennedy III and IV. This increase must be attributed to greater stress being applied to the abutment teeth with free-end saddles. (Statistically significant at 1%)

5. For RI IAB Kennedy Class I and II the mean was .7701 and for RI IAB Kennedy Class III and IV was .6809. Here again the Russel's Index IAB was higher for the free-end saddle dentures than for tooth-borne saddles, however the difference was not as great as for Direct Abutment teeth. (Not significant statistically).
6. For MOBILITY DAB Kennedy I and II the mean was .3159 and for MOB DAB Kennedy III and IV the mean was .1653. Again Mobility DAB teeth was much higher for the free-end saddle dentures. (Significant at 1%)
7. For MOB IAB Kennedy I and II the mean was .3839 and for MOB IAB Kennedy III and IV was .2208. Here again MOB IAB for free-end saddle cases was greater, however, the difference was not as great as for MOB DAB teeth. (Significant at 1%)

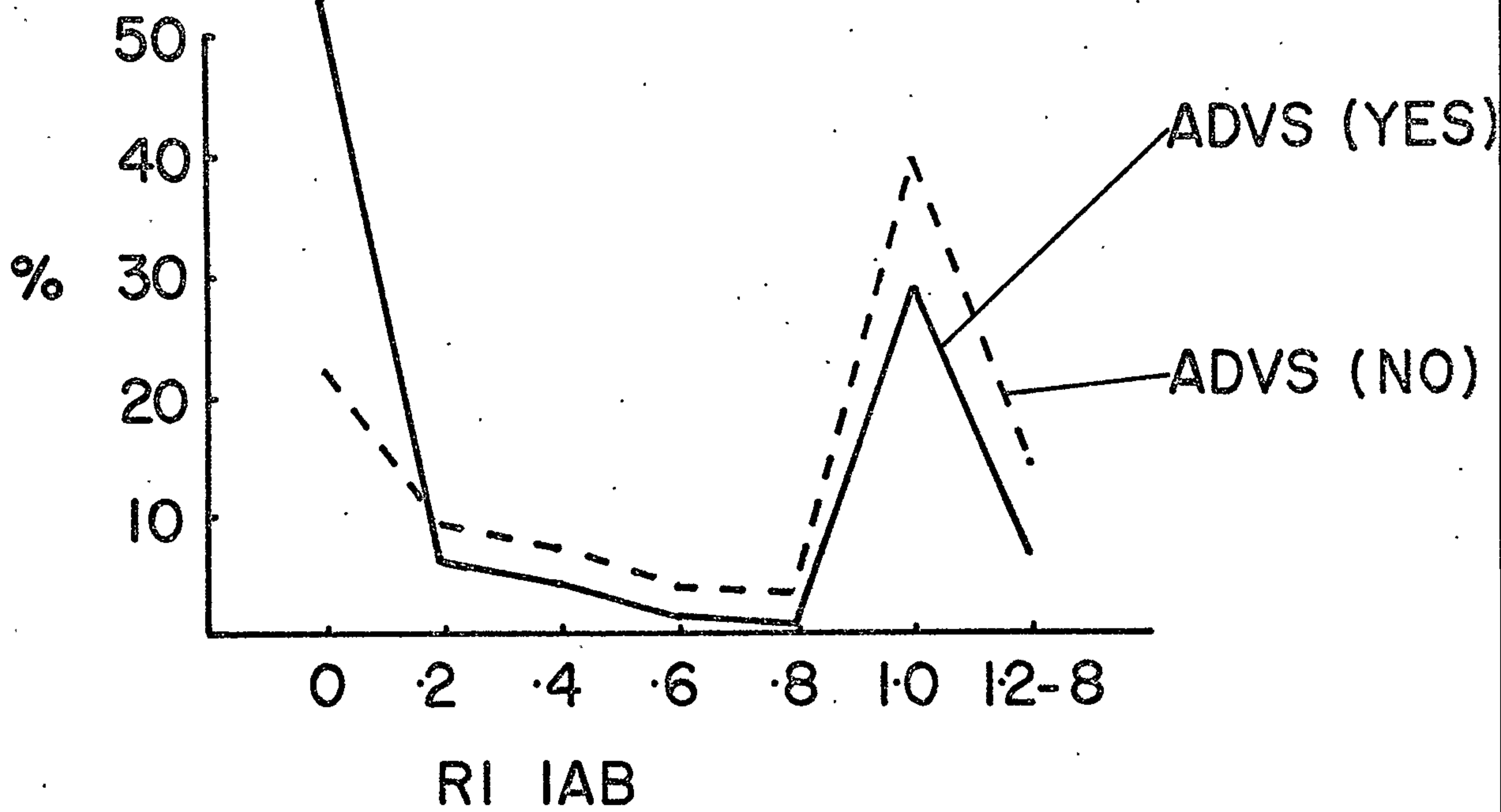
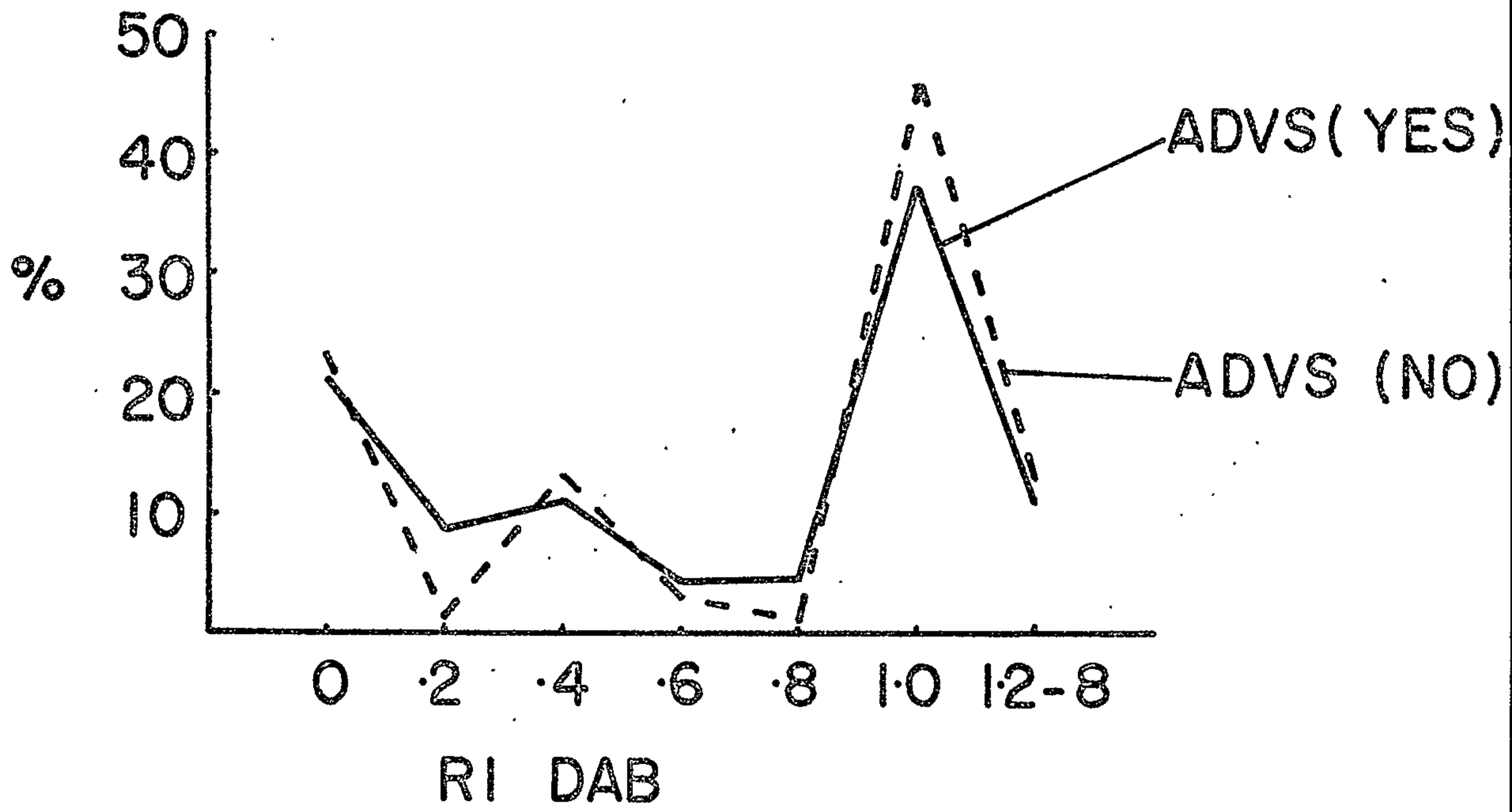
Method 3.

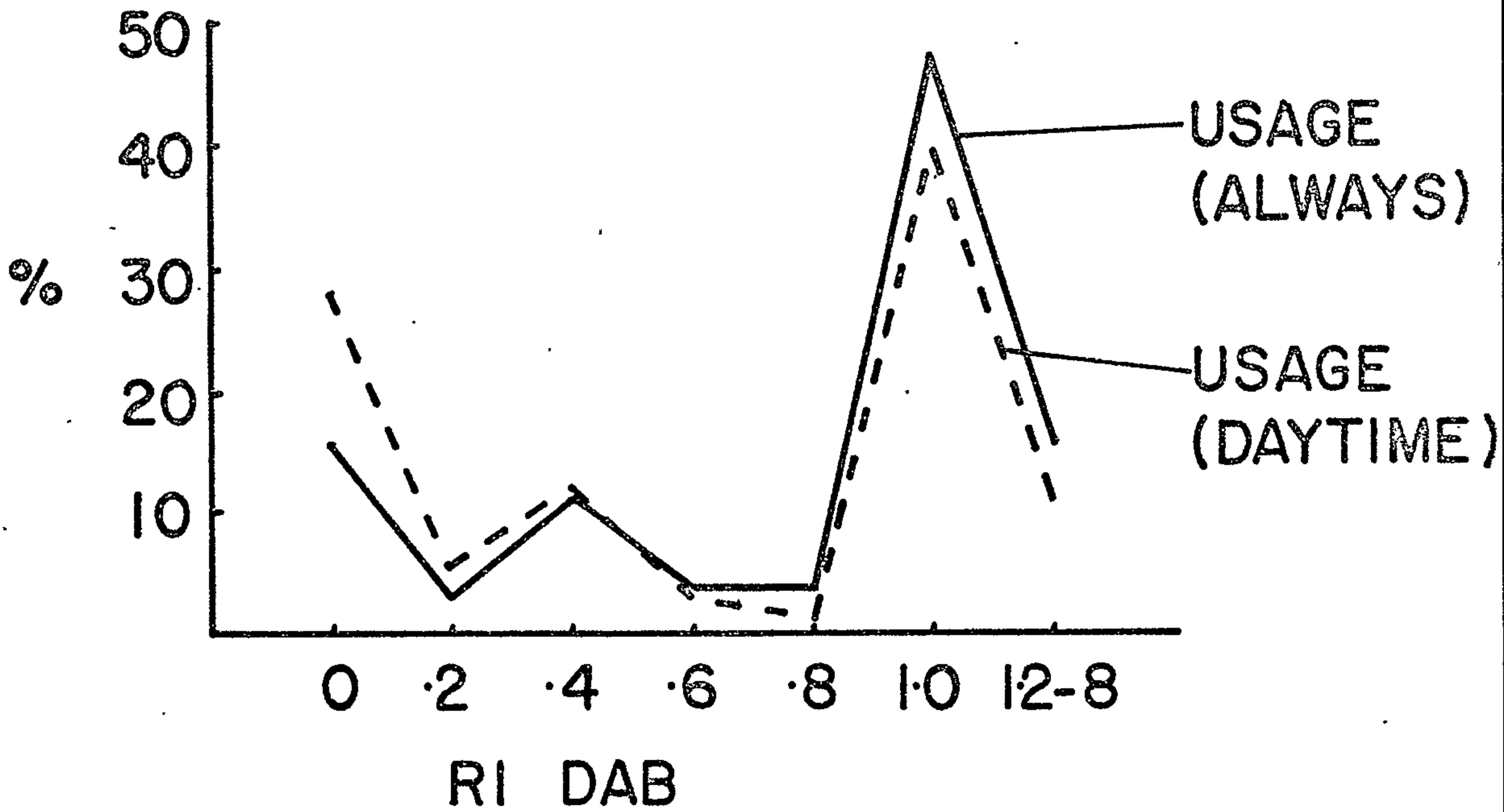
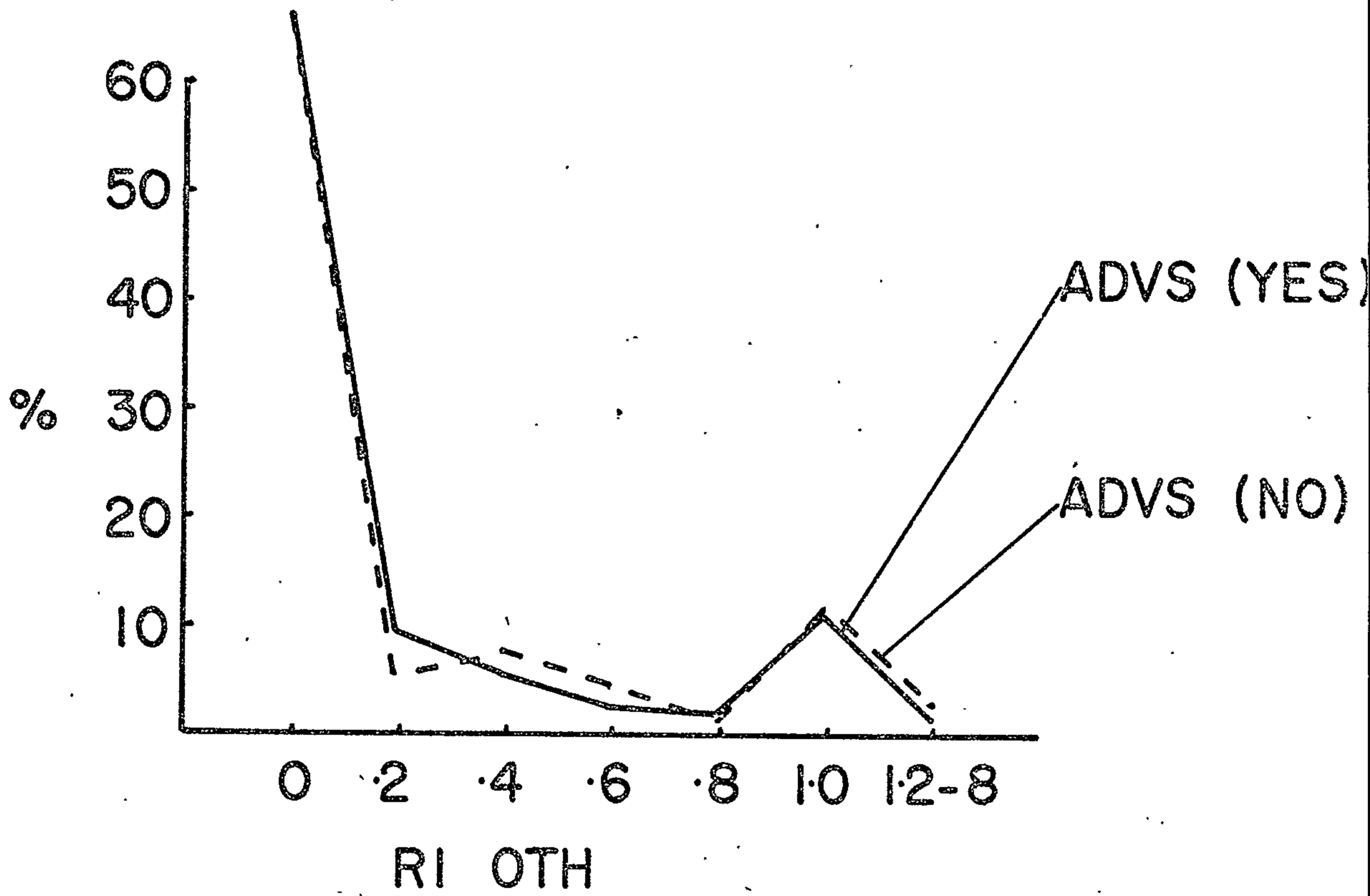
Comparison of factors by two way tables (percentages and actual numbers) with Russel's Index values ranging from 0 - 8 by 0.2 intervals.

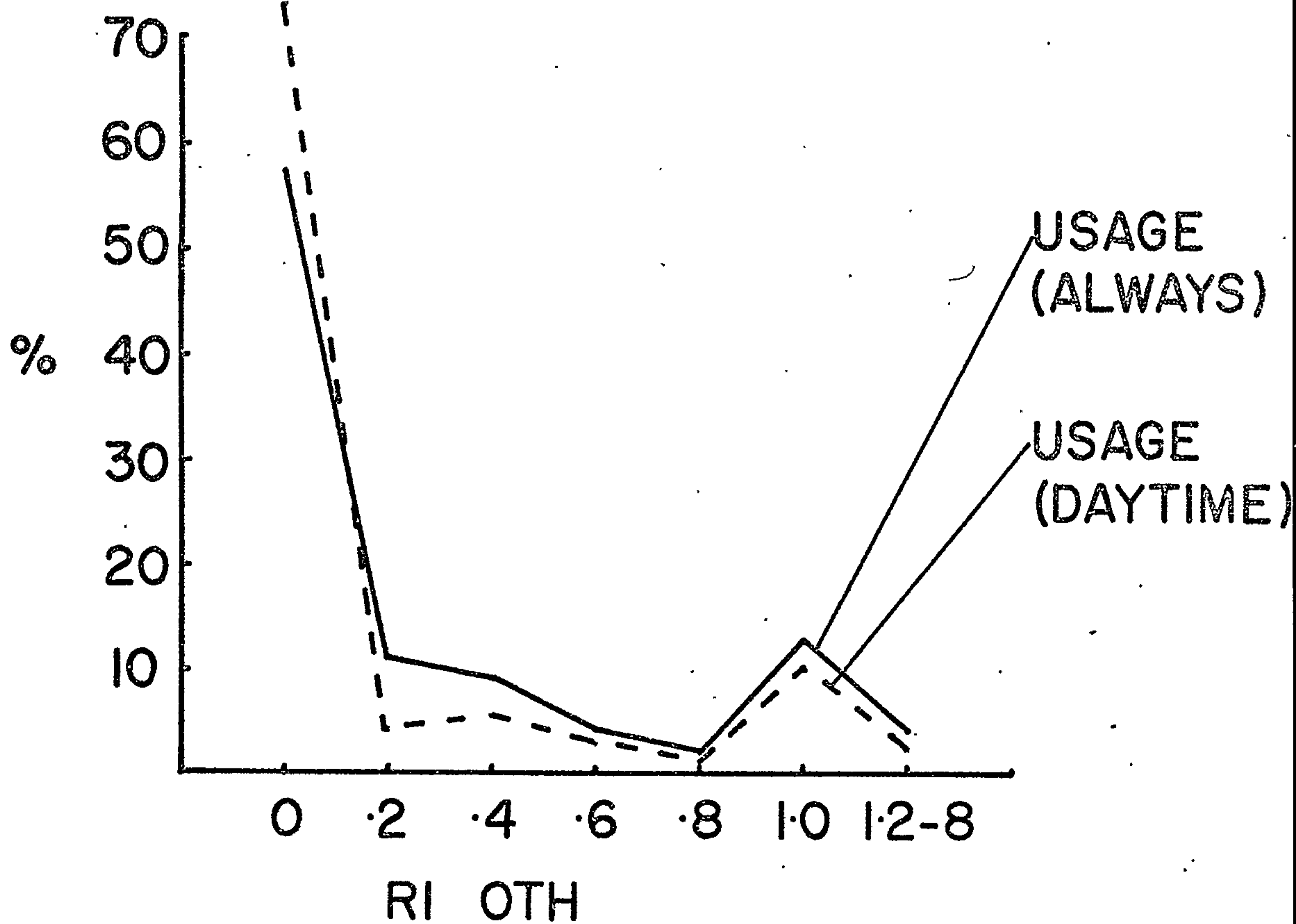
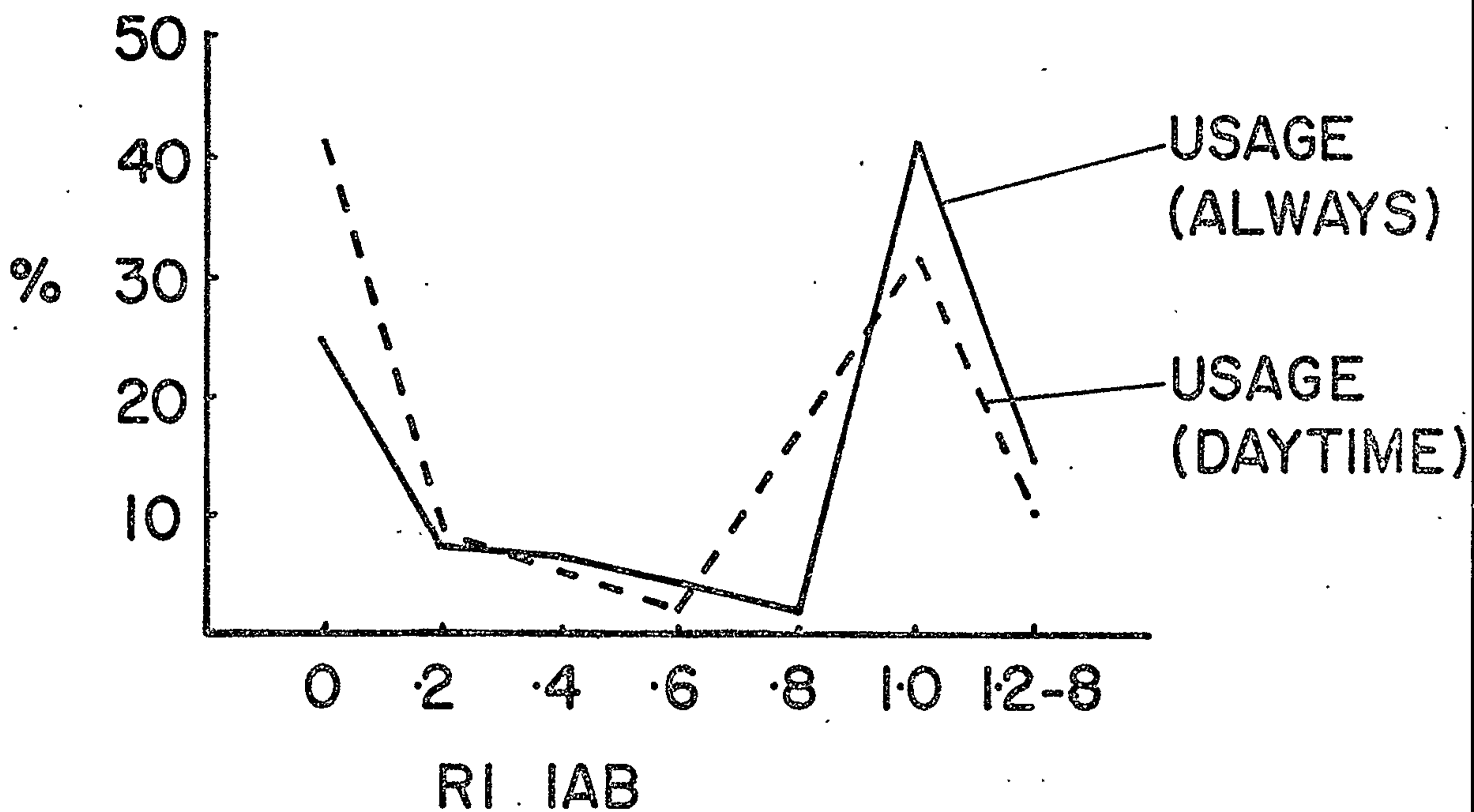
The factors reviewed were -

1. ADVS (YES), ADVS (NO)
2. USAGE (ALWAYS), USAGE (DAYTIME)
3. RI DAB
4. RI IAB
5. RI OTH

It was decided to present this data by a series of graphs.







Summary Group 1

561 patients wearing 734 partial dentures were examined. This group was predominantly female, and the mean age of each patient was 56.23 years.

The mean age of partial dentures in this group was 54.84 months. Almost 17% of partial dentures were over 10 years old, and many had not been relined or remodelled.

63% of cases were Kennedy Class I and Class II indicating at least one free-end saddle was present in this group. This high percentage could be related to the age of the patients in this group.

461 dentures out of a total of 734 did not have adequate vertical support. The mean number of standing teeth supporting a partial denture was 7.32. The Russel's Index mean was higher for Direct Abutment than Indirect Abutment teeth, whilst the index for other teeth was lower still.

Tooth mobility was highest for Indirect Abutments, very slightly less for Direct Abutments and much lower for other teeth.

Mucosa edentulous areas showed no inflammation in 67.85% of cases, whilst 29% showed evidence of some inflammation and 2.86% had gross inflammation involving the entire edentulous mucosal area.

14% of patients were able to close into centric relation without any decided prematurities being detected. For 70% of cases "centric balance" or a reasonably functional centric occlusion existed.

There were eccentric interferences attributable to the artificial teeth or denture components in almost 47% of cases.

56.82% of dentures were assessed as satisfactory according to the examiner's assessment. This meant that these dentures fitted well visually, were stable and some had active retention, whilst in the others, active

retention had been lost.

Most dentures were worn "daytime" only, closely followed by "always"; "spasmodic" and "never" were rare. However, patients who were not wearing any partial denture were not included in this study. An example of "never" wearing was when a partial upper was being worn and the lower Kennedy Class I "gum stripper" was not being worn.

Most of the dentures were clean (84.6%). The incidence of breakages was rather small and showed nothing of great significance.

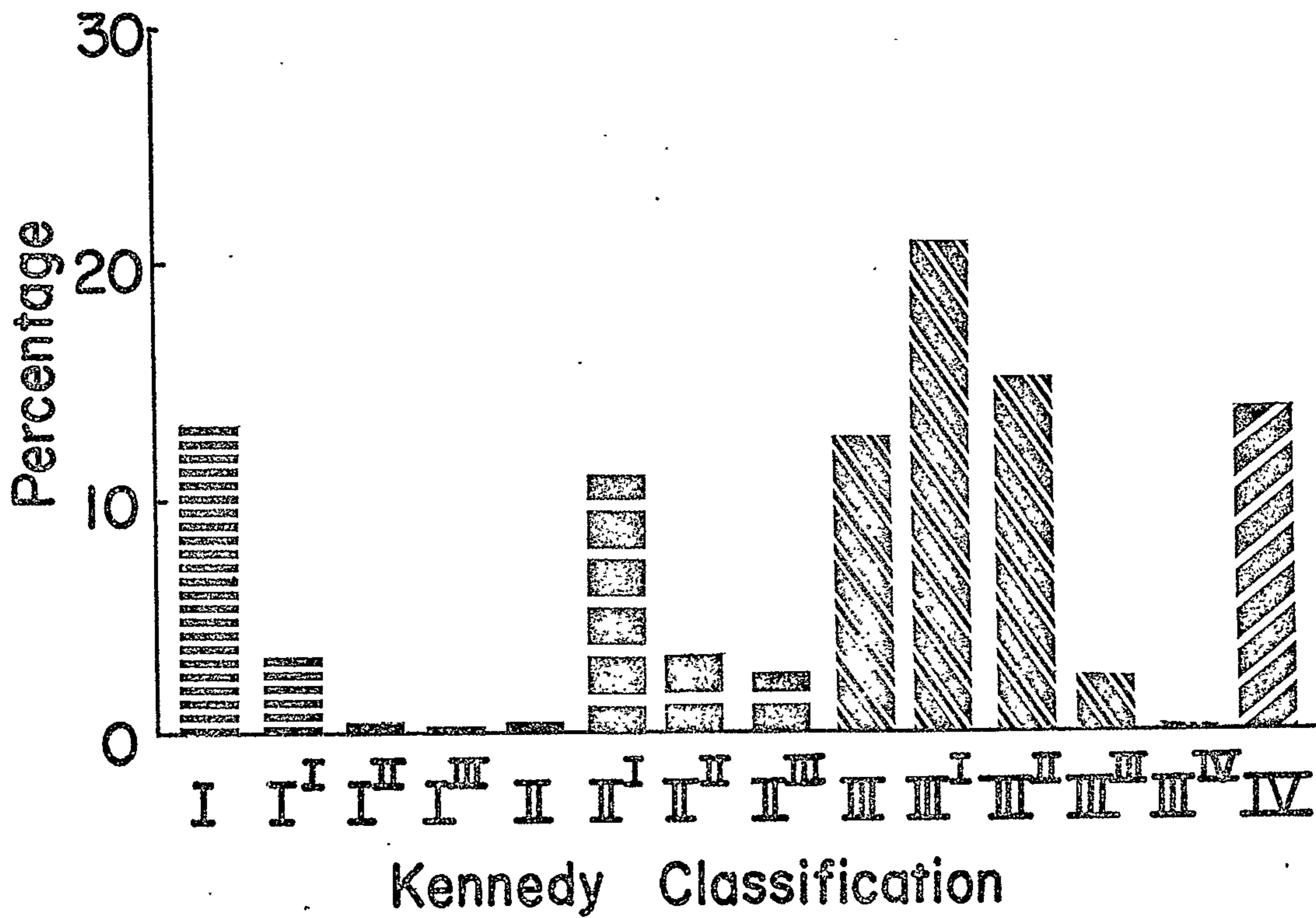
Aesthetics was the cardinal factor in patient motivation for partial denture wearing, followed fairly closely by function. Phonetics barely got a mention and patients with a negative attitude to partial denture requirement were also quite rare.

The comparison of data by correlation produced the following information of interest.

1. Russel's Index tended to increase by linear progression of Direct Abutment, Indirect Abutment and Other teeth. In other words, the general periodontal picture was such that when there was an increase in Russel's Index, there tended to be an increase in Direct Abutment, Indirect Abutment and Other teeth together, not just for Direct Abutment or Indirect Abutment teeth alone.
2. The retention factor for wrought arms was superior to retention factor for cast arms.
3. Inflammation of mucosa edentulous areas was not related to the type of base, when these bases were acrylic resin or cast cobalt chrome.
4. Inflammation of mucosa edentulous areas was not influenced by denture usage "always" versus "daytime".
5. Russel's Index for Direct Abutment teeth was greater for Kennedy I and II cases than for Kennedy Class III and IV cases.
6. Russel's Index for Indirect Abutment teeth was greater for Kennedy I and II cases than for Kennedy III and IV cases.

7. Mobility for Direct Abutment teeth was greater for Kennedy I and II cases than for Kennedy III and IV cases.
8. Mobility for Indirect Abutment teeth was greater for Kennedy Class I and II cases than for Kennedy Class III and IV cases.
9. Russel's Index for direct abutments was only lower for partial denture wearers with adequate vertical support, than those with inadequate vertical support when those values were 1 and greater than 1. For values 0 - 0.8, Russel's Index was greater for dentures with adequate vertical support than for those without adequate vertical support.
10. Russel's Index for indirect abutments was markedly lower when the partial denture had adequate vertical support than when there was inadequate vertical support.
11. Russel's Index for other teeth when the partial denture had adequate vertical support or inadequate vertical support was very similar throughout the range of values 0 to 1 and above.
12. Russel's Index for direct abutments was generally higher for "always" partial denture wearers than for "daytime" only.
13. Russel's Index for indirect abutments was higher for "always" partial denture wearers than for "daytime" only, and the difference was much greater than for direct abutment teeth.
14. Russel's Index for other teeth was higher generally for "always" partial denture wearers than for "daytime" only. The contrast for other teeth was not as great as for indirect abutments.

Denture Classification (2) Kennedy Classification



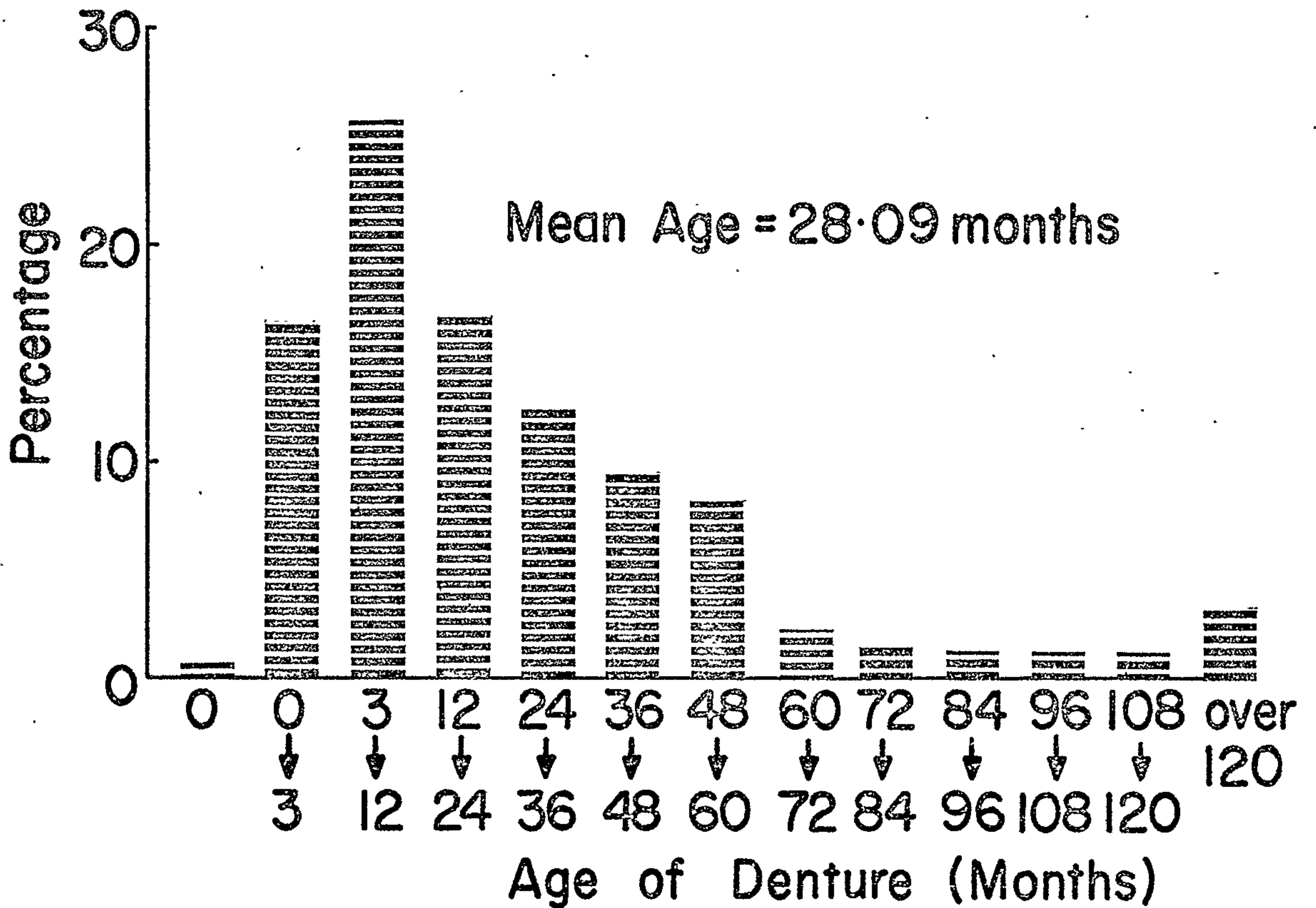
Type	%	No. of partial dentures
1 P/N	58.38	195
2 N/P	4.49	15
3 P/P	26.05	87
4 F/P	10.48	35
5 P/F	0.60	2
TOTAL	100.00	334

P = Partial Denture

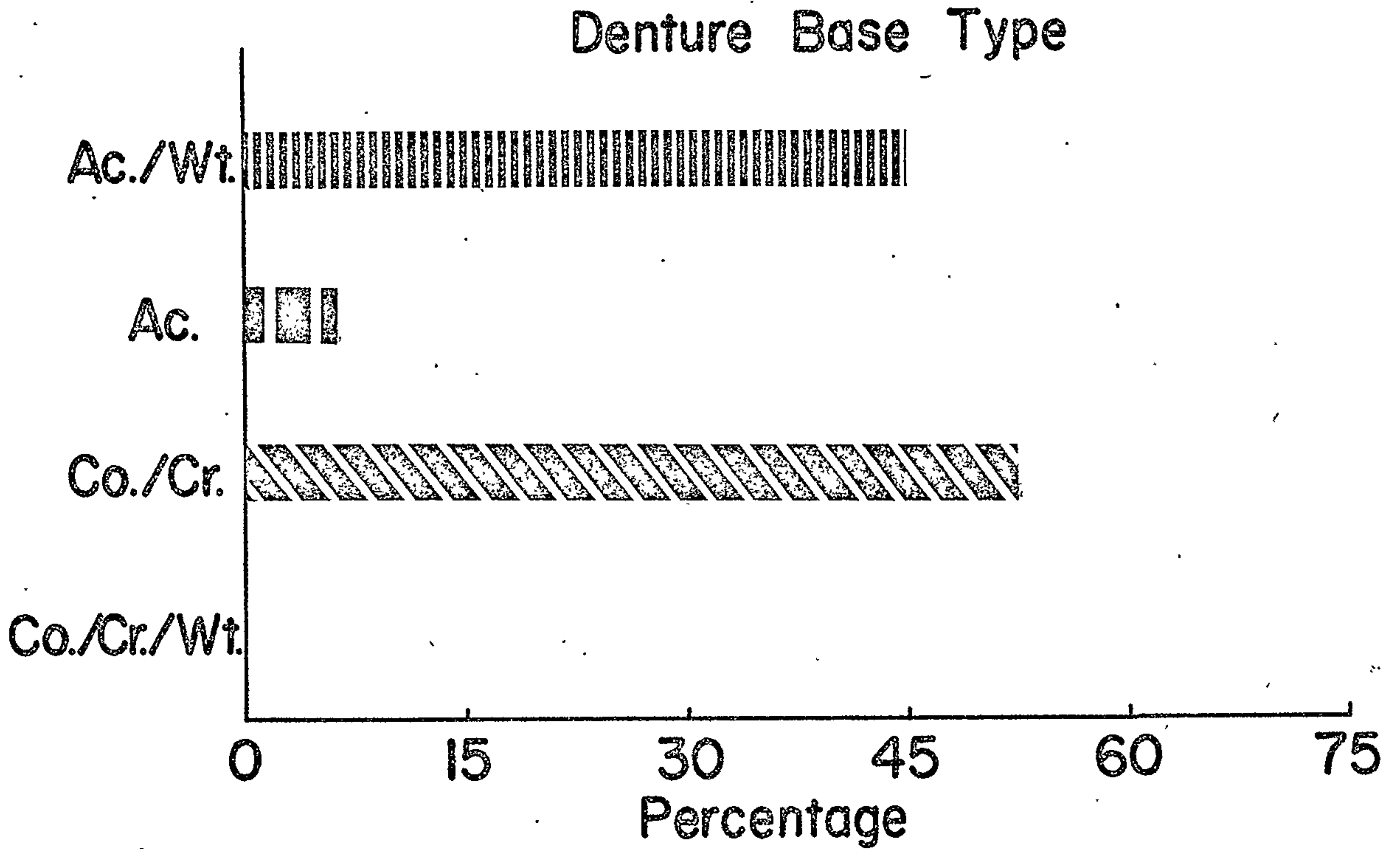
N = Natural Antagonists

F = Full Denture

Age of Denture



Denture Base Type



Table

Adequate Vertical Support (ADVS)

Base	%	Actual No.	ADVS (YES)	ADVS (NO)
Ac/wt	41.02	137	13	124
Ac	6.59	22	0	22
Co/Cr	52.40	175	173	2
Co/Cr.wt	0	0	0	0
TOTAL	100.00	334	186	148

Ac/wt = Acrylic Wrought

Ac = Acrylic

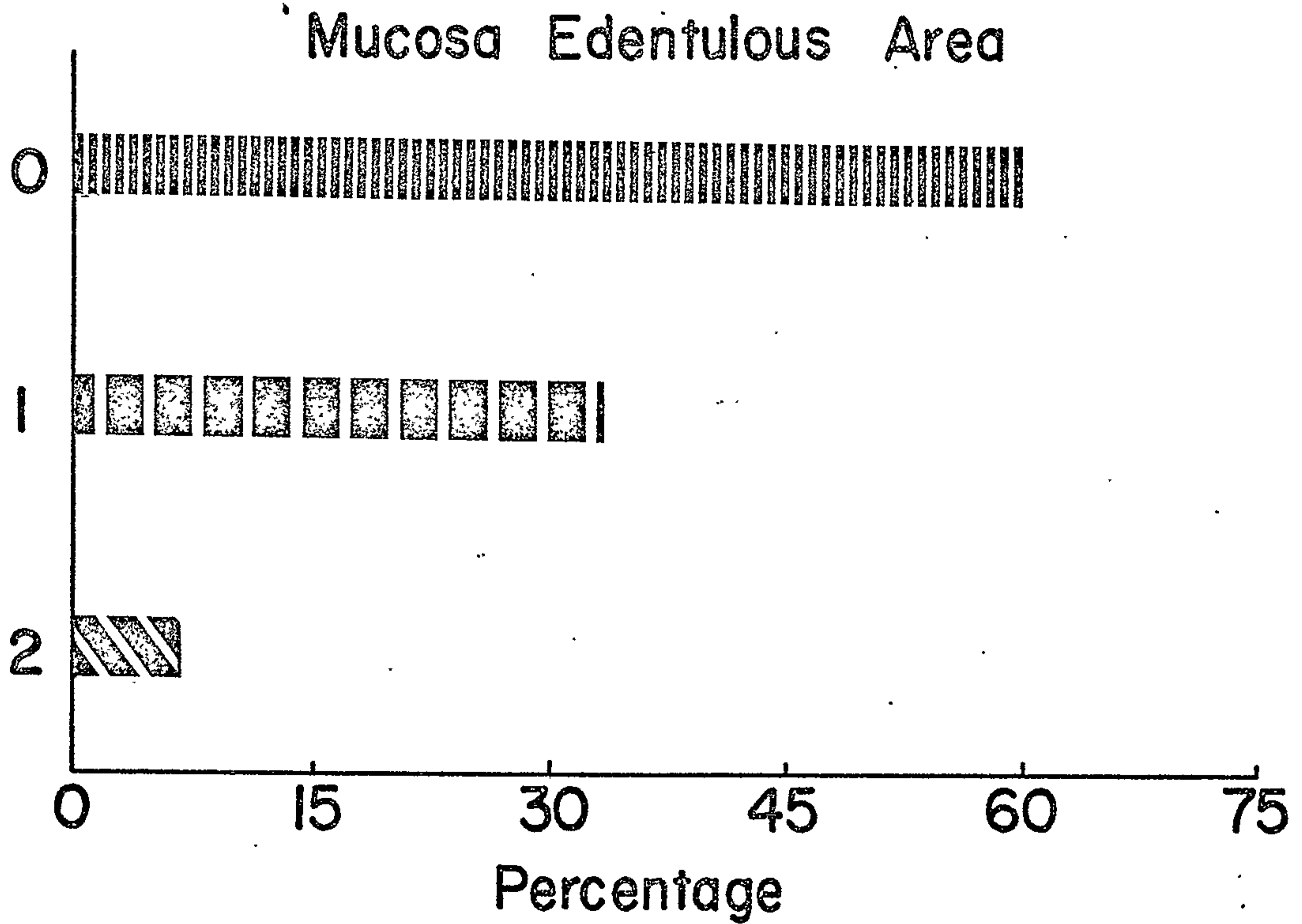
Co/Cr = Cobalt Chrome

Co/Cr/wt = Cobalt chrome wrought

Table 290 Patients wearing 334 Partial Dentures

Teeth	No. of teeth		Russel's Index		Mobility	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
DAB	3.40	.10	0.6925	.02	0.0671	.006
IAB	3.16	.12	0.4943	.02	0.0731	.007
OTH	8.84	.09	0.3416	.01	0.0302	.002

Mucosa Edentulous Areas



Occlusion

Table

Relationship	%Yes	%No	S.E. of Proportion
CR/CO	11.68	88.32	.018
CB	88.62	11.38	.018
ECC.INT	50.60	49.40	.029

CR = Centric Relation

CO = Centric Occlusion

CB = Centric Balance

ECC.INT = Freedom from eccentric interferences associated with denture base or components.

Table

Examiner's Assessment of Dentures

Fit, Stability, Retention

Group	%	No.Dent.	Group	%	No.Dent.
1	34.13	114	5	14.07	47
2	47.60	159	6	0.00	0
3	0.00	0	7	1.80	6
4	1.50	5	8	0.90	3

Groups 1-8, see master sheet for coding. Page 45.

By calculation

Factor	%	No.Dent.	Factor	%	No.Dent.
Good Fit	83.23	278	Bad Fit	16.77	56
G.Stab.	84.43	282	B.Stab.	15.57	52
G.Retten.	35.03	117	B.Retten.	64.97	217

Add groups 1 + 2 81.73% Satisfactory

 18.17% Unsatisfactory

Group 1 [Good Fit, Good Stability, Good Retention

 +
Group 2 [Good Fit, Good Stability, Bad Retention

= Satisfactory according to examiner's assessment.

Patient's Assessment of Dentures
Function, Comfort

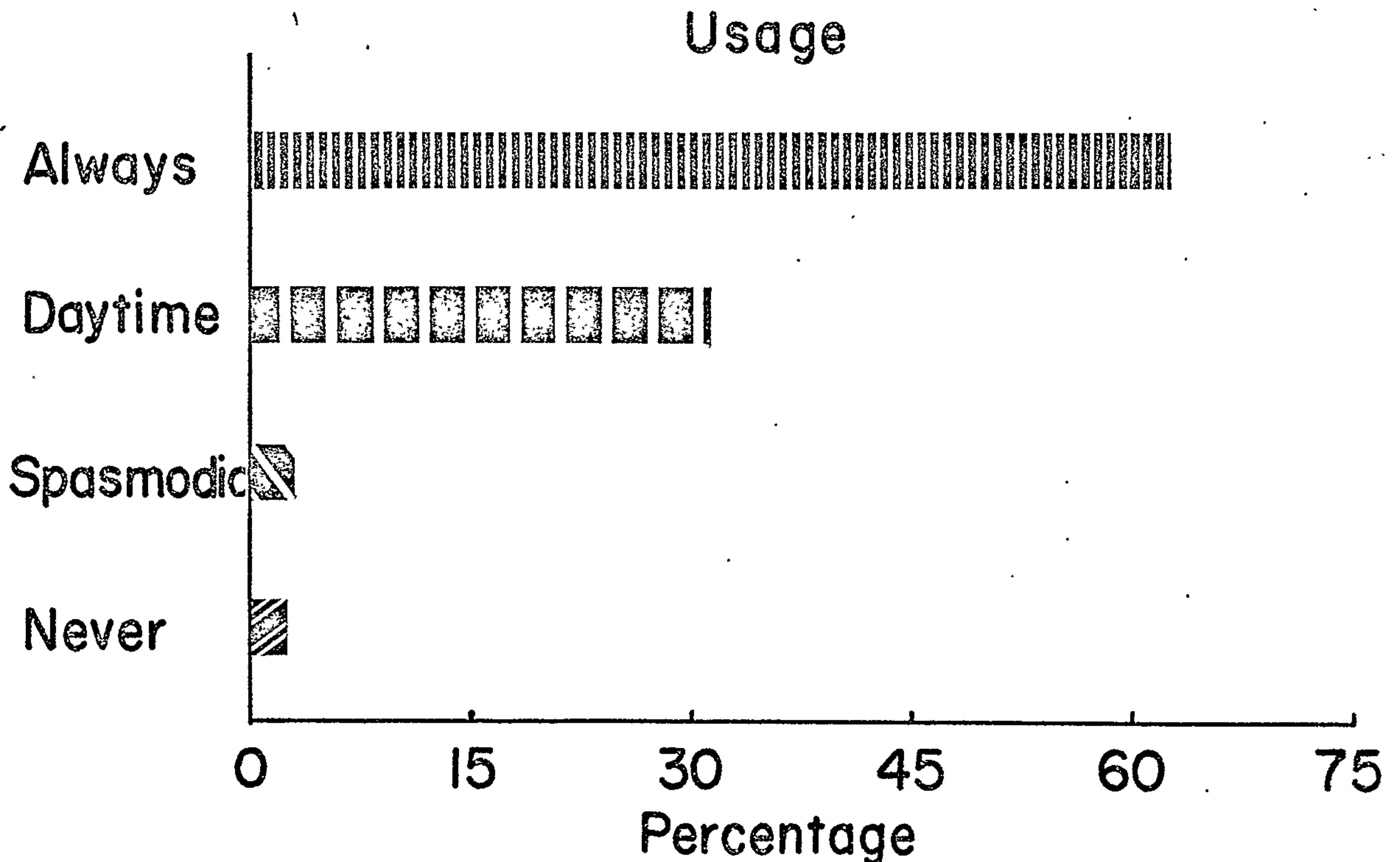
Groups 1-4, see master sheet for coding. Page 45.

Group	%	No.Dent.
1	84.13	281
2	4.49	15
3	4.49	15
4	6.89	23

By calculation

Good Function	=	88.62%	(296)
Bad Function	=	11.38%	(38)
Good Comfort	=	88.62%	(296)
Bad Comfort	=	11.38%	(38)
Satisfactory	84.13%	(281)	
Unsatisfactory	15.87%	(53)	

Usage



Denture Cleanliness

YES = 92.81% (310)
NO = 7.19% (24)

Breakages

Type	Overall %	No. Breakages	Actual no. dentures
Wt. Clasp	2.10	7	137
Cast Clasp	1.80	6	175
Cast Connector	0.00	0	0
Resin base	2.10	7	159
Teeth	0.60	2	334

Patient Motivation for Partial Denture Requirement

Aesthetic 63.17%
Function 30.84%
Phonetic 1.80%
Negative 4.90%

Relationship of Data by correlation

Method 1. Pearson product moment correlation coefficient. Most of the coefficients were small with the exception of -

RI IAB - RI DAB correlation = 0.33
RI OTH - RI DAB correlation = 0.45
RI OTH - RI IAB correlation = 0.35

and these were significant at the 1% level. The findings were similar to Group 1 and indicate that -

- (1) RI DAB, RI IAB, and RI OTH tend to increase together.
- (2) The Pearson test was considered invalid for the other correlations (data too heavily grouped).

Method 2.

Calculation of the standardized difference of two means, dividing by the standard error of the difference, the following comparisons were of interest.

1. For wrought arms the mean retention factor was .7372 and for cast arms the mean was .5429. Therefore retention was superior for wrought arms than for cast arms. (Significant at 1% level)
2. For the inflammatory condition of mucosa edentulous areas for patients wearing acrylic bases the mean was 1.6164 and for the inflammatory condition of mucosa edentulous areas for patients wearing cobalt chrome bases, the mean was 1.3371. Therefore inflammation of mucosa edentulous area for this group was higher for acrylic bases than for cobalt chrome bases. (Significant at 1% level)
3. For the inflammatory condition of mucosa edentulous areas usage always, the mean was 1.2733 whilst for mucosa edentulous areas usage daytime, the mean was 1.3879. Here inflammation mucosa edentulous areas was slightly greater for daytime than for always which was unexpected. (Significant at 5% level)
4. For RI DAB Kennedy I and II cases, the mean was .6371 and for RI DAB Kennedy III and IV cases, the mean was .7429. This result was contrary to expectation. (Significant at 5% level)
5. For RI IAB Kennedy I and II cases, the mean was .4818 and for Kennedy III and IV cases .5057. Here the differences were minor, however the Russel's Index IAB is again greater for the III and IV groups. (Not statistically significant)
6. For RI OTH Kennedy I and II, the mean was .2925 and for RI OTH Kennedy III and IV the mean was .3863. Again the Russel's Index was greater for Kennedy III and IV groups. (Significant at 5% level)

7. MOB DAB Kennedy I and II the mean was .0805 and for Kennedy III and IV the mean was .0549. Therefore mobility DAB was greater for the free-end saddle dentures in this group. (Not statistically significant)
8. For MOB IAB Kennedy I and II the mean was .1050 and for MOB IAB Kennedy III and IV .0440. Here the MOB IAB was significantly higher for the free-end saddle dentures. (Significant at 5% level)
9. For MOB OTH Kennedy I and II the mean was .0245 whilst for MOB OTH Kennedy III and IV the mean was .0354. The differences here were quite small and not significant statistically.

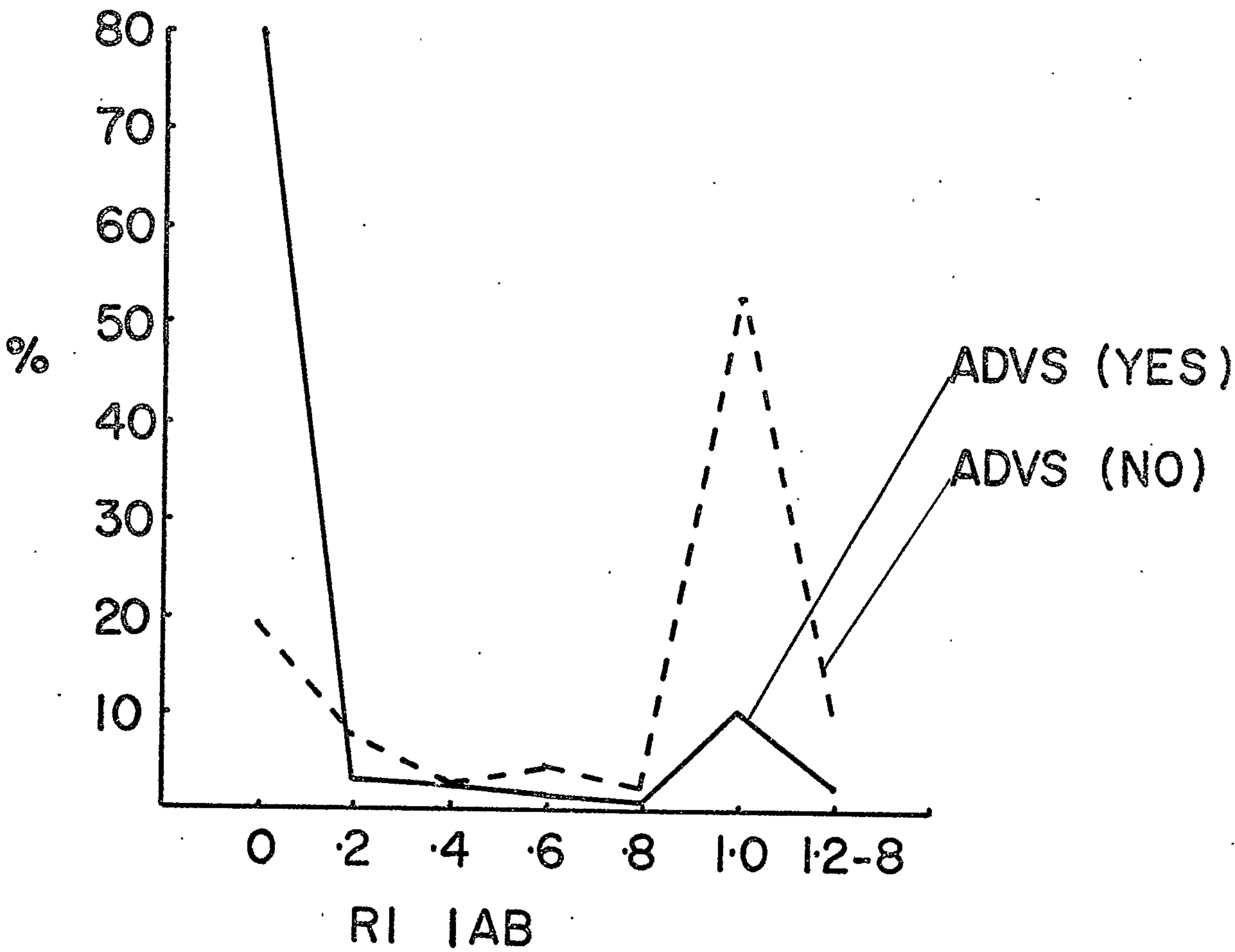
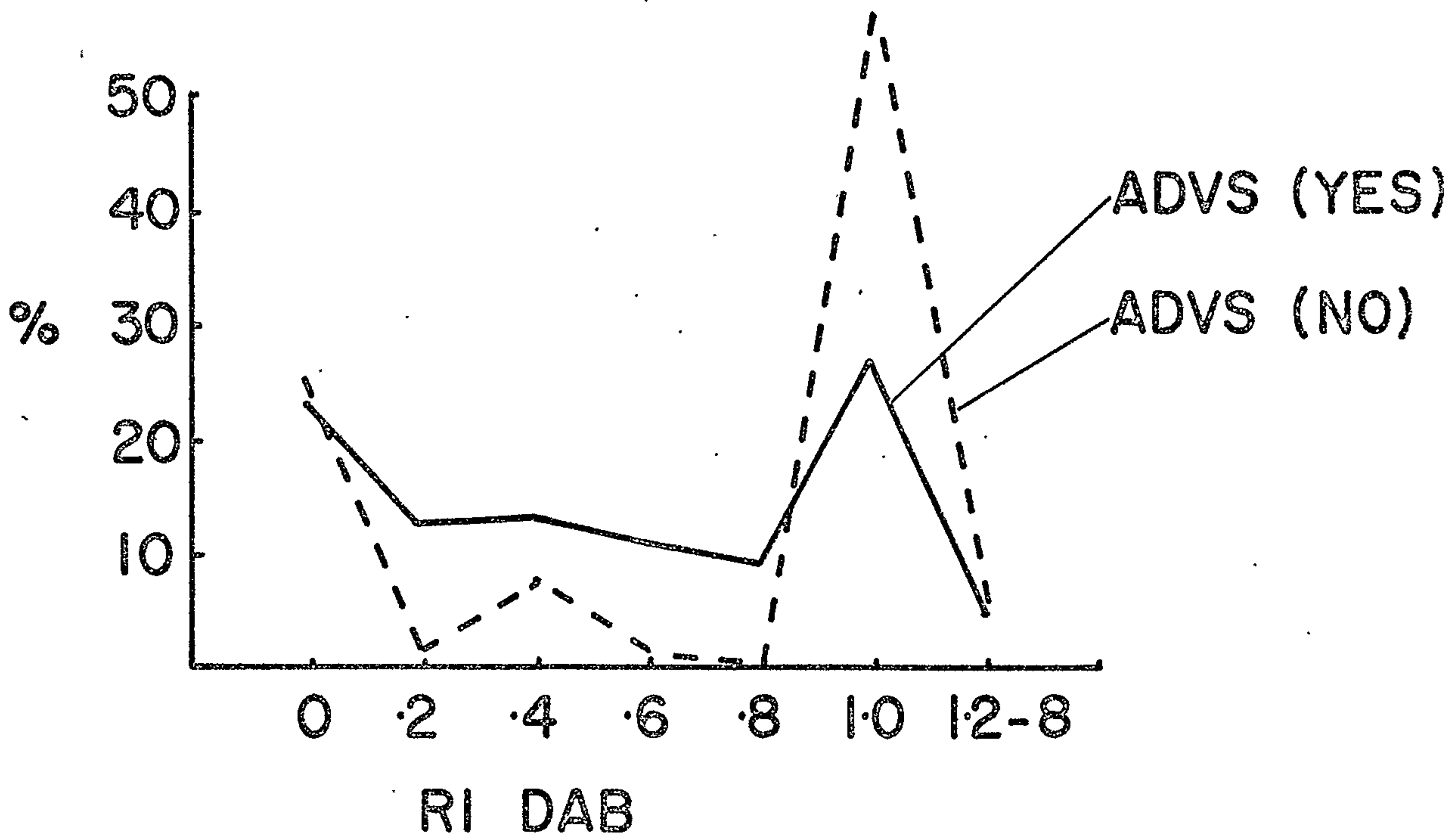
Method III

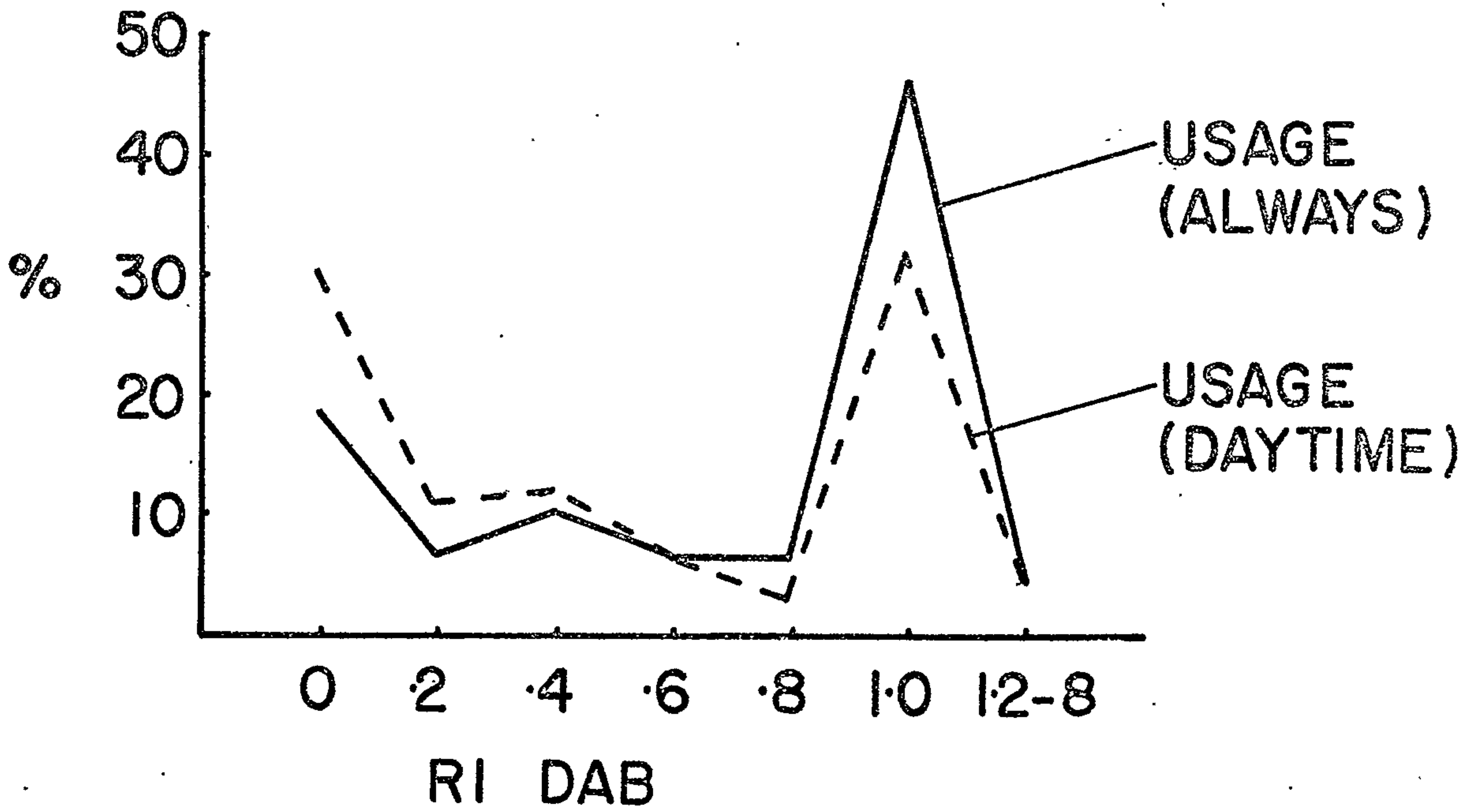
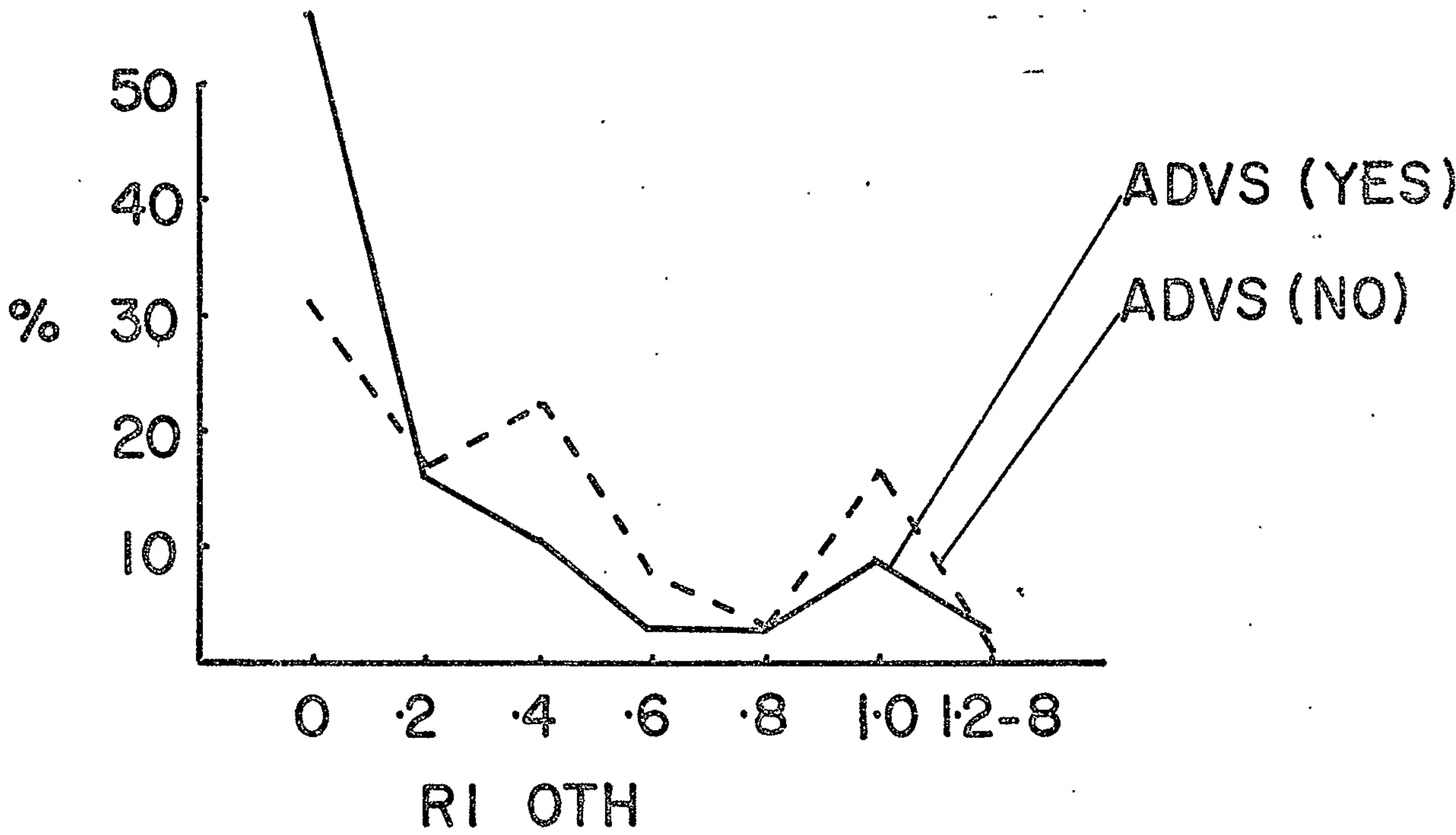
Comparison of factors by two way tables (percentages and actual numbers) with Russel's Index values ranging from 0 - 8 by 0.2 intervals.

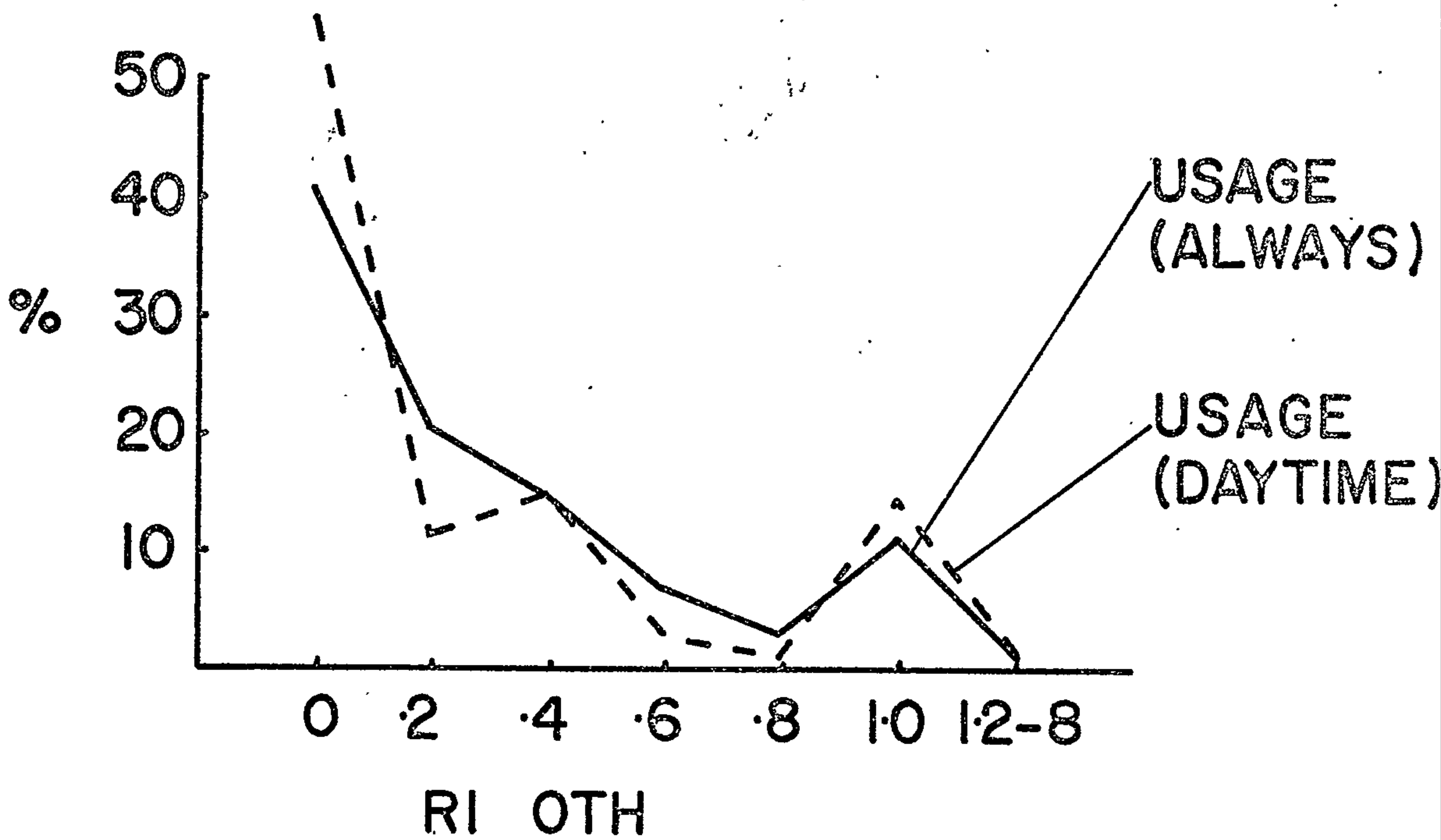
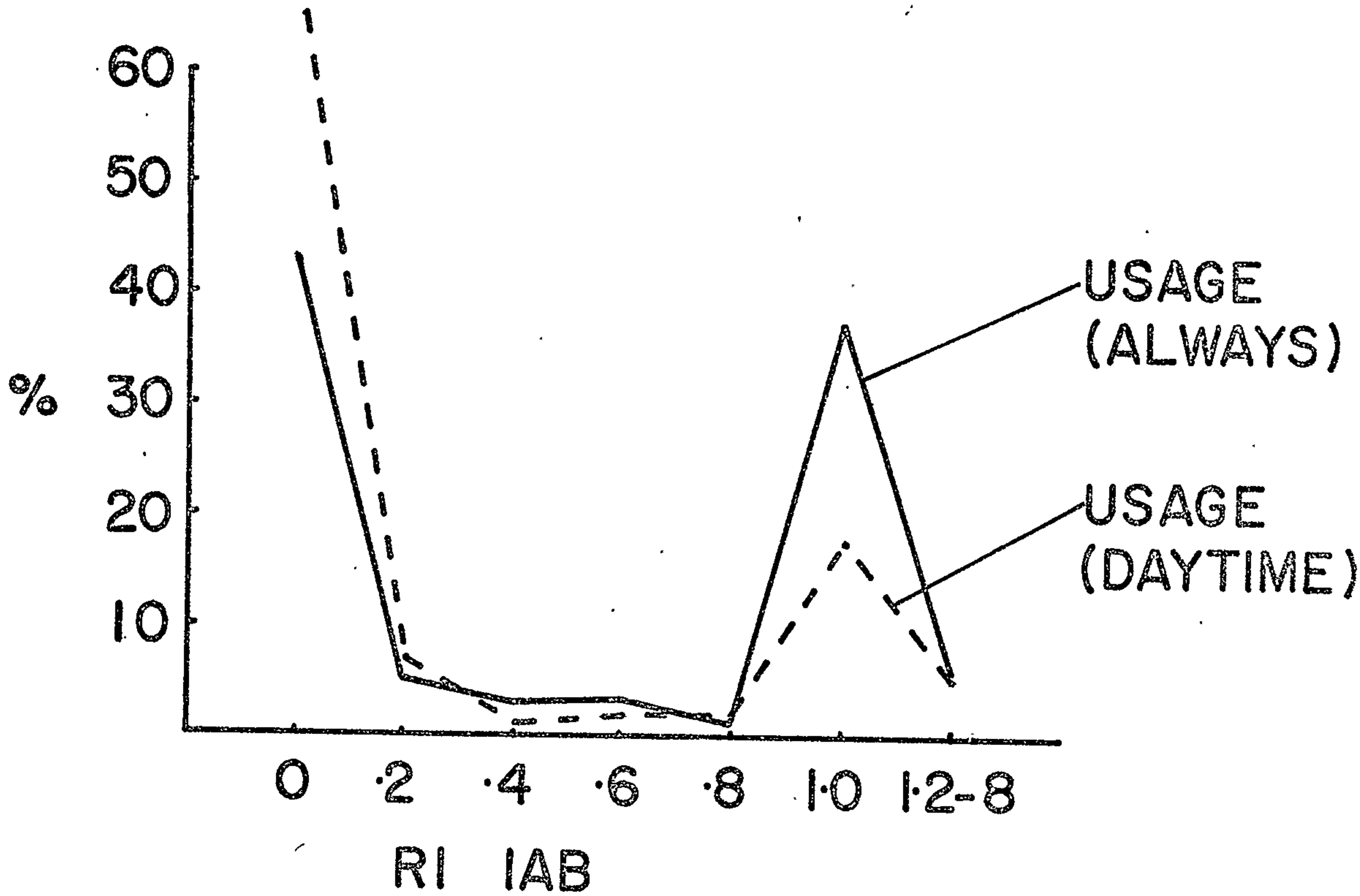
The factors reviewed were -

1. ADVS (YES), ADVS (NO)
2. USAGE (ALWAYS), USAGE (DAYTIME)
3. RI DAB
4. RI IAB
5. RI OTH

It was decided to present this data by a series of graphs.







Summary Group 2

290 patients wearing 334 partial dentures were examined. This group was almost entirely males and the mean age of the patients was 34 years. The mean age of partial dentures worn in this group was 28.09 months. 73% of the total number of dentures were partial uppers and in 58% of cases, the partial upper was worn alone. 3% of these dentures were over 10 years old.

The Kennedy Classification showed 13.77% of cases were Class IV partials. This was quite high, and enquiry showed the reason to be traumatic injuries from motor accidents and contact sports, particularly football and boxing. 50.80% of cases were Kennedy Class III and 35% of cases belonged to Class I and Class II.

Cast cobalt chrome bases were present in 52% of cases whilst the remainder were acrylic and acrylic wrought. 149 partial dentures out of a total of 334 did not have adequate vertical support. (Total number of acrylic wrought plus acrylic partial dentures was 159).

The mean number of standing teeth supporting a partial denture was 8.84. The Russel's Index mean was higher for Direct Abutment than Indirect Abutment teeth, whilst the index for other teeth was slightly lower.

Tooth mobility was highest for Indirect Abutments, very slightly less for Direct Abutments and much lower for other teeth.

Mucosa edentulous areas showed no inflammation in almost 60% of cases, whilst 33% showed some inflammation and 6.89% showed gross inflammation involving the entire edentulous mucosal area.

11.68% of patients were able to close into centric relation, without any decided prematurities being detected. For 88.62% of cases "centric balance" or a reasonably functional centric occlusion existed.

There were eccentric interferences attributable to the artificial teeth or denture components in 49.40% of cases. 81.73% of dentures were assessed as satisfactory according to the examiner's assessment. This meant that the dentures fitted well visually, were stable and some had active retention, whilst in the remainder, active retention had been lost.

The patients assessed the same dentures as satisfactory in 84% of cases. Most dentures were worn always (62.87%) followed by daytime (31.44%). Spasmodic and never combined was 5.69%. Patients not wearing a partial denture at all were not included in this study. However, they were included if they were wearing a partial upper and not wearing their partial lower or vice versa.

92% of the dentures were clean. The incidence of breakages was small. Most of these patients have dental facilities available to effect repairs promptly, so no great significance could be attached to this information.

Aesthetics (63%) was the major driving force in patient motivation for partial denture requirement, followed by function (30.84%).

Phonetics (1.8%) was the major factor for a few, e.g. drill instructors. Patients with a negative attitude to partial denture requirement at 4.19% was fairly high. Since economics was not a major consideration in this group for partial denture construction, 4.19% of patients received a denture he didn't really want.

The comparison of data by correlation produced the following information of interest.

1. Russel's Index Direct Abutment, Russel's Index Indirect Abutment and Russel's Index Other teeth tend to increase together.
2. The retention factor for wrought arms was superior to the retention factor for cast arms.
3. Inflammation of mucosa edentulous areas was higher for patients wearing acrylic bases than for those wearing cast cobalt chrome bases.

4. Inflammation of mucosa edentulous areas was not influenced to any degree by denture usage "always" versus "daytime". Surprisingly, the inflammation was slightly higher for usage daytime than always.
5. Russel's Index for Direct Abutment teeth was less for Kennedy Class I and II cases than for Kennedy Class III and IV cases.
6. Russel's Index for Indirect Abutment teeth was less for Kennedy I and II cases than for Kennedy Class III and IV cases.
7. Russel's Index for Other teeth was less for Kennedy I and II cases than for Kennedy Class III and IV cases.
8. Mobility for Direct Abutment teeth was greater for Kennedy Class I and II than Kennedy Class III and IV cases.
9. Mobility for Indirect Abutment teeth was greater for Kennedy I and II cases than for Kennedy Class III and IV cases.
10. Mobility for Other teeth was greater for Kennedy I and II cases than for Kennedy III and IV cases.
11. Russel's Index for Direct abutments was higher for partial dentures with adequate vertical support than those with inadequate vertical support for values 0 - 0.8 respectively. Where Russel's Index value was 1.0 the reverse applied, and the difference between the two groups was quite marked. There was no appreciable difference for Russel's Index values 1.2 - 8 in either group.
12. Russel's Index for Indirect Abutments was markedly lower for all values when the partial denture had adequate vertical support than when vertical support was inadequate.
13. Russel's Index for Other teeth when the partial denture had adequate vertical support was less than when inadequate vertical support was present.
14. Russel's Index for Direct Abutments was generally higher for "always" partial denture wearers than for "daytime" only.
15. Russel's Index for Indirect Abutments was generally higher for "always" partial denture wearers than for "daytime" only.
16. Russel's Index for Other teeth was slightly higher for "always" partial denture wearers than for "daytime" only in most interval groups compared from 0 - 1 and above.

CONCLUSIONS (1)

1. Conclusions from Investigation of Study Groups I and II.

1. The partial dentures have not promoted the well being of Direct Abutment or Indirect Abutment teeth, since both Russel's Index and tooth mobility were higher for the Direct Abutment and Indirect Abutment teeth than for other teeth. The Russel's Index for Direct Abutment, Indirect Abutment and Other teeth in both study groups was shown to increase progressively together. This indicated that the inflammatory gingival condition when present was generalised and therefore could probably be attributed in the main to a lack of adequate mouth preparation in some cases, and most assuredly to a lack of adequate preventive maintenance for the majority of these cases. Adequate daily preventive maintenance must exist for successful removable partial denture prostheses and could probably be assessed as the most important essential factor for a favourable prognosis. Tooth mobility increased for Direct and Indirect Abutment teeth in both study groups and particularly so in relation to Kennedy Class I and Class II cases. The free-end saddles must be maintained as good fitting components in relation to the supporting mucosa and alveolar bone otherwise undue stress is placed upon abutment teeth in rigidly designed dentures or undue stress is placed on the mucosa and supporting alveolar bone in stress broken cases.

2. Adequate vertical support for removable partial dentures is mandatory for the proper function of retainers and for the protection of the underlying supporting mucosa, periodontal membranes and gingivae. The Russel's Index for direct abutments in both Group I and II was higher for cases where the direct abutments had an occlusal rest than for those cases without adequate vertical support for all values between 0 - .8.

However where Russel's Index was 1 and above, the position was reversed. The Indirect Abutments showed markedly higher Russel's Indices for all values from 0 - 1 and all values above where there was inadequate vertical support. Possible explanation for these findings was that the direct abutment devoid of its occlusal rest was acting more as an

indirect abutment than a proper direct abutment. This could help to explain the generalised increase in Russel's Indices for indirect abutment where there was inadequate vertical support, because these indirect abutments were receiving greater stresses than would occur where the direct abutments were suitably constructed complete with an appropriately placed occlusal rest.

Unfortunately in the groups studied, there were many cases where maintenance of the removable partial prostheses post insertion had been ignored, to the detriment of abutment teeth, gingivae, mucosa and supporting alveolar bone. The great frequency of cases where occlusal rests were entirely ignored or inadequate could only be condemned and not defended on economic grounds.

The viability of such unsupported, poorly designed removable partial dentures could best be described as transitory. Removable partial dentures should not be constructed unless they can be adequately planned, designed and maintained in a suitably prepared mouth, where successful daily preventive maintenance is practised. Ideally, the patient should be recalled every six months to assess the general dental condition, check that preventive measures are adequate and to assess the removable partial dentures for fit and function. Necessary corrective action such as rebasing or relining of saddles and adjustment of any undesirable occlusal discrepancies should be carried out as required.

3. Inflammation of the mucosa in edentulous areas in Group I was not affected by the different types of denture base, i.e. acrylic versus cobalt chrome or by usage always versus daytime. More pertinent considerations probably include -
 1. Fit of the denture base.
 2. Adequate vertical support.
 3. State of the oral hygiene.
 4. Traumatic occlusion.
 5. Possible presence of candida infection.
 6. Systemic factors.

4. Inflammation of the mucosa in edentulous areas in Group II was higher for acrylic bases than for cobalt chrome bases. Possible explanation for this finding could be a tendency within Group II patients to limit the construction of cobalt chrome castings to those who were relatively periodontally sound and who could maintain a reasonably effective daily preventive programme.

In other words some of the acrylic partials being worn were in mouths demonstrating a complete lack of oral hygiene, where the patient was disinterested in maintaining or retaining the remaining natural dentition. These partial dentures were almost invariably lacking in adequate vertical support. Such partial dentures would be best described as training dentures for the full denture of the near future. Accordingly, I would subscribe to the findings in Group I where neither acrylic bases nor cobalt chrome bases were shown to have an effect on the inflammation of the mucosa in edentulous areas.

5. Retention factor for wrought arms was greater than for cast arms.
6. The occlusion, assuming it had been acceptable prior to and immediately after denture construction, had deteriorated markedly. Few instances of centric relation being assumed without prematurities existed (Gp.I, 14%), (Gp.II, 11%), and eccentric interferences attributable to the artificial teeth or the denture components were present in almost 50% of cases.
7. Comparison between the examiner's assessment of dentures and the patient's assessment, showed the patients were slightly optimistic. However, the assessments were fairly similar.
8. The mean Russel's Index for Direct Abutment and Indirect Abutment teeth was slightly greater in Group I than in Group II, however Russel's Index for other teeth was higher for Group II than Group I.

Since most of the dentures were Kennedy I and II cases in Group I, where patient mean age was much higher, and the mean age of dentures was much higher than Group II, the Russel's Index for Group I unexpectedly compared favourably with that of Group II.

Effort to thoroughly cleanse the individual mouth by suitable means to eliminate plaque must enhance the periodontal condition and assist in dental caries prevention. Special attention must be paid to inaccessible areas such as the buccal surfaces of maxillary posterior teeth and the lingual surface of mandibular posterior teeth. The distal and proximal surfaces of adjacent abutment teeth and their supporting gingivae must be kept scrupulously clean to prevent plaque adherence and subsequent pathology. Use of suitable disclosing solutions would assist in adequate plaque control. The removable partial denture should be kept free from plaque adherence by frequent and thorough cleansing of its components.

In Group II, the younger patient was wearing a relatively new denture, only 35% of cases were Kennedy Class I and II and over half were cobalt chrome castings, and yet the Russel's Index Direct Abutments and Indirect Abutments were fairly high and the Russel's Index Other teeth higher still when compared with Group I. Possible explanation could be in less thorough periodontal preparation for Group II patients than for Group I prior to partial denture construction, or perhaps preventive maintenance was carried out more thoroughly in Group I than Group II after denture insertion. The majority of Group II patients were wearing their dentures "always", whilst in Group I "daytime" wearing predominated. This could partially explain the unexpected higher Russel's Index in Group II cases compared with Group I, since "always" wearing produced higher Russel's Indices for direct abutment, indirect abutment and other teeth in both study groups when compared with "daytime" wearing.

9. For Kennedy Class I and II cases, one would expect Russel's Index for Direct and Indirect Abutments to be greater than for Kennedy Class III and IV cases, owing to added stresses involved for abutment teeth in rigidly designed free-end saddle partial dentures. This occurred in

Group I, but in Group II the opposite applied.

Possible explanation for Group II was that the periodontal condition generally for the patients wearing Class III and IV dentures was poorer overall prior to and following denture construction than was the case for Kennedy Class I and II cases in this group. The Russel's Index for Other teeth in Group II was higher for the Class III and IV cases than for Class I and II.

10. Aesthetics was the major driving force in patient motivation for partial denture requirement. Function was a secondary consideration, although more emphasis was placed on this factor for the older patients in Group I.

Phonetics was of moment for drill instructors in the services, whilst 4.19% of this group did not really want the partial dentures they were wearing. The patient's attitude to dental procedures generally and for removable partial denture requirement in particular, should be assessed when deciding whether the denture should be made at all, and in assessing its probable prognosis.

11. There was only nine stress broken dentures seen during the entire survey and the effective stress breaking achieved in most of these cases was debatable. Eight cases had cobalt chrome bases and used split bars or hinges for their stress breaking effect.

The stress breaking effect of split bars in cobalt chrome bases does not appear to be ideal, bearing in mind the rigidity of the material. Hinge-type stress breakers as used in the cases reviewed were also of questionable value, since they not only allowed the free-end saddles to move freely vertically, but also provided some horizontal movement. This caused harsh loads to be thrust upon the alveolar ridges and the mucosa during function.

The ninth stress broken case, a maxillary Kennedy Class II^{II} partial denture, used a cast gold base and a soldered round gold wrought wire for its stress breaking action. This type of design ensured minimal stress transmission from the free-end saddle to the abutment teeth.

CONCLUSIONS (2).

2. Suggested Criteria for favourable Prognosis in Removable Partial Dentures.

1. Partial dentures should only be constructed when necessary, where the advantages outweigh the disadvantages.
2. The planning and design for removable partial dentures must be thorough and painstaking.
3. All necessary mouth preparations for teeth and supporting structures must be completed before commencing the secondary impressions.
4. Preventive measures must be taught to the patient and checked frequently to ensure their maintenance. The denture itself must be kept meticulously clean and free from plaque and debris.
5. Correction of unwanted prematurities and high spots in the natural dentition for centric relation, and eccentric excursions should be completed before commencement of partial denture construction. The artificial teeth and denture components should blend with the natural dentition to produce a harmonious functioning masticatory system.
6. Care must be taken to ensure the cast metal skeleton or denture base of the partial denture seats accurately in the mouth. Otherwise retainers will not be in their predetermined positions and abutment teeth could thus be subjected to unnecessary torque. Ill-fitting denture bases may rock and thus cause trauma to the underlying mucosa and gingivae.
7. Removable partial dentures should be worn daytime only, since "always" wearing increased the Russel's Index for direct abutment and indirect abutment teeth.
8. The partial denture should be checked frequently for fit of the saddles especially in Kennedy I and II cases, otherwise undue stress is placed upon the direct abutment teeth in rigid designs, or in stress broken dentures undue forces may increase alveolar resorption or fracture of the stress breaker components. The occlusion should be checked to maintain stability and to eliminate any unwanted changes which may have occurred.

The long term favourable prognosis for removable partial dentures can be assured by the implementation of these major criteria.

However, the chances of success will diminish when any or many of these considerations are ignored.

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