CHAPTER-I
INTRODUCTION

Forensic anthropology emerges at the intersection of knowledge production in both anthropology and forensic science. Legality of its application makes it an imperative science with implications for and in law. The legality associated with modern day laws embodied in human bodies presents a challenge for people involved in process of knowledge production in this field. It becomes a challenge for forensic anthropologists where dismembered and commingled human remains are brought for identification (Pretty and Sweet 2001). Cause and intention become central in this process. The need to establish the identity of the dismembered, mutilated and highly decomposed human remains arise in cases of mass disasters (Disaster Victim Identification- DVI) like terrorists’ attacks, mass murders, transport mishaps, tsunamis, floods, earthquakes, etc. or in other forensic cases where after killing, the body is intentionally dismembered. In these situations, the primary aim of the investigation is to determine age, sex, ancestry, and other physical features of the body like height, body weight, health and individualistic characteristics. These parameters of determining age, sex, ancestry, and other physical features of the body like height, body weight, health and individualistic characteristics help in narrowing down the pool of possible victim matches in the investigation process involving unknown commingled skeletal remains. The materiality of the evidence, ranging from mutilated and dismembered parts, skeletal remains having some of the bones, soft tissues, hairs, teeth, etc. determines the plausible course of action (Thompson and Black 2007).
Anthropological knowledge production and application has been more or less population based process. Utilisation of expertise in forensic matters gains specific positioning with anthropological significance especially in case of mass disasters. Causality of mass disasters could be attributed to natural calamities, accidents or criminal terror attacks. The identification of people in large number of casualties in mass disaster is a complex process. Technological advancement provides an impetus towards accuracy in human identification in mass disasters. Identifying the deceased is an important task after mass disaster, and various biometric techniques are very effective for this. Fingerprints, dental records, DNA records and other means of physical identification are used. There have been numerous mass disasters around the world and each event is an experiment and a lesson in itself with usage of new techniques or limiting gaps and voids in tackling it. Some prominent mass disasters with humanitarian, security and legal implications include:

- The crash of the Swiss Air flight 111 crash in 1998 off the coast of Nova Scotia killing 229 people.
- The World Trade Centre attack of September, 2001 that killed 2,819 people.
- The tsunami in December 2004, in south Asia leaving more than 283,000 dead with around 10,000 amongst those from various foreign countries.

Of various techniques and methodologies involved in process of identification, dentition emerges out to be of great significance. The primary role of a forensic odontologist during any DVI incident is the confirmation of
the identity of the deceased person by the matching of post-mortem data with the ante-mortem dental records of the missing person. This process is simple in concept, but complex in execution and requires the skills and expertise of fully trained and experienced forensic odontologists, working in teams (Clement 2000).

Teeth are the hardest part of the body and can withstand even the most extreme situations such as extreme temperatures, corrosion, fire, putrefaction and decomposition, explosions and thermal trauma as compared to the other elements of the human skeleton. Therefore, in these situations, the teeth are the most available and favoured skeletal element for the identification of the unknown human remains (Gulati 2011). In 2004 tsunami, where South East Asia region was immensely affected, 80% of the dead bodies were recognized on the basis of teeth remains (Schuller-Gotzburg and Suchanek 2007).

_Homo sapiens_ usually possess two sets of teeth during their life time. Primary (or deciduous) teeth are the first set of teeth to develop and erupt between 6 months to 6 years of age. Transition period, also known as the mixed dentition period, is when the eruption of first permanent teeth (at around 6 years of age) begins to develop. Permanent teeth in a sequential manner eventually replace the deciduous teeth during this phase (from 5-6 years to 12-13 years of age). Permanent dentition is usually fully developed by 17-23 years of age with the eruption of the permanent third molars (Cameron and Widmer 2008). The deciduous dentition consists of 20 teeth: four incisors, two canines and four molars in the maxillary (upper jaw) and mandibular (lower jaw) arches. In each arch, the permanent dentition usually
consists of 32 teeth: four incisors, two canines, four premolars and six molars. Dental formula for humans is, 2123/2123 (Berkovitz et al. 1978).

Apart from determining age and sex from the teeth, there are two methods by which these could be used in the identification process. The first method involves a comparison of ante-mortem (AM) and postmortem (PM) dental records of the individual. There are no set criteria for the number of matching points of AM and PM records that should be used for the identification. However, in some cases, one distinct dental radiograph feature may be sufficient to prove the matching (Carr et al. 2011). Similar to any other technical scientific method, this too presents range possibilities for identification: positive identification, possible identification, this may also help in establishing the exclusion-inclusion criteria. However, sometimes, it is not possible to achieve any concrete conclusion for identification (American Board of Forensic Odontology- ABFO Guidelines for Dental Identification). American Board of Forensic Odontology (ABFO) recommends the following four categories for dental identification:

✔ **Positive identification:** The antemortem and the post-mortem data match in sufficient detail to establish that they are from the same individual.

✔ **Possible identification:** The antemortem and the post-mortem data have consistent features, but, due to the quality of either the post-mortem remains or the antemortem evidence, it is not possible to positively establish dental identification.
- **Insufficient evidence:** The available information is insufficient to form the basis for a conclusion.

- **Exclusion:** The antemortem and the post-mortem data are clearly inconsistent. However, it should be understood that identification by exclusion is a valid technique in certain circumstances.

The second method deals with making a postmortem dental profile where the individualistic features of the teeth are recorded which can ultimately help in the narrowing down of the possible victim matches in the investigation process. DNA typing years old exhibits is also possible in forensic examination. The data generated through this exercise further provides information on the age, sex, and ancestry of the unknown individual (Gulati 2011, Pretty and Sweet 2001).

Of the various features associated with dentition, dental anomalies and dental characteristics are the unique characteristics which can be visually recorded from the teeth. The dental anomalies can be in the shape of the defects, abnormalities of the size, shape, numbers, structure, eruption, or position of the teeth. The structure and shape of teeth and details of their arrangement in the dental arches provides information that can be unique to an individual. Even in the identical twins, the slight variations in tooth form and position can enable the twins to be separated on the basis of their dentition (Clement 2000). Therefore, dental anomalies are special features of the teeth which are known to vary according to sex and ancestry in a population. Hence, dental anomalies are helpful in distinguishing and identifying the sex and ancestry of an individual.
Dental anthropologists have classified human dental variations (non-metric dental traits) into two basic types. The first type involves major deviations (dental anomalies) from the normal dental blueprint (e.g. extra tooth or fused teeth). The next basic type of dental variation is minor and more delicate and involves variations in secondary cusps, fissure patterns, and supernumerary roots (amongst others) (Scott and Turner 2000). Dental anthropologists have been studying minor variations since the 20th century as they are more common and vary within and between populations, and thus, they are largely considered to be useful in evolutionary and forensic contexts (Scott and Turner 2000). Studies, however, have shown that there are shared genetic mechanisms for dental anomalies (Kurisu and Tabata 1997, Vastardis 2000, Frazier-Bowers et al. 2002, Lidral and Reising 2002, Matalova et al. 2008, Shalish et al. 2010). These major variations (dental anomalies) are found in different frequencies in global populations, and between both the sexes within a population (Vastardis 2000, Bailleul-Forestier et al. 2008, Kositbowornchai et al. 2010, Gupta et al. 2011). Thus, utilisation and development of forensic anthropology and its contribution in matters of legality and identification is significant. The basic technicalities that help in identification through dentition have been discussed below to garner some clarity on the significance of dentition as an instrument of identification.

Forensic odontology is a branch of forensic science which deals with the examination and identification of dental remains, it also provides personal information for determination of sex, age and individualization. It is concerned with the identification of teeth, jaws, bite marks and dental injuries. Forensic dentistry involves the analysis of dental evidence for human identification,
especially in loss of life, and catastrophic accidents involving plane crashes, fires and explosions. Thus the forensic dentist or forensic odontologist has a role on reconstructive post-mortem dental profiling for purposes of identification of accident victims and in investigative criminology. Inspections of teeth and jaws have been used for centuries to identify humans. However, in recent times, the evidence needed to identify human remains or suspected offenders of a crime has become more sophisticated.

**Tooth is composed of four different tissues:**

- **Enamel**- It is the hard covering substance which covers the tooth root.

- **Dentine**- It is a bone like substance which forms the body of the tooth.

- **Cementum**- It is the bone like substance which covers the tooth root.

- **Pulp**- It occupies the central cavity of the tooth.

Enamel, dentine and cementum are hard tissues and the pulp is soft tissue which provides blood and nerve supply to the tooth. Teeth are held in the socket present in alveolar bone or alveolar process. Incisal ridge or edge is present on the crown of the tooth in case of central and lateral incisors. In case of canines, the surface present towards lips is called labial and towards tongue is lingual and in the case of premolars and molars, the surface towards cheeks is called buccal. In the same dental arch, the teeth surface facing adjoining teeth is called mesial towards mid line and surface facing away from the mid line is known as distal.
Characteristics and identification of teeth:

1. **Incisors – upper or maxillary incisors**

   The maxillary central incisors are the sheering and cutting teeth. They are the widest of anterior teeth and the lingual surface is irregular and less convex than the lateral incisors. The lateral incisors are smaller in all dimensions except root length and are more variable in form than any other tooth except the 3rd molars. A pointed form of lateral incisor like a peg shaped is occasionally present. Other features include large pointed tubercles developed mental grooves, twisted roots and distorted crowns. The labial surface of lateral incisor or aspect of lateral incisor has more curvature than the central and is narrower (Ash and Nelson 2007).

2. **Lower mandibular incisors**

   These are the smallest teeth in the dental arch. Central incisors are smaller than the lateral incisors and show uniform development and are rarely deformed unlike the upper central incisors and lateral incisors. The lingual surface of the lower incisors is very smooth with less curvature than that of the upper central incisors. Mandibular central incisors and lateral incisors are very similar in shape, which make them tough to distinguish in recovered specimens when they found separated from dental arch (Ash and Nelson 2007).

3. **Canines**

   Both upper and lower canines are similar in form and function. They are the longest teeth in mouth and crowns are usually as long as those of
maxillary central incisors and their roots are usually longer. They have a single cusp which is well developed. Crown and roots are markedly convex because of labio-lingual thickness of crown and root in the alveolar process of the jaws. They are the most stable of all the teeth. The lingual surface of crown is smoother and has less cingulum developed and less bulk to marginal ridges in the mandibular canines (Ash and Nelson 2007).

3. Premolars- upper or maxillary

One of the major differences between anterior incisor and canines and premolars is the development in the later of well developed lingual cusps. This cusp arises from lingual lobe which is represented by the cingulum in incisors and canines. The buccal cusp is long and sharp in 1st maxillary premolars. The crowns and roots of maxillary premolars are shorter than maxillary canines. When premolars have two roots, one is placed lingually and other buccally (Ash and Nelson 2007).

4. Mandibular premolar

Lower, 1st pre-molar has a large well formed buccal cusp and a non-functioning lingual cusp. The 1st premolar is always the smaller of the two mandibular premolars where as opposite is true in many cases of maxillary premolars. The 2nd premolar is more rounded than the 1st and usually has a single root. The buccal cusp is not as long as that of the 1st premolar and is less pointed. The form of both mandibular premolars often does not confirm to implication of term bicuspid which implies two functioning cusps. Both mandibular premolars exhibit more variability on their occlusal surface than the maxillary premolars. The single root of 2nd premolar is larger and longer
than 1st premolar. Their roots are seldom bifurcated. The lingual cusp of mandibular 2nd premolar is well developed and function by being supplementary to the mandibular 1st molar (Ash and Nelson 2007).

5. Molars (maxillary)

Generally, the crown of 1st maxillary molar is wider buccolingually than mesio-distally and is normally the largest tooth in upper jaw. It has four large cusps, mesiobuccal, distobuccal, mesiolingual, distolingual. 5th cusp is known as Carabelli’s complex or trait which is often present on the maxillary molar. Carabelli’s cusp may also appear as a pit, a tubercle or a well developed cusp. This cusp is present on the mesio-lingual cusp which is the largest of the other cusps. The 1st molar has 3 well developed and separate roots. Morphologically, it may resemble the 1st, 3rd and occasionally with the combination of both. The Carabelli’s trait may be present but in a very lower frequency than that of the 1st molar. Maxillary 3rd molar varies in size, contour and relative position and the basic morphology is similar to the 2nd molar. 3rd molar is heart shaped because disto-lingual cusp is smaller, poorly developed or absent. Occasionally they may be so deformed that they no longer resemble either 1st or 2nd molar (Ash and Nelson 2007).

6. Molars (mandibular)

Each of the mandibular molars has two roots, one is mesial and other one is distal. Their crowns i.e. upper portion of the teeth are roughly quadrilateral being somewhat longer mesiodistally than buccolingually which is the case of maxillary molars. The mandibular 1st molar is the largest of all the molars having five well developed cusps, two buccal, two lingual and one
distal. The roots are widely separated at the apices. The mesial root is broad and curved distally. The crown of the mandibular 2nd molar has 4 well developed cusps. The tooth has well developed roots, one mesial and one distal. The roots are broad buccolingually but not as broad as those of the 1st molar. The 3rd mandibular molar is variable both in form and position. It is seldom fully developed. The crown is irregular in form with undersized roots that are usually fused or malformed or distorted. Generally, they confirm to the general form of the 2nd, more than to the 1st molar. Occasionally, a 3rd molar may have five or more cusps, due to a lack of space to accommodate them, 3rd molars are often completely or partially impacted (Ash and Nelson 2007).

**Dental anomalies**

Craniofacial abnormalities in form function or position of the teeth, bones and tissues of the jaw and mouth or disturbance in development of tooth is known as tooth anomalies (Raščić et al. 2006). These can be congenital or acquired in nature. They may include malformations, changes in number of teeth, inherited disturbances or oral environmental changes that may occur during development. Anomalies of the teeth may range from number, size, shape, and position of the teeth in jaws. They may occur solely or jointly with other symptoms depending upon the tooth development stage (Raščić et al. 2006). Tooth development starts in the sixth week of intrauterine life and it can be divided into five physiological stages:

a) Initiation stage

b) Proliferation stage
Depending upon the stages of tooth development, dental anomalies can be classified as follows:

a) Anomalies of number (initiation stage)

b) Anomalies of size (proliferation stage)

c) Anomalies of shape (morphodifferentiation stage)

d) Anomalies of structure (histodifferentiation and apposition stages)

e) Anomalies of color (apposition stage)

f) Anomalies of position.

Anomalies of number (initiation stage):

Anomalies of the number of teeth occur as a result of disturbances in the initiation stage during the tooth bud development.

Anomalies of size (proliferation stage):

Anomalies of the size of teeth are a consequence of disturbances in the proliferation stage of the tooth bud development.
Anomalies of shape (morphodifferentiation stage):

Anomalies of the shape of teeth are caused by disturbances in the morphodifferentiation stage in the tooth bud development. They represent the biggest group of dental anomalies.

Anomalies of structure (histodifferentiation and apposition stages):

Anomalies of the structure of teeth are a consequence of disturbances occurring either in the histodifferentiation stage or the apposition stage (layering of mineral components in the organic matrix of the hard tooth tissues).

Causes of Dental Anomalies:

a) Congenital

b) Heredity (approximately 25%)

c) External factors (only 1%)

d) Multicausal etiology (hormones, maternal diseases and defects, respiration etc.)

Acquired Anomalies

a) Malnutrition (energetic and protein deficiency)

b) Influence of chemical substance, drugs and vitamins deficiency etc. (3-4%)

c) Disturbance of metabolism (2%)

d) Infections, especially of viral etiology (2-3%)
1.1 Dental characteristic features for identification:

1. Shovelling

It is manifested by the prominence of the mesial and distal ridges enclosing a central fossa in the lingual surface of incisors. As compared to primary dentition, shovelling is found more commonly in permanent dentition. Shovelling of incisors is considered to be a polygenic inherited trait. In monozygotic twins, the degree of expression is concordant. In case of mandibular incisors, shovelling is less pronounced as on the maxillary incisors (Dalhberg 1950, Hrdlicka 1929). It is a feature which differs considerably between groups of racial populations but is relatively stable within each group. Subjective scale describes four degrees of shovelling: no shovelling, trace shovelling, semi-shovelling and shovelling. This classification is based on the relative variability of the primary maxillary incisors and canines and mandibular canines (Hanihara 1961).

2. Protostylid

It is a continuous variable found on the buccal or mesiobuccal part of the mesiobuccal cusp (Dalhberg 1950). It is a type of extra cusp located in the anterior of the buccal surface of lower molars. The term was given by Dahlberg in 1951. It arises along the gingival portion of the buccal groove from which its parts and courses antero-occlusally. The appearance of trait ranges from a pit, a furrow to a larger cusp. It varies from tooth to tooth in the frequency of occurrence and expressivity (Gómez 2013). Its frequency and expressivity also varies from population to population (Hanihara 1961).
3. Carabelli’s trait

It is a series of expression ranging from pits to larger cusps. The cusp was first described by the Carabelli (Mitchell 1892). Mesiolingual cusp is a main site for the occurrence of trait. Frequency of trait decreases from first molars to third molars. It has mostly seen or detected symmetrically on both sides of the upper jaw. The formation of Carabelli’s trait takes place by interaction between a complex system of ontogenetic and environment factor (Shethri 2011). The degree of expression and incidence differ among different populations. Therefore, it can be used to detect and compare different populations (Palomino et al. 1978). Mostly, classifications for Carabelli’s trait are based on the size of cusp, hence, there are problems when a variety of grooves, furrow or pits occur. According to Dalhberg’s classification, Carabelli’s trait was expressed in 8 different types, ranging from a completely smooth uninvolved surface to a single furrow, a pit, a double furrow, a Y-form and three grades based upon size.

4. Peg-shaped lateral incisor

Maxillary lateral incisors vary in the form more than any other tooth in the mouth except the third molar. If variation is too great, it is considered a developmental anomaly. A common situation is to find maxillary lateral incisors with, pointed form, such teeth are called peg-shaped laterals.

5. Occlusion

Occlusion is the relationship between the maxillary (upper) and mandibular (lower) teeth when they approach each other, as occur during
chewing or at rest. Malocclusion is the misalignment of teeth and jaws, or more simply, a "bad bite". Malocclusion can cause a number of health and dental problems.

Angle’s classification system is a method commonly used to classify various occlusal relationships. This system is based upon the relationship between the permanent maxillary and mandibular first molars.

6. Class I occlusion

In this classification, the maxillary first molar is slightly back to the mandibular first molar, the mesiobuccal cusp of the maxillary first molar is directly in line with the buccal groove of the permanent mandibular first molar. The maxillary canine occludes with the distal half of the mandibular canine and the mesial half of the mandibular first premolar. The facial profile is termed mesognathic.

7. Class II occlusion

In this classification, the maxillary first molar is anterior to the mandibular first molar, the buccal groove of the mandibular first molar is distal to the mesiobuccal cusp of the maxillary first molar.

8. Posterior cross-bite

This refers to an abnormal transverse relationship between upper and lower posterior teeth. In normal circumstances, mandibular buccal cusps occlude in the central fossae maxillary posterior teeth.
9. Anterior cross-bite

Anterior cross bite is defined as a malocclusion resulting from the lingual positioning of the maxillary anterior teeth in relationship to the mandibular anterior teeth (Tsai 2001).

10. Open bite

Open bite is descriptive of a condition where a space exists between the occlusion or incisal surface of maxillary and mandibular teeth in the buccal or anterior segments, when the mandible is brought into habitual or centric occlusion.

11. Groove pattern

The groove pattern of the molars describes the number of cusps and the configuration of the contact between cusps. Grooves form ‘Y’ or *Dryopithecus* pattern originating in the past Asian population and ‘+’ ‘X’ or cruciform form of groove pattern can be seen in Caucasoid group (Gómez 2013).

12. Abrasion

Due to friction of foreign body on a tooth surface, pathologic (mechanical) wear is formed, which results in the loss of tooth structure and termed as abrasion. Vigorous tooth brushing is the most common course of abrasion, which leads to notching of facial root surface adjacent to the gingival. It may also be caused due to pipe smoking, improper use of tooth
picks and misuse of dental floss, biting pencils, cutting tread with teeth, opening bottles or hairpins with teeth and holding nails with teeth.

13. Erosion

Erosion is a result of chemical action, in which loss of tooth structure occurs. All surfaces of teeth are involved in it to differing degrees and sometimes only one type of surface is involved in erosion. Consumption of acidic foods and beverages for short or prolonged periods of times leads to decalcification resulting in erosion. Fruit juices and soft drinks with low pH, also decalcify enamel. Habit of sucking lemon, grapefruits or oranges, results in continuous exposure to high acidity. Generalized lingual erosion of teeth occurs due to chronic vomiting, anorexia nervosa, and bulimia syndrome.

14. Dental crowding

Dental crowding is defined as asymmetry between tooth size and jaw size this results in imbrications and rotation of teeth. There are three main condition which represent crowding are, excessively large teeth, excessively small bony jaws and a combination of large teeth and small jaws (Howe et al. 1983).

15. Hypocone

The crowns of the maxillary molars have four cusps, paracone (mesiobuccal), protocone (mesiolingual), metacone (distobuccal) and hypocone (distolingual). Protocone is the largest in size of all i.e. paracone, metacone and hypocone. The cusp which appears first is paracone, whereas,
hypocone appears last in terms of both ontogeny and phylogeny. The teeth which develops latter ontogenetically are more variable in size and shows greater sexual dimorphism in sex hormone production between males and females (Sharma and Singh 2012).

16. Diastema

It is a gap between maxillary central incisors. It closes after the eruption of the maxillary lateral incisors and maxillary canines. In some cases, this gap remains throughout life. Sexual dimorphism and racial differences also exists for diastema (Huang and Creath 1995).

17. Tooth fracture

It refers to accidental breakage of tooth leaving it with a peculiarity known as tooth fracture, which is also an identifying mark for identification of the individual

18. Supernumerary teeth

Supernumerary teeth or hyperdontia is said to be developed when there is the presence of more than 20 deciduous or 32 permanent teeth in an individual (Ortner 2003, Ramsaran et al. 2005, Orhan et al. 2006, Proff et al. 2006, Refoua and Arshad 2006, Gunduz and Mugułali 2007). Heterotropic is the term used to classify the development of extra permanent tooth and normotopic, term used for teeth developing outside the alveolar region (Langowska-Adsmczyk and Karmanska 2001). It may be normal in shape and size, normal in shape but reduced in size of conical shape or lastly, abnormal
in shape as well as reduced in size (a denticle) (Fastlicht 1943). Teeth can be unilateral or bilateral depending upon the number i.e. single or multiple supernumerary teeth. Mandibular premolar region is mostly affected by the supernumerary teeth. Most common form of hyperdontia can be found in supernumerary upper central incisors. Due to presence of supernumerary teeth, many different types of local disorders can be found like, retention of primary teeth and delayed eruption of permanent teeth, ectopic eruption, follicular cysts, teeth displacement and other which requires surgical or orthodontic intervention (Simoes et al. 2011).

19. **Inter canine distance (maxillary)**

“Distance between the cusp tips of the maxillary right and left permanent canines” (Al-Taee 2012).

20. **Incisor-incisor distance**

It is the distance between the centre points of maxillary left and right lateral incisors.

21. **Dental arch height**

Dental arch height was determined by measuring the perpendicular distance from the occlusal plane constructed from the second primary premolars/permanent first molars. Through a space in a plastic square set, the end of the digital calliper was pressed to the palatal contour, this distance minus the thickness of the square set (2 mm) represented dental arch height.
1.2 Palatal Rugae

Palatal rugae are also known as plicae platinae transversae or rugae palatine. These are transverse ridges formed by connective tissues present on the anterior surface of the palate and cover the maxillary bone and tangentially radiate out from the incisive papilla in the form of 3-7 rigid and oblique ridges (Hemanth et al. 2010, Warwick et al. 1979). They appear in the third month of intrauterine life (Venegas et al. 2009). Epithelial mesenchymal interactions controlled the growth and development, where development is spatiotemporally articulated by definite extracellular matrix molecules (Amasaki et al. 2003). Next to the incisive papilla, first ruga is distinguished in human embryos of 32 mm CRL (Buchtová et al. 2003). Once they are formed, their shape is maintained, but may experience changes in their size due to growth of the palate (Jordanov 1971, Lang and Baumeister 1984) and after the age of ten years, lengths of anterior rugae do not increase (Vander Linder 1973).

In order to examine individuality, palatoscopy or palatal rugoscopy is the name given to the study of palatal rugae. Individuality of palatal rugae has been shown consistent in form throughout life. Extreme finger sucking in infancy and persistent pressure with orthodontic treatment and some events like trauma can also contribute to change in rugae pattern (Lysell 1955).

Due to panfacial third degree burns, most burn victims do not sustain any palatal rugae pattern changes, and when changes appear, they are less prominent than the generalized body state. Due to internal position in the
head, rugae are protected from trauma and are insulated from heat by the tongue and the buccal fat pads (Limson and Julian 2004, Nayak et al. 2007). One of the study (Shukla et al. 2011) shows that there is no dependence on heredity in determining the form and orientation of rugae pattern. It has been reported that no similarity exists in palatal rugae patterns of siblings and even their parents and even in case of twins, palatal rugae are similar but not identical.

Generally, herbivorous animals have many well-grown and firm rugae similar to a strap over the palate. On the other hand, carnivorous or omnivorous animals have few and varied rugae similar to a string only in the anterior part of the hard palate (Buchtová et al. 2003). In the human mouth, palatal rugae take part in the digestion process and have supplementary functions in mastication, pronunciation, swallowing and drinking milk during infancy (Thomas et al. 1987).

If palatal rugae are removed clinically, after some months, they return at their anatomical position as before, so, palatal rugae could easily be forged in cases of speech improvement. In the cases of burn victims and cadavers, the preservation of palatine rugae is more useful in matters like incineration and development. In a study, it has been shown that, Human cadaver was kept for minimum of seven days in the mortuary at 50º C with 30% to 40% relative humidity for the assessment of palatal rugae. It was found that the individual with third degree pan facial burn had 93% of normal palatal rugae and 77% of human cadavers showed no change in color or surface anatomy.
of the palatal rugae (Indira et al. 2011). However, in researcher's opinion, this may also depend upon the temperature of the region from where the decomposed dead body has been recovered.

To identify an individual, there are five requirements - individuality, immutability, perenniality, practicality and classification. Without ante-mortem records, post mortem identification is not possible. Palatoscopy is used as necro identification technique. Very good results were obtained by using computerized method for the individualization of rugae. This technique is preferred because of its very low cost effectiveness and reliability. Palatal rugae itself is sufficient characteristic for individuality, so these patterns have been studied in various fields of science such as comparative anatomy, genetics, forensic science, odontology etc. (Kapali et al. 1997). Due to the unique pattern of palatal rugae, they can be easily classified and can be used for individualization purposes (Virdi et al. 2010).

However, whenever the ante-mortem information is available for comparison in the form of dental casts, tracings or digitized rugae patterns, only then rugoscopy can be suitable method for forensic identification. Other features of the cast, such as teeth, edentulous ridge morphology, muscle attachments, vestibular depth, or some combination of these, when used unintentionally help in the identification, may influence their results. According to various researchers, palatal rugae can be successfully implied in human identification as they are unique to each individual (Nayak et al. 2007). Some of the researchers have disagreed as to whether or not legal identification
could be based completely on palatal rugae (English et al. 1988). The purpose of this analysis is to conclude if palatal rugae can be relied upon for identification of the individual and whether it can play a specific role in forensic science. Furthermore, the study of palatal rugae contributes to the anthropological literature by classifying the morphological types and studying their sex differences.