**INTRODUCTION**

“No component of a Removable Partial Denture should be added arbitrarily or conventionally. Each component should be added for a good reason and to serve a definite purpose”.

- McCracken

**Definition**

- A major connector is the part of a partial removable dental that joins the components on one side of the arch to those on the opposite side. (GPT-8)
- It is that unit of the partial denture to which all other parts are directly or indirectly attached.
Functions

► Unification of the major parts of the prosthesis.
► Distribution of the applied force throughout the arch to selected teeth and tissue.
► Minimization of torque to the teeth.

► The principle of leverage is connected with this component part.
► A rigid major connector will limit movement possibilities by acting as a counteracting lever.
► This phenomenon is referred to as cross–arch stability.

IDEAL REQUIREMENTS

1. It should be rigid.
2. It should not impinge on free gingival margin and other soft tissues.
3. The borders should be parallel to the mean marginal gingival line and gingival margins should be crossed at right angle.
4. Should not allow food lodgment beneath it.
5. Should provide vertical support (Maxilla) for the RPD.
6. Should provide indirect retention when needed (Mandible).
7. Should enable to place the denture bases where required.
8. Should be comfortable to the patient.
9. Should be made with a material, which is biocompatible.
TYPES OF MAXILLARY MAJOR CONNECTORS

1. Single palatal bar
2. Single palatal strap
3. U-shaped palatal connector
4. Anterior-posterior palatal bar
5. Combination anterior and posterior palatal strap-type connector
6. Palatal plate-type connector

TYPES OF MANDIBULAR MAJOR CONNECTORS

1. Lingual bar
2. Lingual plate
3. Sublingual bar
4. Lingual bar with cingulum bar
5. Cingulum bar
6. Labial bar

Selection of a major connector for the extension base removable partial denture

According to Arthur M. Lavere, the selection of a major connector is not a difficult procedure if the dentist considers two important factors.

- The first is the degree to which the removable partial denture must be supported by structures other than the natural teeth.
- The second is the degree of rigidity required of the major connector to adequately distribute functional stresses from one side of the arch to the other.

( JPD 2005; 94: 207-8)

Support for the maxillary major connector is partly dependent upon the hard palate. The greater the coverage of the hard palate, the greater the support received from the palate.

Thus, the "snowshoe" principle is in effect in that the stress load is distributed over a large area, and the force per unit area is reduced.

Unfortunately, support similar to that derived from the palate cannot be obtained from the mandibular removable partial denture.

Rigidity

- Rigidity of a maxillary major connector is enhanced by the joining of the anterior and posterior bars to form a circle.
- The periodontally diseased mouth requires a rigid major connector that permits optimum palatal support.
Additional rigidity is obtained by use of the “L” beam effect, i.e., metal lying in two different planes.
For the mandibular major connector, encirclement cannot be accomplished. However, acceptable rigidity is obtained by thickening the inferior border of the lingual bar or plate.

Other considerations for selecting a major connector might be,
- Whether the removable partial denture is opposed by an artificial denture.
- Whether the residual ridge tissues are firm or movable.
- Whether the remaining natural occlusion is heavy or weak.
- Whether tori are present.
- Whether the residual ridges are resorbed.
- Whether the tissues of the floor of the mouth are attached high or low.

Preferred maxillary major connectors
- Posterior palatal strap
- Anteroposterior palatal strap
- Complete palatal plate

Non-preferred maxillary major connectors
- Anteroposterior palatal bar
- Posterior palatal bar
- Anterior palatal strap (horseshoe)

Factors affecting selection of the maxillary connector
- Rigidity
- The presence of palatal tori
- The requirement for indirect retention
- The need for anterior tooth replacement
- The need to stabilize weakened teeth
- Phonetic considerations
- The mental attitude of the patient

SINGLE PALATAL BAR
- A palatal connector component of less than 8 mm in width is referred to as a bar.
- It is a narrow half—oval with its thickest point at the centre.
- The bar is gently curved.
**Effective** - located between the two halves of the denture and must be rigid enough to provide support and cross-arch stabilization.
- Is often either too thin and flexible or too bulky.
- Patient comfort and alteration of palatal contours – objectionable

**Disadvantages**
- The decision to use a single palatal bar instead of a strap should be based on the size of the denture-bearing areas that are connected and on whether a single connector located between them would be rigid without objectionable bulk.

**Limited to replacing short span class 3 situations and placed no further anterior to the second premolar position.**
- Only indication - as an interim partial denture until a more definitive treatment can be considered.

**SINGLE PALATAL STRAP**
- Most versatile therefore most widely used.
- It consists of a wide band of metal with a thin cross-sectional dimension.
- It should not be less than 8mm wide.

**The width** – increased as the edentulous space increases in length.
- Bilateral tooth - supported restorations, even those with short edentulous spaces, are more effectively connected with a single, broad palatal strap connector.

**Narrow anterior-posterior width** - little vertical support from the bony palate and must derive its support by rests on the remaining natural teeth.
• A wide palatal strap type may be used for unilateral distal extension situation.
• If the edentulous area is extensive, bilateral and is not supported posteriorly to the junction of the hard and soft palate, the connector is modified to complete palatal type.

ADVANTAGES
• Located in 2 or more planes - offers great resistance to bending and twisting forces.
• Covers large area of palatal tissue - stress distribution is good.
• Forces transmitted on different planes are counteracted more easily.
• Greater rigidity with less bulk - patient comfort.
• Retention - by the intimate contact between the metal and soft tissue.

Disadvantages
• The patient may complain of excessive palatal coverage.
• Papillary hyperplasia.

Indications
• Bilateral edentulous spaces of short span in a tooth - supported restoration.

Waxing specification
• Anatomic replica pattern equivalent to 22–24 gauge wax, depending on arch width.

This is a preferred connector because:
• It may be used for most designs
• Distributes masticatory stress over a wide area
• May be made wide or narrow depending upon the desired stress distribution.

Blockout and relief of master cast
1. Usually none required except slight relief of elevated medial palatal raphe or any exostosis crossed by the connector.
2. One thickness of base plate wax over basal seats

Finishing lines
1. Undercut and slightly elevated.
2. No farther than 2mm medial from an imaginary line contacting lingual surfaces of principal abutments and teeth to be replaced.
3. Follow curvature of arch.
U-SHAPED PALATAL CONNECTOR

- It consists of thin band of metal running along the lingual surfaces of the remaining teeth and extending onto the palatal tissues for 6-8 mm.
- The borders – extend 6 mm from the gingival margin.
- The lateral palatal borders should be at the junction of the horizontal and vertical slopes of the palate.
- The borders extend 6 mm from the gingival margin.
- The lateral palatal borders should be at the junction of the horizontal and vertical slopes of the palate.

Indications

- Can be in case of a large inoperable tori.
- When several anterior teeth are to be replaced.
- In case of patients with exaggerated gag reflex.
- When periodontically weakened anterior teeth need some stabilizing support.

Disadvantages

- Lack of rigidity – lateral flexure under occlusal force, induce torque or direct lateral force to abutment teeth.
- Bulk to enhance rigidity results in increased thickness.
- May permit impingement of underlying tissues when subjected to occlusal loading.

Anterior And Posterior Palatal Bar-type Connectors

- The anterior bar is relatively flat.
- The posterior bar is half-oval, similar to the single posterior palatal bar connector but less bulky.
- The two bars are joined by flat longitudinal elements on each side of the lateral slopes of the palate.

- The rigidity can be increased by extending the borders slightly onto the horizontal palate surface.
- The connector should be symmetric, with the palatal borders extending to the same height on both sides.
- All borders or angles of the connector should be gently curved and smooth.
- The lateral palatal borders should be at the junction of the horizontal and vertical slopes of the palate.
The posterior bar should be located well back in the palate just anterior to the vibrating line. The two bars, lying in different planes, produce a structurally strong C-beam effect. Both borders should be gently curved and beveled.

**Indications**
- When support is not a major consideration and when the anterior and posterior abutments are widely separated.
- Presence of torus palatinus that is either undercut, lobulated, or too massive.
- It may be used as a compromise for the patient.

Contraindications
- In reduced periodontal support of the remaining teeth

**Advantages**
- The main advantage - rigidity.
- In comparison to the amount of soft tissue coverage, it is by far the most rigid maxillary major connector

**Disadvantages**
- Because of the limited palatal tissue contact, little support is derived from the bony palate.
- May interfere with speech—especially the anterior bar.

ANTERIOR AND POSTERIOR PALATAL STRAP-TYPE CONNECTOR

- Structurally, this is a rigid palatal major connector.
- Each palatal strap should be flat and a minimum of 8 mm wide.
- The straps should be located as far posteriorly as possible to avoid interference with the tongue.

- The thickness of metal in the straps should be uniform.
- Borders - 6 mm from the free gingival margin or should extend onto the lingual surfaces of the teeth.
- All the borders should be finished in smooth, gentle curves.
- The open area in the palatal region should be at least 20 × 15 mm.

**Indications**
- Kennedy’s class 1 and class 2 arches.
- Long edentulous spans in class 2 modification 1 arches.
- Class 4 arches.
- In case of inoperable tori.

**Disadvantages**
- Even though metal over rugae area may be thinner - interference with phonetics.
- The extensive length of borders may cause annoyance or discomfort.
**PALATAL PLATE-TYPE CONNECTOR**

- The full palate connector - thin, broad, contoured palatal coverage, with the natural anatomy of the palate reproduced.
- The anterior border - 6 mm from the marginal gingiva or must cover the cingula of the anterior teeth.
- The posterior border - extends to the juncture of the soft and hard palate.
- The material which covers the residual ridges should be one that can be refitted easily (acrylic resin).
- The posterior border can be fabricated of either metal or acrylic resin.

**Advantages**

- It is thin and reproduces faithfully the anatomic contours.
- Its uniform thickness and the thermal conductivity of the metal are readily acceptable to the tongue and underlying tissue.
- The corrugation in the anatomic replica adds strength to the casting; thus a thinner casting with adequate rigidity can be made.
- Interfacial surface tension between metal and tissues provides the prosthesis with greater retention.

**Disadvantages**

- Inflammation or hyperplasia
- Problems with phonetics

**Indications**

- Class 2 arch with a large posterior modification space.
- In most situations in which only some or all anterior teeth remain.
- when the last remaining abutment tooth on either side of a class 1 arch is the canine or first premolar tooth.
- In the absence of a pedunculated torus.

**Contraindication**

- Presence of tori which cannot be surgically removed.
- A full palatal coverage cannot be given.
Design of maxillary major connectors

In 1953 Blatterfein, described a systematic approach to designing maxillary major connectors.

Step 1: outline of primary bearing areas. the primary bearing areas are those that will be covered by the denture base(s)

Step 2: outline of nonbearing areas. the nonbearing areas are the lingual gingival tissues within 5 to 6 mm of the remaining teeth, hard areas of the medial palatal raphe (including tori), and palatal tissues posterior to the vibrating line.

Step 3: Outline of connector areas.

Step 4: Selection of connector type
- Connectors must have a maximum of rigidity to distribute stress bilaterally.
- Connectors should be of minimum bulk.
- When edentulous areas are located anteriorly, the use of only a posterior strap is not recommended.
- When only posterior edentulous areas are present, the use of only an anterior strap is not recommended.
- The need for indirect retention influences the outline of the major connector.

Step 5: Unification. after selection of the type of major connector, the denture base areas and connectors are joined.

Mandibular Major Connectors

Lingual bar major connector

- The basic form of a mandibular major connector is a half-pear shape, located above moving tissue but as far below the gingival tissue as possible.

Criteria for the selection of the mandibular connector

- The requirement for indirect retention
- Horizontal stability and stress distribution
- Anatomical considerations
- Esthetics
- Contingency planning
- The patient preference factor

Characteristics and location

- Half-pear shaped with bulkiest portion inferiorly located.
- Superior border tapered to soft tissue and located at least 4mm inferior to gingival margins.
- Inferior border is located at the ascertained height of the alveolar lingual sulcus where the patients tongue is slightly elevated.
Availability of space for connector is one of the important factors to be considered. At least 8mm of vertical space between the active tissues of the floor of the mouth and the gingival margins of the teeth is required.

There are two clinically acceptable methods to determine relative height of the floor of the mouth to locate the inferior border of the major connector.

**First method:** Patients tongue should touch the vermillion border of the upper lip and measurements were made in relation to the lingual gingival margins of the adjacent teeth using a periodontal probe. The readings are transferred to the master cast.

**Second method:** This method uses an individualized impression trays having its lingual border 3mm short of the elevated floor of the mouth is molded with an impression material during functional movements of tongue.

**Advantages**
- Lingual bar connector has minimal tissue coverage and has minimal contact with oral tissues.
- It does not contact the teeth, so decalcification of the tooth surface is minimized.

**Disadvantages**
- It may be flexible if poorly constructed.
- Rigidity is less compared to a well constructed lingual plate.

**Indications**
- Where sufficient space exists between the slightly elevated alveolar lingual sulcus and lingual gingival tissues.

**Contraindications**
- Inoperable lingual tori.
- Highly attached lingual frenum.
- Interferences to elevation of the floor of the mouth during functional movements.
**Blockout and relief of master cast**

- All tissue undercuts parallel to path of placement.
- An additional thickness of 32-gauge wax when the lingual surface of the alveolar ridge is either undercut or parallel to the path of placement.
- No relief is necessary when the lingual surface slopes inferiorly and posteriorly.
- One thickness of base plate wax over basal seat areas.

**Waxing specifications**

- Six-gauge, half-pear shaped wax form reinforced by 22-24 gauge sheet wax adapted to the design width.
- Long bar require more bulk than short bar.

**Finishing lines**

- Butt joints with minor connectors for retention of denture bases.

**Lingual plate**

- lingual plate, lingual strap, lingual apron, lingual shield.
- The lingual plate must be used when a high lingual frenum or the floor of the mouth prevents the use of a lingual bar.
- It may be used in combination with a labial bar for splinting.
- Terminal tooth rests should be used to provide a vertical stop at each end of the lingual plate to prevent labial movement of teeth.

**Characteristics and location:**
- Half-pear shaped with bulkiest portion inferiorly located.
- Thin metal apron extending superiorly to contact cingula of anterior teeth and height of contour of posterior teeth.
- Scalloped contour of apron as dictated by interproximal blockout.
- The superior border finished to continuous plane with contacted tooth.
- Inferior border at the ascertained height of the alveolar lingual sulcus when patients tongue is elevated.

**Indications:**

- Where alveolar lingual sulcus so closely approximates the lingual gingival crevice, such as high lingual frenum attachments.
- If residual ridges in Class I arch have undergone severe vertical resorption so that they will offer only minimal resistance to horizontal rotation.
- It can be used to stabilize periodontally weakened tooth.
- When future replacement of one or more incisor teeth will be facilitated by the addition of retention loops to an existing lingual plate.

**Contraindications:**

- In lingually inclined mandibular anterior teeth.
- Mandibular teeth with wide embrasures and diastema.

**Advantages:**

- The lingual plate is a rigid mandibular major connector and it provides more support and stabilization when compared to other connectors.
- Can be used in stabilizing the periodontally weakened teeth.
- When it is supported at each end by a rest it contributes to the action of indirect retention.
- When properly contoured and fabricated, it will not cause interference with tongue movements and will be more comfortable to the patient.

**Disadvantages:**

- It covers the tooth structure and the gingival tissue.
- The metal coverage of the free gingival tissue prevents physiological stimulation and self-cleansing of these areas by saliva.
Blockout and relief of master cast:
- All involved undercuts of contacted teeth parallel to the path of placement.
- All involved gingival crevices.
- Lingual surface of alveolar ridge.

Waxing specifications:
- Inferior border 6-gauge, half pear shaped wax form reinforced with 22-gauge sheet wax.
- Apron 24-gauge sheet wax.

Finishing lines:
- Butt-type joints.

Sublingual bar major connector:
A modification of the lingual bar that has been demonstrated to be useful when the height of the floor of the mouth does not allow placement of superior border of the connector at least 4-mm below free gingival margin.

Characteristics and Location:
- It is same as lingual bar except that the bulkiest portion is located to the lingual and the tapered portion is towards the labial.
- The superior border of the bar should be at least 3-mm from the free gingival margin.
- Inferior border is located at the height of the alveolar lingual surface.

Indications:
- The height of the floor of the mouth in relation to the free gingival margin is less than 6-mm.
- If it is desired to keep the free gingival margins of anterior teeth exposed and there is inadequate depth of the floor of the mouth.

Contraindications:
- Lingually tilted remaining natural teeth.
- Inoperable lingual tori.
- High attached lingual frenum.

Mandibular lingual bar with continuous bar (cingulum bar or double lingual bar or split bar)
- This type of major connector is also called "Kennedy bar" as it distributes stresses to all of the teeth which it comes in contact with by reducing the stresses to the underlying tissues.
- It is also referred as "continuous lingual clasp" major connector, because of series of clasp arms connected on the lingual surfaces of lower anterior teeth.
Characteristics and location:
- Shaped same as lingual bar.
- Thin narrow metal strap located on cingula of anterior teeth scalloped to follow interproximal embrassures.

Blockout and relief of master cast:
- Same as for lingual bar.
- No relief for continuous bar except blockout of interproximal spaces.

Indications:
- It is mainly used as a major connector in periodontally treated anterior teeth with wide interproximal embrassures.
- When linguoplate is contraindicated due to poor axial alignment of anterior teeth.

Contraindications:
- In severely crowded anterior teeth.

Advantages:
- The double lingual bar effectively extends indirect retention in an anterior direction is supported by adequate rest.
- It also contributes to horizontal stabilization.
- It helps in minor amount of support to the prosthesis.
- The gingival tissues and interproximal embrassures are not covered by the connector, which helps in free flow of saliva.

Disadvantages:
- Patient may feel discomfort because it alters the normal position of the tongue.
- If connector does not maintain intimate contact with tooth surface there will be food entrapment.

Waxing specifications:
- Same as lingual bar.
- Continuous bar pattern found by adapting two strips of 28-gauge sheet wax over the cingula and into interproximal embrassures.

Finishing lines:
- Butt joints.

Mandibular continuous bar (Cingulum bar)

- Improper axial alignment of the anterior teeth will necessitate excessive blockout of interproximal undercuts. These types of cases indicates continuous bar major connector.
- Contraindications
  - Lingually tilted anterior teeth.
  - Wide diastema between mandibular anterior teeth.

Characteristics and location:
- Thin narrow metal strap located on cingula of anterior teeth, scalloped to follow interproximal embrassures.
- Originates bilaterally from rests of the adjacent principle abutments.

Blockout and relief of master cast:
- No relief for cingulum bar except interproximal spaces.
**Waxing specifications:**
- A cingulum bar pattern formed by adapting two strips of 28-gauge, 3mm wide over the cingula and into interproximal embrasures.

**Finishing lines:**
- Butt-type joint.

**Mandibular labial bar major connector**
- The labial bar has a limited application in cases where large inoperable lingual tori and severely lingually inclined lower anterior and premolars prevents the use of other mandibular major connectors.

**Characteristics and Location:**
- Half-pear shaped with bulkiest portion inferiorly located on the labial or buccal aspect.
- Superior border tapered to soft tissue and 4mm inferior to labial gingival margins.
- Inferior border located in the labial buccal vestibule.

**Blockout and relief of master cast:**
- All tissue undercuts parallel to path of placement and when the labial surface is either undercut or parallel to the path of placement.
- No relief if labial surface of alveolar ridge slopes inferiorly.

**Waxing specifications:**
- 6-gauge half-pear shaped wax form reinforced with 22-24 gauge
- Long bar more bulkier than shorter bar.
- Minor connector joined with occlusal or other superior components by a labial approach.

**Finishing line:**
- Butt-type joints.

**Hinged continuous labial bar**

*This type of major connector is the modification of linguaplate which is incorporated in the “Swing-lock” design consists of labial or buccal bar i.e. connected to the major connector by hinge on one end and latch at the other end.*

**Support provided by multiple rests on the remaining natural teeth.**
- Stabilization and reciprocation provided by a lingual plate.
- Retention is provided by bar type retentive clasp arms projecting from the labial or buccal bar and contacting the infra bulge areas on the labial surfaces.
**Indications:**
- Missing key abutments.
- Unfavorable tooth contour.
- Unfavorable soft tissue contours.
- Teeth with questionable prognosis.

**Contraindications:**
- Poor oral hygiene.
- Shallow buccal labial vestibule.
- High frenal attachment.

**Design of mandibular major connectors**

The basic principles of major connector design includes:

**Step I** - Outline the basal seat areas on the diagnostic cast.

**Step II** - Outline the inferior border of the major connector.

**Step III** - Outline the superior border of the major connector.

**Step IV** - Connect the basal seat area to the inferior and superior borders of the major connector and add minor connectors to retain the acrylic resin base.

**Review of literature**

**KARL A. HANSEN et al**
- To evaluate patient acceptance of the sublingual bar when compared with lingual plate major connector and to determine the preferred design.
- Concluded - the sublingual bar compares favorably with the lingual plate in patient acceptance and should be considered as a variable design alternative when a lingual plate is not indicated.

*(JPD 1985; 54: 805-808)*

**K.L. GREEN, et al**
- Evaluated the effect of design modifications on torsional and compressive rigidity of u-shaped palatal connectors (effects of changing width thickness and shape).
- The aim was to determine the on rigidity of u-shaped maxillary major connector.
- Thick groups were more rigid than other frameworks when torsional load was applied a-p strap was more rigid on compression.
- Doubling the thickness of anterior strap of u-shaped maxillary major connector improved rigidity of framework to torsional loads.

*(JPD 2003; 89: 400 – 407)*
A.J. Beaumont

- observed that provision for esthetic rpd maybe made with selection of appropriate major connector.
- major connector selected should not be observable from conversational distance.
- u-shaped palatal connector is an esthetic maxillary major connector which may be applied when several anterior teeth are to be replaced.

(QJ 2002; 33: 747)

Zeev Ben-ur et al

- evaluated the stiffness of different designs and cross sections of maxillary and mandibular major connector for rpd.
- 5 maxillary and 5 mandibular casted cr-co alloy was chosen
- Concluded - In maxillary arch, the stiffest was a-palatal bar, most flexible was the u-shaped design.

(JPD 1999; 81: 526-531)

Zeev Ben-ur et al

Conducted a study to check the rigidity of five lingual bar type mandibular major connectors with different cross-sections a micrometer microscope and a system of pulley and weights were used and torsion forces were measured to compare rigidity.

They concluded that the lingual bar type with half-pear shaped cross section showed the highest degree of rigidity. Among the conventional lingual bars the wide semielliptical bar showed the highest degree of rigidity and narrow semielliptical bar was most flexible.

(JPPD 1989; 62: 537-582)

Kenneth R. McHenry et al

- Conducted a clinical trial using the experimental gingivitis model developed for periodontal clinical research to evaluate the effect of removable partial denture mandibular major connector design on surrounding gingival tissues. A comparison between the linguoplate (control) and cingulum bar (test) major connectors were made at 7 day intervals for 21 days.
- Results showed a greater increase in mean gingival inflammation with the control than with the test suggesting that cingulum bar has fewer detrimental effects on gingival tissues than linguoplate.

(JPD 1992; 68: 799-803)

Laboratory Procedures
MATERIALS USED FOR MAJOR CONNECTORS

The various alloys that can be used in constructing removable partial denture framework are:

- Type iv gold alloy
- Nickel chromium
- Cobalt-chromium
- Co-cr-ni
- Titanium and its alloys

Base metal alloys have relatively high elastic modulus. This property suggests that the thickness of partial denture frameworks can be thinner than those of other metals.

The ductility of titanium is greater than that of the others.

Base metal alloys have higher hardness compared with tooth enamel which causes in vivo wear.

Alloys for partial denture frameworks have high melting points and they exhibit high casting shrinkage with potential for casting defects.

Summary

- The borders are placed a minimum of 6 mm from gingival margins or are positioned on the lingual surface of the teeth.
- The location is determined by the need for support, stabilization, and/or oral hygiene.
- Anterior borders of major connectors that extend onto the rugae area should follow the valleys between the crests of the rugae.
- The posterior component of an anterior-posterior palatal bar or a closed horseshoe should be either half-oval or strap-like with a minimal width of 8 mm, and should be located as far posteriorly as possible without contacting the movable soft palate.
- All borders should taper slightly toward the soft tissue.
- Both anterior and posterior borders should cross the midline at right angles, never diagonally.

For a tooth supported removable partial denture the lingual bar is the suitable major connector.

- Long span edentulous ridges in which there is posterior abutment and indirect retention is needed, the lingual plate is indicated.
- When anterior teeth are periodontally treated and needs support and stabilization, the lingual plate or double lingual bar may be used.
- When the tissue of the floor of the mouth are active and ~8mm space available between tissue and marginal gingiva, a lingual plate is preferred.
- Labial bar is rarely used.
REFERENCES

► K. Rudd, Robert M. Morrow; Dental Laboratory Procedures Removable Partial Dentures
► Advanced removable partial prosthodontics. James S. Brudovic.
Introduction
- Pain is probably the most fundamental & primitive sensation
- It is basically a perception of various stimuli & an integral part of the nervous system.
- Naked nerve endings are presumably the sense organs for pain & are distributed all over the body.
- Pain is mainly a protective mechanism of the body.

Anatomy Of Nervous System
- The nervous system & endocrine system controls the func of the body.
- The nervous system is composed of specialized cells ... func... receive sensory stimuli ... transmit ... effector organs... muscular & glandular.
- Nervous system is divided into two parts, 1. CNS... Brain & Spinal cord. 2. PNS... Cranial & spinal Nerves... ganglia.

It occurs whenever tissues are being damaged, either structurally, or due to functional & metabolic derangements.
It causes the individual to react to remove pain stimulus.

- TMJ Pain
- Pains of Dental Origin
  - Neural Pathways Of Pain
  - Pain Receptors
  - Theories Of Pain
  - Pain Pathway & its components
  - Tracts... spinothalamic Tract
  - Dental Pain Pathway
  - Dual Nature of Pain
  - Control Of Pain
  - Summary & Conclusion
  - References
In the CNS, the brain & spinal cord are the main centers where co-relation & integration of NS occurs.
- Both are well protected.
- CNS is composed of large no. of nerve cells & their processes, which are supported by neuroglia.

The interior of CNS is organized into gray & white matter.
- Gray matter consists of nerve cells & proximal portions of their processes embedded in neuroglia.
- White matter consists of nerve fibers embedded in neuroglia.

In PNS the cranial & spinal nerve, which consists of bundles of nerve fibers or axons, conduct information to & from the CNS.

Anatomy Of Brain & spinal cord

BRAIN
- lies in the cranial cavity & is continuous with the spinal cord ... foramen magnum
- surrounded by three meninges:
  1. Dura Mater
  2. Arachnoid Mater
  3. Pia Mater
    continuous with meninges of spinal cord.

The brain is divided into 3 main divisions:
1. Rhombencephalon (Hind Brain)
   i. Medulla Oblongata (Myelencephalon)
   ii. Pons (metencephalon)
   iii. Cerebellum
2. Mesencephalon (mid brain)
3. Prosencephalon (Fore Brain)
   i. Diencephalon; central part of forebrain
   ii. Telencephalon; ... Cerebrum

Higher centers
- Brain Stem ... Medulla Oblongata, Pons, & midbrain
- Cerebellum
- Diencephalon... Thalamus & hypothalamus
- Cerebrum
Spinal Cord
- Cylindrical in shape, grayish white structure.
- Begins superiorly in the foramen magnum & terminates inferiorly at the L1 vertebra in adults & at L3 vertebra in children.
- 31 pairs of spinal nerves ... attached by anterior or motor roots & posterior or sensory roots. Structure of spinal cord
- Inner core of gray matter, surrounded by an outer core of white matter.

NEURAL STRUCTURE
- The structural & functional unit of the nervous system is the nerve cell or neuron.
- Composed of cell body & processes.
  **Cell Body**
  - Nucleus... central part of soma... one nucleolus
  - No centrosome means a neuron cannot multiply.
  - Nissle bodies...tigroid substance...basophilic substances...synthesize proteins of neuron.

- mitochondria
- Golgi apparatus
- Neurofibrils
- Processes of the nerve cell body are called dendrites and axons.
- Depending on the number of axons present a nerve cell is unipolar, bipolar, multipolar.
- Peripheral sensory neurons are unipolar.

- The single axon leaves the nerve cell body located in the dorsal root ganglion and branches into two parts.
- A peripheral branch that extends to terminates in a sensory receptor.
- A central branch that passes through the root of the nerve to terminate in the gray substances of the CNS.

- Depending on their location and function, neuron are designated by different terms.
- An afferent neuron conducts the nervous impulse towards the CNS.
- Efferent neuron conducts it peripherally.
- Internuncial neurons lie wholly within the CNS (inter neurons).
► Preganglionic neurons: is an autonomic afferent neuron whose nerve cell body is located in the CNS and terminates in an autonomic ganglion.

► Postganglionic neuron: has its nerve cell body in the autonomic ganglion and terminates peripherally.

REFLEX ARC

► Nerve signals are transmitted from one neuron through interneuronal junctions called synapse.

► Impulses that cross these synapse create an action potential that is carried down to the terminal end of the axon to the synapse with another neuron.

SYNAPSE

► Each pre synaptic terminal is separated from its adjacent neuron by a small distance called the synaptic cleft.

► Humans have 2 types of synapses
  Chemical... CNS.
  electrical... smooth & cardiac mus

► Presynaptic terminal ... syn vesicles, mitoch.

► Synaptic vesicles... transmitter substances.

► Mitochondria... ATP.
NEUROTRANSMITTERS

- The neurochemicals that transmit impulses across the synaptic cleft are called neurotransmitter.
- Neurotransmitters are:
  - Small rapid acting molecules.
  - Larger slower –acting molecules.

- Large slow acting molecules: These large molecules are the neuropeptides and represent a different group of chemicals.
  - These are not produced in presynaptic terminal but instead in the ribosomes of the neuronal body.

SUBSTANCE P

- It is polypeptide composed of 11 amino acids.
- Released at the central terminals of primary nociceptive neurons.
- Act as a transport system.
- Centrally it act as an excitatory neurotransmitter for nociceptive impulse.

- Its modulating action on pain is both rapid and short-lived.
- Its concentration is highest in the most severely inflamed joints.

ENDORPHINS

- are polypeptides, behave like morphine.
- bind to morphine receptors to obtund pain.
- important contributors to pain threshold & pain tolerance.
**BRADYKININ**

- Endogenous polypeptide consisting of 9 Amino acids.
- Released as a part of inflammatory reaction.
- Vasodilator... increase capillary permeability.
- Requires the presence of prostaglandin to act.
- Most potent pain producing substance that appears in injured tissue.

**NERVE IMPULSE TRANSMISSION**

- Resting state
- Depolarization
- Repolarization

**Resting state**

- Anions present inside the nerve cell memb.
- Potassium ions... inside, sodium & chloride ions...outside.
- A membrane potential... ionic imbalance.

This is accomplished by:

1. An active diffusion of ions through memb.
2. Diffusion of ions across the memb is because of gradient difference.

- Electrochemical gradient between inside & outside the memb is – 70 to -90 mv.
- Resting potential is maintained by an active sodium pump which moves the sodium ions from inside the cell to outside.

**Depolarisation**

- When a stimulus is applied ... memb activated ... alteration in its permeability... due to... release of Ach at the site of stimulus.
- Sodium diffuses inside & potassium diffuses outside.
- In large myelinated nerves stimulation takes place at the nodes of Ranvier... saltatory conduction.

**Repolarization**

- Permeability of nerve membrane decreases
- Potassium ions move freely out of the cell... conc gradient.
- Sodium pump actively transports sodium out of the membrane & potassium inwards... Resting potential
- The return of resting potential occurs within 3 to 4 m sec after stimulation.
- During this period, the membrane has a reverse potential & cannot be stimulated...... ........ Absolute Refractory Period.
PROPERTIES OF NERVE FIBERS:
➢ Two basic properties of nerve fibers are:
  1) Excitability
  2) Conductivity
GRADE POTENTIAL:
When a subthreshold stimulus is applied to a nerve, there is no development of action potential.

ACTION POTENTIAL:
➢ When a threshold stimulus is applied to a nerve fiber, the fiber develops and action potential, which propagates onwards without any reduction in amplitude until it reaches the end of the fiber.
➢ This is mode of signalling of the nerve.
➢ This mechanism of development of action potential was described by Hodgkin-Huxley theory.

DEFINITION OF PAIN
➢ An unpleasant sensory and emotional experience associated with actual or potential tissue damage.
[proposed by the international association for the study of pain].
Or

Purpose of Pain:
It is the warning signal of tissue damage. Causes the individual to react for the pain - to withdraw from noxious stimulus.

HISTORY
➢ Pain a burden to be borne.
➢ 1800s... a punishment of God for the wicked & purifying trial for good.
➢ Woman... labor pain... spiritual experience.
➢ History of mapping pain pathway & reading sensations.
➢ 19th century... field of neurology... pain was mediated by specific pain pathways.
➢ 1890s physiological & medical concepts... as of body & of disease.

➢ Rudolf Virchow in 1850s & 1860s... cellular assoc infection & trauma.
➢ Charles Bell & Francois Magendii... post root of spinal nerves responded to sensations, ant roots.... Motor responses.
➢ In 1839 Johannes Muller... law of specific nerve energies.
➢ The same cause... electricity... sensory organs... every sensory nerve react to it in a diff way.
In 1898... Charles Scott Sherrington...... Key concept of Nociception.

“The struggle between the dissimilar arcs for mastery over their final common path”.

In 21st century... mechanical warning of actual or potential damage to cells & tissues in a specific body area.

TYPES OF PAIN
There are two types of pain:

1) FAST PAIN
- Acute pain, first pain, sharp pain.
- No tissue destruction.
- Pain occurs in skin.
- Cause of acute pain is not fully known.
- Transmitted by "A-δ" fibers.
- It is better localized.
- Fast pain occurs within 0.1 sec of stimulus.

2) SLOW PAIN
- Chronic pain, second pain, throbbing pain, burning pain.
- Associated with tissue destruction.
- Pain occurs in both skin and deeper tissues.
- Cause for chronic pain is release of "Algonenic substances" i.e., pain producing substances. For eg., Bradykinin, K⁺ ions, Acetylcholine, AMP, Prostaglandins, Serotonin.
- Pain receptors are "free nerve endings".
- Transmitted by "C" fibers.
- It is not localized.
- Slow pain takes more than 1 sec.

CHARACTERISTICS OF PAIN

1) Threshold & Intensity: Sub threshold stimulus does not produce pain. Increasing strength of stimulus causes increased intensity of pain.

2) Adaptation: Pain receptors do not adapt. This is beneficial. This makes efforts to remove the injurious agent.

3) Localisation: Superficial pain is better localised than deep pain. Visceral pain is often “referred”.

4) Emotion: Pain sensation is often accompanied by unpleasant emotions. For eg. Crying.

5) Extent of tissue damage: Higher tissue damage → more is the intensity of pain.

VIScerAL PAIN

- Visceral pain sensations are carried by afferent sympathetic fibers.

- Causes:
  1. Ischaemia
  2. Inflammation
  3. Distention

- Features of visceral pain
  1. Visceral pain is often "referred".
  2. Often accompanied by vomiting and ↓ B.P.
  3. Drugs which act on visceral pain do not affect somatic pain.
  4. Pain of hollow viscus is often "colicky".

After receiving a nociceptive stimulus, two types of nerve fibers are stimulated.

<table>
<thead>
<tr>
<th>A-δ fibers</th>
<th>'C' fibers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Thick &amp; finely myelinated.</td>
<td>1. The thin &amp; non myelinated.</td>
</tr>
<tr>
<td>2. Fast rate of conduction (15-20m/s).</td>
<td>2. Slower rate of conduction (0.5-2m/s).</td>
</tr>
<tr>
<td>3. The less in no. than 'C' fibers.</td>
<td>3. These fibers out no. A-δ fibers.</td>
</tr>
<tr>
<td>4. Sensation due to the stimulation of A-δ fibers is felt earlier than 'C' fibers.</td>
<td>4. Sensation due to the stimulation of 'C' fibers is felt after a long interval.</td>
</tr>
<tr>
<td>5. They conduct impulses to laminae I &amp; V fibers.</td>
<td>5. They conduct impulses to laminae I &amp; II of substantia gelatinosa of Rolando.</td>
</tr>
</tbody>
</table>
REFERRED PAIN
➢ Visceral pain is often “referred”.
➢ Usually it is felt on body surface.
➢ Mechanism: (Convergence theory)
  ▪ Branches of visceral pain fibers synapse in the spinal cord with some of the second order neurons that receive pain fibers from the skin of corresponding dermatome.
  ▪ These two different neurons converge on the same second order neuron.
  ▪ Hence, the brain interprets that the origin of pain is from corresponding dermatome of the skin, though it is coming from viscera.

PSYCHOGENIC PAIN
➢ Defined as unpleasant sensation that has no organic basis.
➢ It is any pain that originates wholly in the mind and is fixed on some part of the anatomy.
➢ In many cases pain is a symptom of a deep underlying neurosis of which the patient himself may be unaware.

Classification of Pain

Neuralgic Pain
➢ Characterized by sudden electric like volleys of pain that are felt in the exact distribution of involved nerve.
➢ These shock like pain are called paroxysmal pains & are usually momentary & severe.
➢ They are often triggered by relatively mild mech stimulation at a site in the peripheral distribution of the same nerve involved in the neuralgia.
These pains are often recurrent with no pain experienced between the episodes.
Paroxysmal neuralgias are named for the nerve that is affected,
E.g.: Trigeminal neuralgia

TEMPEROMANDIBULAR JOINT PAINS
Arthralgia emanating from the TMJ may be classified as:

1. Ligamentous pain: Any condition or event that leads to elongation of the discal ligaments or thinning of the disc can cause derangement of the condyle-disc complex disorders. Most common factor is Trauma.

2. Retrodiscal pain: Acute retrodiscitis should be considered in traumatic incidents that involve the mandible, both with & without osseous fracture.

3. Capsular pain: Results from inflammation of the synovial and fibrous capsules, which is referred to as synovitis and capsulitis.
   - Synovitis – may result from localised trauma, abusive use, toxemias, specific infection or allergic response. It occurs as a manifestation of arthritis.
   - Capsulitis – may result from acute trauma or from intrinsic strains that injure the capsular ligament.

4. Arthritic pain: Inflammation of the articular surfaces of the joint is termed inflammatory arthritis.
   - Inflammation may be due to trauma (traumatic arthritis).
   - Can occur as a result of proliferation of inflamed synovial membrane onto the articular surfaces (Rheumatoid arthritis).
   - Pain is felt as dull aching sensation, sometimes described as persistent burning pain.

Pains of dental origin
Dental Pains of Pulpal origin:
- Acute Pain
- Chronic Pain
- Recurrent Pain
- Mixed with periodontal origin
Dental Pains of Periodontal origin

Acute Pulpal Pain
- Most typical of all visceral pain
- Caused by noxious stimulation
- May range from occasional hypersensitivity to spontaneous, violent, throbbing toothache of intolerable intensity.
- Inc by both heat & cold, or inc by heat & relieved by cold.
- Intermittent & continuous.
- May induce referred pain.
Chronic pulpal pain
► Injured Pulpal tissue may progress from acute to chronic inflammatory phase.
► Tooth may become symptom less
► Pain response is milder & less discomfort.

Recurrent pain
► Consists of recurrent period of inflammation
► Sensed as rec periods of hypersensitivity
► Associated changes in vascular pressure or fluid imbalance.

Dental Pains of Periodontal Origin
► Deep somatic pain of musculoskeletal type
► More localized and related to masticatory function
► Localized pain: localization is identified by applying pressure to the tooth laterally or axially

May be caused by trauma, occlusal over stressing, contact with an adjacent embedded tooth, dental prophylaxis, endodontic treatment, orthodontic therapy. Manipulation of teeth for restoration, inadequate opposing occlusal contact, occlusal interference, overcontoured or undercontoured proximal contact areas, stresses applied to abutment teeth, etc.

Neural Pathways Of Pain
► Field has described that the subjective experience of pain arises by four distinct processes.
  - Transduction
  - Transmission
  - Modulation
  - Perception

TRANSDUCTION
► Is the process by which noxious stimuli lead to electrical activity in the appropriate sensory nerve endings. The body has several types of sensory organs that initiate the process of nociception.

TRANSMISSION
► Transmission refers to neural events that carry the nociceptive input into the central nervous system for proper processing.
► There are three basic components to the transmission system:
1. Primary afferent neuron (carries the input from the sensory organ to the spinal cord).
2. Second order neuron (carries the input to the higher centers)
3. Interactions of neurons between the thalamus, cortex and the limbic system as the nociceptive input reaches these higher centers.

**MODULATION**

- Modulation refers to the ability of the central nervous system to control pain transmitting neuron.

**PERCEPTION**

- The final process involved in the subjective experience of pain is perception. If nociceptive input reaches the cortex, perception occurs, which immediately initiates a complex interaction of neurons between the higher center of the brain.
- It is at this point that suffering & pain behavior begins

**PAIN RECEPTORS**

- Pain is perceived when sensory system brings information from the periphery to CNS
- Chemicals... algesic mediators produce pain: Hypertonic saline, Kcl, Ach, 5HT, histamine, Bradykinin & substance P
- Sensory nerve endings mediating pain.. chemoreceptors & mechanoreceptors.

- Receptors...structures.. Catch sensory stimulus.
- First structure in sensory path.
- Receptor...special structure or a bare nerve terminal....... “End organs”.
- Stimulus...receptors...nerves excited... impulse reaches brain... specific sense perceived.

**HISTOLOGY OF RECEPTORS**

Some receptors are encapsulated structures within which lies the beginning of the afferent nerve. Eg. 1) Meissner’s corpuscle.
- 2) Pacinian corpuscle.
Some receptors are expanded structures which form the beginning of an afferent sensory nerve. Eg. 1) Merkel’s disc
- 2) Ruffini’s end organ
Some receptors are free nerve endings.
Eg. Pain receptor
Classification of Receptors

- A. End Organ (Receptors) of special senses:
  - i. Vision: rods & cones
  - ii. Audition: Hair cells of organ of corti
  - iii. Gustation: Gustatory cells of taste bud
  - iv. Olfaction: olfactory neurons
- B. Somaesthetic & Visceral sense receptors
  - i. Touch-pressure
    - a) Merkel's disc
    - b) Meissner's corpuscle
    - c) Pacinian corpuscle
    - d) Ruffini's end organ
    - e) Hair end organ
    - f) Free nerve endings
  - ii. Pain
    - a) Free nerve endings

Theories Of Pain

I. Specificity Theory
- Proposed by Descartes in 1844... pain system as a straight-through channel from the skin to brain.
- In 19th century Muller... theory of information transmission... sensory nerves.
- In the late 19th century, Von Frey... concept of specific cutaneous receptors for the mediation of touch, heat cold & pain.
  Free nerve endings... pain receptors

II. Pattern Theory
- In 1984 Goldscheider proposed... stimulus intensity is the central determinant of pain.
- Theory... pattern of nerve impulses that evoke pain... by summation of sensory input... dorsal horn of spinal column.
- Pain results when the total output of the cells exceed a critical level.

III. Gate control Theory
- Melzack & Wall in 1965
- Briefly postulates the following:
  1. Information about the presence of injury is transmitted to the CNS by small peripheral nerves.
  2. Cells in the spinal cord or the nucleus of the fifth cranial nerve, which are excited by these injury signals are also facilitated or inhibited by other large peripheral nerves that carry information about innocuous events (eg. Temperature or Pressure).

3. Descending control systems originating in the brain modulate the excitability of cells that transmit information about injury. Therefore, the brain receives messages about injury by way of the gate control system, which is influenced by:
   - a) Injury signals
   - b) Other types of afferent impulses
   - c) Descending control
Pain Pathway

- The A delta (carrying first pain) and the C (carrying the second pain) terminate on the dorsal horn of the spinal cord. The first order neuron end here.
- The tip of the dorsal horn is called substantia gelatinosa Rolandi [SGR].
- From SGR, the second order neurons arise and cross to the opposite and form the spinothalamic tract... end in thalamus.

From the thalamus the third order neuron arises to end in the sensory cortex in the parietal lobe.
- Some descending fibers from the brain terminate on the SGR.
- They constitute the tract that causes inhibition of pain.

Closes the gate to central progression of the impulse carried by small fibers.
- Acupuncture & transcutaneous electrical nerve stimulation (TENS) produce analgesic effect.
- Modulation within substantia gelatinosa determines afferent patterns before they influence the T cell.

Substantia Gelatinosa
- Facilitation & inhibition occurs within the dorsal horn of the spinal cord & the nucleus of 5th cranial nerve.
- Gate control theory... large diameter fiber input... modulates synaptic transmission of small diameter fiber.
- Large diameter fibers... signals initiated by pressure, vibration, & temperature.
- Small diameter fibers... noxious & painful stimulus.
- Intentional stimulation of large fiber system...inhibits synaptic transmission...small fibers.

Activation of the action system
- Gate control theory... presence of action system.
- Action system is a complex interconnection of high nervous system centers that sub serve emotion... attention, memory, spatiotemporal & motor mechanism.
- Involved with cortical as well as sub cortical areas, including the limbic system, thalamus hypothalamus & reticular activating system.
Sensory Discriminative System
► Modulation of peripheral input within dorsal horn allows activation of the T cell, the impulse then ascends to higher nervous system levels.
► A noxious stimulus ... localized in time & place.
► Somatosensory pathways ascending in the dorsal column & dorsolateral spinal cord are so organized that this information is rapidly transmitted.
► This system allows identification of pain duration & its exact location.

Motivational affective system
► Paleospinothalmic system consists of ventrolateral system that synapse in the reticular formation of the brain stem, where neurons form a complex network with ascending & descending systems.
► Reticular formation acts as a relay station for nociceptive impulses & regulates vasomotor & autonomic function.
► This complex system provides neural pathways for aversive motivational compartment of pain.

System interacts with limbic system & hypothalamus.
► Periaqueductal gray matter... interacts with descending impulses ... modulation of impulse transmission within substantia gelatinosa.
► When the pain does not evoke its usual response the individual’s ability to tolerate pain is increased.
► Narcotic analgesic can alter the aversive motivational aspect of pain.

Activation of Motor Mechanism
► Motor mechanism that are responsible for many overt reactions to pain are interrelated with spatiotemporal analysis & affective aspects of painful experience.
► Once integrated & modulated within CNS, the impulse triggers a sequence of response startle response, flexion reflex, postural readjustment, vocalization orientation of the head & eyes to examine damaged area, evocation of post exp, prediction of the consequence of stimulation, other behavior.

Facial grimacing, clenching of teeth, crying
► Changes in vital signs mediated through hypothalamus & medulla... activation of motor mechanism.
► Sympathetic nervous system function is enhanced.

Descending control
► Important aspect of gate control theory is the ability of the nervous system centers located within the brain to either facilitate or inhibit neural transmission at first synaptic levels.
► This is called analgesia system.

Consists of 3 major components:
1. Periaqueductal gray matter & preventricular areas of mesencephelon & upper pons.
2. Raphe Magnus nucleus, a thin midline nucleus located in lower pons & upper medulla.
3. Pain inhibitory complex located in the dorsal horn of spinal cord.
► some fibers ... brain stem...terminate...SGR
► Stimulation of these fibers lead to pain inhibition... serotonergic or enkephalinergic neurons..
►...synapse with Aδ & C fibers.
Most enkephalinergic fibers arise from PAG & terminate on Magnus raphe nucleus.

Fibers carrying pain from periphery terminate at SGR.

Spinthalamic tract which carries pain to thalamus arise from SGR.

Stimulation of these descending tracts cause synaptic inhibition or block at the SGR .... spinthalamic tract is no longer stimulated in spite of presence of stimulus in periphery.

Magnus Raphe nuclei

A very important group of nuclei are present in the median plane of pons ... median raphe nuclei.

They are downward projections of median raphe nuclei and occupy a site at junction of pons & medulla in median plane.

Causes of stimulation of descending fibers

These fibers are stimulated by pharmacological & psychological means.

a) Enkephalins & endorphins when applied locally to PAG or Magnus raphe nucleus.

b) Exogenous opiates (Morphine).

c) Electrical stimulation.

d) Collaterals from spinthalamic tract join the raphe nucleus.

e) Fibers arising from the limbic system terminate on PAG.

Fibers carrying different sensations enter the spinal cord through the posterior roots. Inside the cord arrangement takes place

Fibers carrying one kind of impulse tend to collect into a bundle.

Such bundles are called sensory tracts.

Motor tracts are formed on the same lines.

Tract - a bundle of fibers carrying one or a group of motor or sensory impulse in the CNS

Functionally nerve tracts (fasciculi) may be grouped in each column (funiculus) into ascending (sensory), descending(motor) & intersegmental fibers.

Ascending Tracts (Sensory tracts)

Afferent tracts

Afferent tracts in post column (Funiculus):

1. Fasciculus Gracilis (Tract of Goll)
2. Fasciculus cuneatus (Tract of Burdach)
3. Comma tract of schwulze(Tractus interfascicularis)

Afferent tracts in lateral column:

1) Dorsal spinthalamic tract ( lat spino thal)
2) Anterior spinocerebellar tract
3) Posterior spinocerebellar tract
4) Spino olivary tract
5) Spino reticular tract
6) Spino tectal tract
7) Spino vestibular tract
8) Spino pontine tract
9) Spino cortical tract
Afferent tract in the anterior column:
- Ventral (ant) spinothalamic tract (light, touch & pressure)

**Descending Tract (Motor tract)**
- Pyramidal tracts
  a. Crossed P T(large lat cerebrospinal tract)
  b. Direct PT(Uncrossed ant corticospinal tract)
  c. Uncrossed small lateral P T (corticospinal)
- Corticobulbar tract

Extra pyramidal tracts
- a. Rubrospinal tract
- b. Tectospinal tract & Tectobulbar tract
- c. Reticulospinal tract
- d. Dorsal Vestibulospinal tract
- e. Ventral Vestibulospinal tract
- f. Olivospinal tract
- g. Descending medial longitudinal Fasciculus

**Intersegmental fibers**
1. Ground bundle of anterior column or funiculus(anterior intersegmental faciculus)
2. Ground bundle of lateral column or faciculus(lateral intersegmental faciculus)
3. Posterior column or funiculus
   a. Posterior intersegmental Fasciculus
   b. Septomarginal Fasciculus

Dorsal Spinothalamic Tract
- Is an ascending tract
- Occupies lateral column of white matter in spinal cord
- Some post root fibers(axons of first order N) ... Spinal cord...end... SGR......... Posteriorlateral Tract of Lissauer
- 2\textsuperscript{nd} order neuron starts from here... axons of these neurons cross... anterior white commissure to the opposite side.
- Some fibers may ascend in the lateral column of the cord

This tract with ventral spinothalamic tract & spinotectal tract...spinal leminiscus... medulla oblongata
- Spinal leminiscus... ascends... medial leminiscus...term... ventral posterolateral nucleus of the thalamus
- Lateral spinothalamic tract...collaterals to reticular formation...end... thalamus... Here 3\textsuperscript{rd} order neuron starts ...term... post central gyrus of cerebral cortex
Functions:
1. Carries fibers of pain impulses
2. All temperature impulses

- Pain impulses ascending through lateral spinothalamic tract travel in two pathways:
  - Initial sharp pricking pain... terminates in ventral posterolateral nucleus of thalamus & relayed to cerebral cortex
  - Burning pain... terminates in reticular formation... activates nervous system

Functions of ascending tract:
- Painful & thermal sensations ascend in lateral spinothalamic tract
- Light touch & pressure... anterior spinothalamic tract
- Discriminative touch... post white column
- Unconscious information from muscles, joints, & skin subcutaneous tissue... ascends ant & post spinocerebellar tract... cerebellum

CLINICAL SIGNIFICANCE
Injuries to ascending tracts within the spinal cord

Lateral spinothalamic tract:
Destruction of this tract produces contralateral loss of pain and thermal sensations below the level of the lesion

Anterior spinothalamic tract:
Destruction of this tract produces loss of light touch and pressure sensibility below the level of lesion.
**DENTAL PAIN PATHWAY**

- The trigeminal nerve... principal sensory nerve of the head region
- Any stimulus in area of trigeminal nerve...first received...myelinated & non-myelinated fibers & conducted as an impulse along afferent fibers...Ophthalmic, Maxillary & Mandibular branches...semilunar or gasserian ganglion
- From ganglion...impulse mediated by sensory root of nerve...pons
- Here the sensory root either ends directly in main sensory nucleus or bifurcates into ascending or descending fibers

- Ascending fibers...Tactile sensibility
- Descending fibers...Pain & temperature
- Pain impulse descend...pons by spinal tract fibers of trigeminal nerve...through medulla...second cervical segment where tract terminates
- The mandibular, maxillary & ophthalmic branches terminate in the nucleus in that order
- Axons of secondary neurons emerge...spinal nucleus...cross midline...ascend to join...fibers of mesencephalic nucleus...to form trigeminal lemniscus or spinothalamic tract
- Tracts...continue upwards...terminate...posteroventral nucleus of thalamus
- Impulse mediated...by secondary connecting neurons...posteroventral convolutions of CC

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**Sensory Nerve Supply of Teeth**

The trigeminal nerve has 3 divisions:

1. Ophthalmic division
2. Maxillary division
3. Mandibular division

The branches of maxillary & mandibular divisions supply the teeth

**TEETH**

<table>
<thead>
<tr>
<th>SENSORY NERVES</th>
<th>Mandibular</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior alveolar nerve of V3</td>
<td>to 1,2,3,4,5,6,7,8</td>
</tr>
</tbody>
</table>

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**Dual Nature Of Pain**

**Pain Perception**

- physioanatomical process...an impulse is generated...stimulus...transmitted to CNS

**Pain reaction**

- psychophysiological process...Cortex, limbic system, hypothalamus & thalamus...determine how the individual reacts to unpleasant experience.
- Pain reaction threshold inversely proportional to pain reaction
Factors effecting pain reaction Th

1. Emotional States
   ► Emotionally unstable... low pain reaction threshold
   ► Pain perception... normal limits, pain reaction... greatly increased
2. Fatigue
3. Age
   ► Older individuals... high pain reac threshold
   ► Extreme age or senility... pain percep affect..

4. Racial & Nationality Characteristic
   ► Latin Americans & southern Europeans......... emotional... low threshold

5. Sex
   ► Men have higher pain reaction threshold than women

6. Fear & Apprehension
   ► lowered pain reaction threshold

Control Of Pain

Methods of pain control:-
► Removing the cause
   - Affects pain perception

► Blocking the pathway of painful impulses
   - Local anesthetic solution
   - Interferes with pain perception

► Raising the pain threshold
   - Interferes with pain perception & pain reac
   - Drugs raises the pain threshold & interferes with pain reaction
   - Aspirin .... Mild discomfort
   - Morphine.... severe pain
   ► Preventing pain reaction by cortical depression-
     - General anesthetics... depression of CNS... prevents conscious reaction to a painful stimulus
   ► Using psychosomatic methods
     - Affects pain perception & pain reaction

TENS
► Intentional stimulation of large fiber system results in inhibition of small fibers... closes the gate to central progression of impulse.
► By application of non noxious stimuli
► An interrupted current of very low intensity ... 50 to 100 Hz
► Cutaneous stimulation... massage, analgesic balms, counterirritants, mustard plaster, hot & cold compresses, vibration, vapocoolant therapy.

► Acupuncture... Chinese medicine... 1972
► Needle & electroacupuncture ... noxious stimulation of ... endorphins
References: