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DENTAL PULP TESTING : A REVIEW

AASTHA BUCH

ABSTRACT

Dental pulp testing is a major and essential part of endodontic diagnostic process. The routinely used tests are the thermal and electric sensibility tests which have a major short coming that they only indirectly provide an indication of the state of pulp by measuring a neural response rather than the vascular supply, so both false positive and negative results can occur. Actual assessment of vitality can be done through Pulse Oximetry and Laser Doppler Flowmetry.

This article focuses on the rationale, indications, limitations and interpretation of sensibility tests and assesses the promising prospects : vitality tests.

Keywords : pulp, diagnosis, cold test, heat test, electric pulp test, vascularity assessment.

INTRODUCTION

Before commencing any treatment, one must first assemble all the available information regarding symptoms and history of the disease. These should then be combined with the findings of the clinical examination and the results of relevant diagnostic tests. This helps the clinician to formulate a differential diagnosis of all possible disease entities consistent with history, examination and results of tests. For this purpose, the clinician must have a thorough knowledge of examination procedures, tests as well as their limitations.

Dental pulp tests are investigations that provide valuable diagnostic and treatment planning information to a dentist.

Sensibility Tests : Thermal and electric are sensibility tests because they assess whether pulp’s nerve fibres can respond to a stimulus when applied to the tooth. The results help determine whether a pulp is likely to be alive(with response) or necrotic(without response).

Vitality Tests : Vitality implies that a blood supply is present within the tissues. Hence true vitality tests that actually measure or assess pulp blood flow are : Laser Doppler Flowmetry and Pulse Oximetry. These are not commonly used in dental practice due to cost, time, complicated clinical procedures and uncertain results.

PULPINNERVATION

Two types of sensory fibres are present in the pulp: the myelinated (A fibres) and unmyelinated (C fibres). The A fibers predominantly innervate the dentin and are sub grouped according to their diameter and conduction velocities into A- and A- fibers. The A- fibers may be more sensitive to stimulation than A- fibers but functionally these fibres are grouped together. Approximately 90% of A fibres are A- fibres.
The C fibres innervate the body of pulp. The A-fibres have lower electric threshold than C fibres and respond to a number of stimuli which do not activate the C fibres.

A- : Acute, sharp pain by hydro mechanical events in dentinal tubules such as drilling or air drying.

C : Dull, boring and poorly located pain and activated only by stimuli reaching the pulp proper: Intense heat/cold\(^\text{5,6}\). Once activated, the pain initiated by C fibres can radiate throughout the face and jaws. C fibre pain is associated with tissue injury and is modulated by inflammatory mediators, vascular changes in blood volume and flow, and increases in pressure\(^7\).

**PULP TESTING TECHNIQUES AND EFFECTIVENESS**

**I. PULP SENSITIVITY TESTING**

Currently, the most widely used vitality tests assess the integrity of A-d nerve fibres in the dentin – pulp complex by briefly applying a stimulus to the outer surface of the tooth. If the A-fibres are successfully stimulated, the patient will respond by acknowledging a short, sharp sensation/tingling from the tooth. A positive response indicates that the nerve fibres are functioning (to some degree) but does not give any indication of pulpal blood flow. In absence of vascular supply to the pulp, it will rapidly become anoxic and A-fibres will cease to function.

**THERMAL TESTS**

These tests involve the application of cold and heat stimuli to a tooth, to determine sensitivity to thermal changes. Although both are tests of sensitivity, they are actually conducted for different diagnostic reasons. A response to cold usually indicates a vital pulp, regardless of whether that pulp is normal or abnormal. In contrast, an increased response to heat is suggestive of pulpal or periapical pathology that may require endodontic intervention\(^8,9\).

**COLD TESTS**

Cold thermal testing causes contraction of the dentinal fluid within the dentinal tubules, resulting in a rapid outward flow of fluid within the patent tubules\(^10\). This rapid movement of dentinal fluid results in “hydrodynamic forces” acting on the A-nerve fibres with the pulp – dentin complex, leading to a sharp sensation lasting for the duration of the thermal test. Various cold tests employed are:

1. Ice sticks: it is perhaps the simplest cold testing agent. Usually made in desired sizes and dimensions by freezing water in empty local anaesthetic cartridges. However the clinical handling, infection control issues, and the direct application of ice can be difficult and problematic. Isolation with rubber dam may be of assistance to avoid thermal stimulation of multiple teeth\(^4,11\).

2. Refrigerant spray: widely used due to its ease of storage, relatively cheap cost and simple application technique. Earlier ethyl chloride spray was used; followed by Dichloro Difluoro Methane. However, DDM has cause environmental concerns due to ozone layer depletion and has been replaced by Tetrafluoroethane (TFE).

3. CO\(_2\) Snow (dry ice)

Temperature range in cold test: -20° to -50° C

The cold test may be used to differentiate between reversible and irreversible pulpitis. It should be noted, however, whether stimulus application produces a lingering effect or if the pain subsides immediately on removal of the stimulus from the tooth. If the patient feels a lingering pain, even after the cold stimulus is removed, a diagnosis of irreversible pulpitis may be reached. Conversely, if the pain subsides immediately after stimulus removal, a diagnosis of reversible pulpitis is more likely. The clinician should also take into consideration other factors such as a history of pain on lying down and the duration of pain. The diagnosis of reversible/irreversible pulpitis is only a clinical diagnosis and may not correlate with histological diagnosis.
HEAT TEST: Temperatures achieved are in the range of 120° - 140° C.

1. Heated gutta percha stick (Grossman’s Method)
2. Hot water bath
3. Warmed hand instrument such as a hot ball burnisher
4. Equipments such as Touch N Heat, System B
5. Frictional Heat

Safety concerns of heat tests: temperatures of up to 150° C have been reported to have been achieved with heated instruments or gutta percha. Even an increase of 11° C that occurs during restorative procedures without adequate cooling can harm the pulp. Therefore, prolonged contact with heat is a safety concern. Hence, it should be applied for no more than 5 seconds. Moreover, application to posterior teeth may be difficult due to limited access.

Before initiating thermal tests, it is important to inform the patient of the nature of the test(s) and what is to be achieved.

The patient must be aware of when the operator requires them to respond and how they can indicate their response; hand signals are an effective means of achieving this, but it is essential to establish a reliable report.

In the event that the patient does not perceive any sensation in the tooth after 5-6 seconds, then the stimulus should be removed.

Some teeth with irreversible pulpitis require repeated stimuli to reach the threshold that provokes pain.

Also, it should be remembered that once a pulp is tested with cold, there is a refractory period of several minutes before a second cold or heat stimulation can be accurately conducted on that same tooth.

Thermal tests are considered to be more accurate when applied to the cervical aspect of a tooth and as close as possible to the gingival margin. This location represents the thinnest aspect of enamel or a restoration and the closest distance to the pulp chamber.

However, some studies have used the middle third of the buccal/labial or palatal/lingual aspect of the crown for thermal testing. Others believe that cold stimulus should be placed in the incisal or occlusal third that approximate the pulp horns, where the pulp innervation is post plentiful.

Teeth should ideally be tested on several surfaces to gain maximum information about the state of pulp. Several adjacent, opposing and contra lateral teeth should be tested before testing the tooth in question, so the ‘normal/response for that particular patient can be determined’.

ELECTRIC PULP TESTING

PHYSIOLOGICAL BASIS

The sensation the patient feels when an electric current is passed through the tooth structure is the result of direct stimulation of the pulp nerve fibres. However, it cannot reasonably indicate that these fibres are present in intact and healthy tissue. Necrotic and disintegrating pulp tissue often leaves electrolytes in the pulp space, which can conduct the electricity to the nerves further down the pulp space, stimulating an apparently normal response.

The principle of the EPT, whether it be a type that measures voltage or current, is to raise the electrical potential through the enamel and dentin into the pulp to provoke a measurable response from the pulp. The basic requirements for this include adequate stimulation, appropriate technique of use and careful interpretation of the results.

Electric stimulation of nerves within the pulp depends on the rate of current increase, its strength (voltage and current), duration and frequency. Current density also plays an important role. Increasing the surface area of the electrode requires greater current to produce a sensation and over any given electrode area, shorter pulse widths require
greater current to produce a sensation.
Two modes of electric pulp testers exist, monopolar (or unipolar) and bipolar, with each being divided into two categories: those with a mains power connection and those that work with batteries.

Nowadays, most EPTs are monopolar with the anode often placed on the lip and the cathode on the tooth. When the electrode is applied to the tooth surface, the circuit is completed through the body of the patient via the lip clip. Alternatively, the circuit can be completed through the body of the practitioner who is holding the alternate end of the probe. In this situation, it is essential for the dentist to touch the patient with the opposite hand not holding the EPT. To ensure suitable contact, the hand should preferably be moistened; it is possible for the practitioner to feel the current passage through his/her own hands.

**CORRELATION BETWEEN EPT RESULTS AND HISTOLOGICAL STATUS**

The most important point regarding the use of EPTs is the interpretation of the results in conjunction with patient’s history, findings from the clinical examination and radiographs, and by comparison with control teeth, because many studies have shown no correlation between positive responses to the EPT and the histological status of the pulp. A positive response simply indicates that there are sensory fibres present within the pulp that can respond to electric stimulus. Despite this, there is a significant relationship between the failure of a tooth to respond to an electric pulp test and histological evidence of total necrosis, so this technique should be only used to determine whether or not there is viable pulp tissue present in the tooth tissues and not to assess the health or vitality of the pulp tissue.

**VARIATION IN READINGS / CREATION OF A FALSE RESPONSE**

1. **Failure to complete the circuit:**
   - Equipment problems – inaccuracy or unreliability of the device
   - Erroneous probe placement
   - Interface media

2. **Patient related factors**
   - Tooth characteristics – thickness and homogeneity of the enamel and dentin, tooth surface wear, calcification, enamel defects such as extensive caries and cracks, size of pulp chamber, moist gangrenous necrosis of pulp, presence of multiple canals.
   - Apex maturation – permanent teeth with open apices usually give little or no response to electrical testing. This is due to the fact that myelinated fibres entering the pulp may not reach their maximum number until 5 years after tooth eruption or until they have been in function for 4-5 years. Also lack of development of the plexus of Rackshon at the pulpo-dentinal junction. CO$_2$ snow can be more reliable than EPT for sensibility testing of immature teeth.
   - Teeth with restorations – large metallic restorations, orthodontic appliances etc.
   - Repeated trials – that elicit false responses on patient habituation or adaptation.
   - Patient’s psychological state - anxious and nervous patients may have a lower response threshold. Local Anaesthetic testing and Test Cavity - are invasive tests to assess sensibility of pulp and are usually not advocated.

**II. PULPVASCULARITY TESTING**

**LASER DOPPLER FLOWMETRY:** It is a non-invasive method for assessing blood flow in microvascular systems. The technique utilizes a beam of infrared light produced by a laser that is directed into the tissue. As light enters the tissue, it is scattered and adsorbed by moving red blood cells and stationary tissue elements. Photons that interact with moving red blood cells are scattered and frequently shifted according to the Doppler principle. Photons that interact with stationary elements are scattered but are not Doppler shifted. A portion of the light is returned to the photon...
detector, and a signal is produced. Because the red blood cells represent the vast majority of moving objects within the tooth pulp, measurement of Doppler shifted backscattered light is interpreted as an index of pulpal blood flow$^{20,24}$.

**PULSE OXIMETRY**: The term oximetry is defined as the determination of the percentage of oxygen saturation of the circulating arterial blood. Oxygenated haemoglobin and deoxygenated haemoglobin are different in colour and therefore absorb different amounts of red and infrared light. The pulse oximeter therefore utilizes probes emitting a red and an infrared light to transilluminate the target vascular area, which allows the photodetector to identify absorbance peaks due to pulsatile blood circulation and thereby calculate the pulse rate and oxygen saturation level$^{20,24}$.

Other vitality tests include

**REFERENCES**


**CONCLUSION**

Pulp sensibility testing, even with its limitations, has been and still remains a very helpful aid in endodontic diagnosis. Attempts at measuring the true pulp blood flow clinically have had mixed success, with laser Doppler flowmetry being one of the popular techniques applied in dental traumatology$^{21}$. Currently, no vitality tests have been proven to be superior in all aspects compared to pulp sensibility tests. Further research is needed to improve the reliability and accuracy of diagnostic dental pulp tests.

**REFERENCES**

INTRODUCTION

In first half we looked at the need and problems of child with cleft lip and palate from birth through to the young adulthood. The second half and final article, mainly deals with paediatric dental care for the patient with a cleft lip and palate from birth through to adolescence and young adulthood and also vital role played by pedodontist in CLP multispecialty team.

Smile on the child’s face always brings joy for everyone, but is so much when it comes on the CLP affected child. The management of children with cleft lip and palate gives many challenges but also present many rewards. Our involvement with these children and their families often begins before birth and can extend into late adulthood. Affected children present a multiplicity of problems and effective management involves a wide range of specialists. The currently accepted model for delivery of this care in the most appropriate way is the multidisciplinary cleft team. It includes oral surgeon for surgical treatment and orthodontics for the growth and aesthetic treatment, but among these, pedodontist can play a very vital role and it can be divided in two major category.

1) Pre operative role:
2) Post operative role:

PRE OPERATIVE ROLE

[ Figure 1 : Showing pre operative role of pedodontist in pediatric dental care of CLP child ]
**Parental counseling:** From the time of first contact with the child and family, every effort must be made to assist the family in adjusting to the birth of a child with a craniofacial anomaly and the consequent demands and stress placed upon that family. Parents appear to value dental advice even before the first teeth erupt and this is an ideal time to discuss preventive care. An appreciation of the family situation is important to allow for the optimum delivery of dental care. Each patient and their family have their own particular needs and these gradually become apparent as a trusting relationship is built with the dentist. The way that we can attempt to do this is to guide parents through a number of stages or tasks:

1. To acquire knowledge and understanding of clefting. For example, to ensure parents understand that in many cases the cause of clefting is as yet unknown. This is particularly important for parents who worry a great deal about whether they have somehow caused the cleft to occur; such as, in the case of a parent who has consumed a very small amount of alcohol during their pregnancy and is worried that this has caused the cleft.

2. To encourage the development of parental confidence and skills in handling and feeding which reduces parental anxiety increases their sense of competency and controllability.

3. To enable the identification and expression of parental emotional reactions. Many parents fantasize about their unborn baby and how the baby’s future will be. When they find out that their baby is not as they imagined, they can experience feelings common to other experiences of loss. These are typically, disbelief, numbness, shock, and immense sadness. Hearing that these reactions are common can help to prevent the parent feeling guilty about having reacted in this way.

4. To reduce anxiety about both short and longer term issues and instill a sense of hope and optimism about the baby’s future, e.g. worries about the child’s future peer relationships and social status.

5. To encourage parents to seek social support, e.g. having access to other parents who have been through some of the same stages they have ahead of them. Also to encourage parents to access voluntary sector support services such as the Cleft Lip and Palate Association (CLAPA).

**Early preventive advice for the child.**

**Child Examination:** The easiest way to examine a baby is with its head gently lowered onto the dentist’s lap and the parent sitting facing the dentist, supporting and controlling the child’s arms and legs. The use of a small dental mirror is helpful in tiny mouths; especially in the patient with a cleft. Dental radiographs, cephalometric radiographs, and other imaging modalities as indicated should be utilized to evaluate and monitor dental and facial growth and development.

**Diet:** Feeding difficulties are a common problem for babies with a cleft palate. The use of feeding plates and pre-surgical orthopedic correction plates is controversial and varies regionally between cleft teams. Specialized feeding bottles such as the Haberman feeder (Athrodax surgical Ltd, Ross-on-Wye, and Herefordshire) and Mead Johnson bottle (Mead Johnson Nutritional, Hounslow, Middlesex) have helped to overcome some of the feeding problems. The Haberman system consists of a standard bottle with a soft variable flow teat and a pump action valve, requiring no active suction for operation. The Mead Johnson is a very soft bottle which can be squeezed to help the flow of milk. Babies with these problems may need a special teat and bottle that allow milk to be delivered to the back of the throat where it can be swallowed.

**Taking impression for Feeding plate:**

Different impression procedures have been
reported in the literature for cleft lip and palate (CLP) infants. Patient positioning, tray and impression material selection are the important factors to consider in impression procedure. The impression is made when the infant is fully awake without any anesthesia or premedication. Infants should be able to cry during the impression procedure and absence of crying may be indicative of airway blockage. Alginate, low fusing impression compound and elastomeric impression materials have been routinely employed for taking impressions of neonates with oral clefts. The use of fast setting color timed alginates has been suggested in cleft infants. Alginate has poor tear strength and at times can cause fragment retained in cleft area on removal especially since the material extrudes deep into the cleft undercuts. One particular method suggests packing the cleft areas with moist gauze to avoid complications when using alginate. Impression compound is also used for impressions of infants with oral clefts. The advantages of its use are that it can be removed before it sets in case of any emergency and it has excellent resistance to tearing. Elastomeric putty impression materials, unlike alginate, does not extrude deep into undercut areas in the region of the cleft. This helps during removal as it resists tearing and, as a result, removal is atraumatic to the infant. Complications encountered when taking impressions in cleft lip and palate infants arise primarily due to the fact that they are obligatory nasal breathers. The following hazards have been encountered by dentists involved routinely in the care of CLP patients:

1. Difficulty in removal of impression due to engagement of undercuts
2. Fragmentation of the impression during withdrawal from the mouth with subsequent respiratory obstruction due to lodgment in the respiratory passage.
3. Cyanotic episodes of which few resulted in asphyxiation and fortunately no fatalities were reported.

So, all infant impressions need to be taken with good care with a surgeon present at all times to avoid complications and to handle airway emergencies. Parents are instructed not to feed the infant for at least two hours prior to the procedure. High volume suction is also ready, at all times, in case regurgitation of the stomach contents occurs during the procedure.

Parents should be recommended milk and cooled, boiled water as the only suitable dentally-safe drinks for use in a feeding bottle. They should be made aware that fruit drinks and squashes, including baby fruit juices, have an erosive potential. Sugar-containing and acidic drinks should be kept to a minimum and given at mealtimes only, with the introduction of a training beaker or cup from the age of 6 months. The dentist is in a position to help with advice on weaning practices. Weaning foods and drinks should be free from non-milk extrinsic sugars, as far as possible, to encourage good dietary habits for a healthy dentition. They need to understand fully the relationship between the frequency of sugar in the diet and tooth decay.

**Medicine:** It is important to obtain details concerning the child’s prescribed medication. The regular administration of sucrose containing medicines (especially syrup) will give rise to dental caries. It is essential to explore the possibility of a sugar-free alternative in these cases. Parents need to appreciate the importance of good dental health before the teeth erupt. Parents need to understand the value of tooth brushing. They should be shown in detail how to brush the teeth and gums properly. It is important to point out the potential problem areas of plaque accumulation around the teeth in the cleft region. The use of the dental mirror with the child supine will aid demonstration of difficult access regions to the parent by indirect vision.
A small baby brush is advised as the first toothbrush. For many children with clefts, this size of brush can be used up until the eruption of the first permanent molars and beyond. A small-sized head is ideal where there is a lack of sulcus depth, or awkward tooth positions in the cleft region. An interspace brush is a useful additional aid where there is overlap and crowding of teeth, or in the case of the bilateral cleft where the upper anteriors can be very retroclined. It is especially helpful for teeth in the cleft region of the hard palate.

BEHAVIOR MANAGEMENT

As described in behavior problems, it is important to get to know the patient as an individual and to allow time for the necessary behavior management, acclimatization and confidence building. However, it is equally important to get to know the parents, as gaining their trust and confidence will facilitate the provision of regular dental care.

PRESURGICAL ORTHOPEDICS

Presurgical infant maxillary orthopedics may prove to be beneficial to the surgeon if a better alignment and closer approximation of the cleft segments is achieved before the actual surgical repair. The contemporary view is that when used as an adjunctive procedure to definitive lip repair, infant maxillary orthopedics provides presurgical benefits. In some cases of bilateral cleft lip and palate, the infant has a premaxillary segment positioned severely anterior to the maxillary arch segments or deviated laterally to one side of the cleft defect. In 1686 – Hofman described the use of a head cap and premaxillary strap to reposition the premaxilla. This type of apparatus is useful for anteroposterior and vertical repositioning. As soon as possible an impression is made of the infant’s maxillary arch for construction of an intraoral obturator in the manner described above. After delivery of the obturator, the infant is allowed to become accustomed to the appliance for 1 week. At the second appointment the infant is fitted with a premaxillary retraction appliance.

POST OPERATIVE ROLE

Parents may be nervous to brush in the region of the cleft, especially following the primary lip and palate surgery. They often think that bleeding from gingival inflammation is caused by damage from tooth brushing or the breakdown of the surgical repair. Where the upper lip has been repaired, parents should be shown how to lift it, stretching the lip carefully by sliding an index finger along the labial gingiva, without doing any damage to the scar. This helps to give them a clear view of the cleft region with good access to the crowns of the anterior teeth and the gingival margins for plaque removal. Parents should be given the opportunity to practice the tooth brushing technique in the dental surgery. Once they understand what they need to do and feel reassured that they are not causing harm to the cleft region, they can then carry out regular tooth brushing with confidence.

For the toddler, parents are advised to stand or kneel...
behind the child when brushing, with the chin supported and head resting against the parents’ chest. It may help if the child is in their baby seat or pushchair, or even lying on the carpet. A low fluoride children’s toothpaste containing not more than 600 ppm fluoride is recommended for children under 6 years of age in order to reduce the likelihood of enamel opacities in the permanent teeth. Children with a high risk of developing caries should use standard toothpaste (1,000 ppm fluoride). The eventual goal is to establish a twice-daily tooth brushing regime with the recommendation of no more than a small pea-sized amount of toothpaste on the brush. Parental help and supervision continues to be important at least until 7 or 8 years of age. 

0.2% chlorhexidine gluconate mouthwash is useful for short periods following surgery or to help stabilize gingival health in severe cases of gingival inflammation, where the patient is anxious about the bleeding gingival tissues and is nervous to brush. However, there is no substitute for good tooth brushing and this should be re-established as soon as possible.

**PREVENTIVE CARE**

Fissure sealants are an important consideration for this group of patients. The procedure is advisable for first and second permanent molars and premolars where indicated. Fissure sealing should be carried out as soon as the teeth have erupted sufficiently to allow adequate moisture control of the occlusal surfaces. Sealant restorations provide a solution to the early carious lesion, especially in the occlusal surfaces of permanent molar teeth. Decisions regarding fluoride supplements will depend on various factors such as the fluoride content of the local water supply, the likelihood of compliance, the caries experience of the patient and other family members, and other factors related to the family’s social circumstances.

*Fluoride varnish.* Regular dental check-ups should help to detect early enamel demineralization which can be arrested by the implementation of a good preventive regimen. The main preventive measures are the dietary control of sugar, thorough tooth brushing with fluoride toothpaste and the use of fluoride supplements where indicated. In addition, the twice-yearly professional application of topical fluoride varnish is a very useful preventive measure for teeth that are at risk from caries. These include hypoplastic or crowded teeth in the cleft region, and any teeth which already show early signs of decalcification. Fluoride varnish should always be applied carefully, bearing in mind the high fluoride concentration of the varnish (5% sodium fluoride). With a co-operative child the best method of application is to apply the varnish with a brush to dried tooth surfaces. The applied varnish sets in contact with saliva.

**Fluoride tablet:** supplements should be continued throughout this phase if appropriate, or fluoride mouthwash usage could be introduced at this stage if only a topical effect is required.

**RESTORATIVE CARE**

As for all children, the aim for the child with a cleft lip and palate is a caries-free dentition. If carious lesions have developed, it is essential that they are restored as soon as possible with the most suitable material. Radiographic assessment is necessary for treatment planning with regard to caries activity and progression. Bitewing radiographs should be considered once the child is able to cooperate satisfactorily.

If restorative work is needed it should be carried out to a high standard. Pulp treatment procedures and stainless steel crowns for primary molars should be used where appropriate. The aim is for these teeth to exfoliate naturally, thereby maintaining the original arch relationships and space for the permanent successors, unless extractions are indicated for orthodontic reasons. Adhesive restorations can be placed to protect these teeth, make them easier to clean and improve their aesthetics. These restorations can serve as an interim measure prior to
more advanced restorative work carried out in the young adult years following the completion of orthodontic treatment and possible surgery. Improvement of appearance is of crucial importance for patients with a cleft lip and palate, who may be subject to teasing and suffer from a poor self-image. Adhesive restorative techniques for the remodeling of tooth form, composite or porcelain veneers and resin bonded bridges are used to achieve aesthetic improvements after the completion of orthodontic treatment. Conventional crowns and bridges or the provision of a chrome-cobalt partial denture (possibly combined with an upper retainer) are sometimes necessary.\[16\]

**ORTHODONTIC CORRECTION OF TEETH**

In some cases, orthodontic treatment is started early. For example, a simple upper removable appliance may be provided to correct an anterior crossbite. Patients with an alveolar cleft may require orthodontic expansion with a fixed appliance to create space for placement of an alveolar bone graft. The alveolar bone graft is usually carried out between the ages of 8–10 years. The aim of this surgical procedure is to repair the residual bony defect to allow the eruption of the permanent lateral incisor and canine tooth into the cleft region. Definitive orthodontic treatment is carried out when the permanent dentition is fully erupted.\[12\]

**CONCLUSION**

The role of pedodontist in paediatric dental care for the patient with a cleft lip and palate extend from birth through to adolescence and young adulthood and also play vital role in CLP multispecialty team. Apart from this pedodontist can also play a very important role in communication with the cleft team. For the parents of babies with a cleft, the stages of cleft surgery are major ‘landmarks’ or ‘milestones’. The dentist needs to have an understanding of the surgical procedures and their timing so that dental care can be integrated sensitively within the overall treatment plan. Good communication between the dentist and the cleft team is essential for accurate exchange of information. It is important for the dentist to liaise with the cleft team (and vice versa) and this should be ongoing throughout the whole of the cleft management period. Two-way communication helps to achieve the most effective treatment plan for the individual. For example, the dentist needs to inform the orthodontist about any relevant dental management problems, such as a high caries rate or behavioural difficulties. Teeth with a poor long-term prognosis should be discussed in order to aid future orthodontic treatment planning. Any extractions as a result of caries should be jointly planned, especially if teeth are to be removed under general anaesthesia. The articles (Pediatric Dental Care of Cleft Lip and Palate Child Part – 1 & 2 have been summarized in the table below.
Table 1

Problems associated with CL-CP

1. Social and Emotional problems
2. Diet and nutritional problems
3. Aesthetic problems
4. Dental problems
5. Behaviour problems
6. Hearing problems
7. Speech problems

ROLE OF A PEDODONTIST

Pre-operative role

1. Parental counselling for diet and oral hygiene maintenance
2. Early preventive advice for the child for caries prevention
3. Construction of feeding plate
4. Presurgical orthopedics for correction or rotated pre maxilla
5. Instils positive attitude towards the dental treatment in a child by behaviour shaping or modification as required.

Post-operative role

1. Post-operative oral hygiene maintenance through professional oral hygiene maintenance aids
2. Preventive care : topical fluoride and sealants application
3. Restorative care for the carious teeth and endodontic treatment for involved teeth
4. Orthodontic correction of mal aligned teeth
5. Palatal plate for correction of speech problems

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A STUDY OF LIP PRINTS AS AID OF IDENTIFICATION AND SEX DETERMINATION

PRITI SHAH*, KEVIN PARIKH**, MONA SHAH***, FAIYAZ KHAN****

ABSTRACT

Identification is the establishment of a person’s individuality. Identification of an individual is a prerequisite for personal, social and legal reasons. Cheiloscopy is an upcoming tool for the identification of a person. Lip print of each and every person is unique. The present study was conducted to determine prominent lip print types in different age groups and in relation to sex. This study was conducted on 258 subjects residing in Kheda district, Gujarat which included 124 males and 134 females between the age group of 1 to 70 years. Lip prints were studied, using Suzuki’s classification. The prominent type in each quadrant was noted and percentage was calculated. Study revealed that none of the lip prints matched each other. Lip prints behold the potential of determination of sex. No change was observed in lip prints of same individual after a period of one year.

Keywords: Cheiloscopy, Lip prints, Suzuki’s classification, determination of sex

INTRODUCTION

Human identification is a universal process based on scientific principles. Establishing a person’s identity can be a very difficult process. Comparisons of Dentitions, fingerprint and DNA comparisons are probably most common techniques used in this context. One of the most interesting emerging methods of human identification which originates from the criminal and forensic practice is human lip recognition.

Lips are two fleshy folds surrounding the oral orifice. They are lined externally by skin and internally by mucosa. External surface of lips has many elevations and depressions forming a characteristic pattern called lip prints. Examination of which is referred to as cheiloscopy. Lip prints are unique to an individual and do not change during entire life of a person. So cheiloscopy techniques have an equal value in relation to the other types of forensic evidence for personal identification. Cheiloscopy is least invasive and easily available mode for study purpose. Lip print recover after undergoing alterations like minor trauma, inflammation and diseases like herpes.

However major trauma to the lips, pathosis and surgical treatment may alter pattern and morphology of grooves. The lip print of parents and children have shown some similarities. It has been suggested that variations in pattern among males and females could help in sex determination. Lip pattern depends on whether the mouth is open or close. In closed mouth position lip exhibits well defined grooves. Any loss of support due to loss of anterior teeth can cause change in lip pattern.

In 1967 Sanlos was the first person to classify lip grooves. Lip prints were classified using the method proposed by Suzuki K and Tsuchihashi Y in 1910 also known as Tsuchihashi’s classification. They classified the natural lip marks and fissures in following four types.
TYPE I: Vertical, comprising of complete (end to end) longitudinal fissures  
Type I’: Incomplete longitudinal fissures  
Type II: Branching Y shaped pattern  
Type III: Criss-cross pattern  
Type IV: Reticular, fence like.

The most characteristic groove patterns are recorded by dividing the lips into four quadrants as given below.

<table>
<thead>
<tr>
<th>Lip Pattern Type</th>
<th>Site</th>
<th>Gender Precedent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I and I’</td>
<td>1st quadrant (right upper lip)</td>
<td>Female</td>
</tr>
<tr>
<td>Type II</td>
<td>2nd quadrant (left upper lip)</td>
<td>Male</td>
</tr>
<tr>
<td>Type III</td>
<td>Never occurs in lower lip</td>
<td>If so, only in male</td>
</tr>
<tr>
<td>Varied patterns</td>
<td>In all quadrants in all quadrants</td>
<td>Male</td>
</tr>
<tr>
<td>Similar patterns</td>
<td></td>
<td>Female</td>
</tr>
</tbody>
</table>

Materials & Methods

This study was carried out in the department of Oral diagnosis, medicine and radiology, Faculty of dental science, DDU, Nadiad, Gujarat to determine the prominent lip print type in the study population according to age distribution and its role in identifying sex.

A sample of 258 individuals comprising 124 males and 134 females between the age group of 1-70 years were included in the study. Selected individuals were without any pathology. Individuals with known hypersensitivity to lipstick were not selected.

Materials used were bright red colored lipstick, bond paper, glue, scissor, magnifying lens and pencil. Lipstick was applied on lips evenly with single stroke. Subject was asked to rub both the lips to spread the lipstick evenly. The subjects are asked to open the mouth slightly and to keep the mouth stationary during the procedure.

White bond paper was held between lips, applying gentle and even pressure for a few seconds. Then the paper was carefully lifted from the lip, from one end to the other. This served as a permanent record.

Lip prints of males and females were studied by first principal researcher. Suzuki and Tsuchihashi’s classification was used dividing the lips into four quadrants. All the subjects were divided in seven groups according to their age and serial numbers were given to hide the sex, age and name of the individuals. Second principal researcher analyzed and interpreted all the lip prints to determine the sex. Lip prints of 60 subjects were again recorded after one year.

Results

The examination of lip print pattern clearly revealed the following observations:

- No two lip prints match with each other thus establishing the uniqueness of the lip prints.
- Type I’ followed by Type II were seen most commonly in males in all quadrants (table-1)
While Type I’ followed by Type I were most commonly seen in females in all quadrants. (Table 2)

119 females were correctly diagnosed among 134 female subjects. (Table 3) and 85 males were correctly diagnosed among 124 male subjects. (Table 4)

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**TABLE-1**

PERCENTAGE OF LIP PRINT TYPES IN 124 MALES

<table>
<thead>
<tr>
<th></th>
<th>Q1 - UPPER RIGHT</th>
<th>Q2 - UPPER LEFT</th>
<th>Q3 - LOWER LEFT</th>
<th>Q4 - LOWER RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRINCIPAL</td>
<td>OTHER</td>
<td>PRINCIPAL</td>
<td>OTHER</td>
</tr>
<tr>
<td>I</td>
<td>20</td>
<td>44</td>
<td>16</td>
<td>39</td>
</tr>
<tr>
<td>I’</td>
<td>53</td>
<td>87</td>
<td>55</td>
<td>96</td>
</tr>
<tr>
<td>II</td>
<td>46</td>
<td>76</td>
<td>47</td>
<td>83</td>
</tr>
<tr>
<td>III</td>
<td>5</td>
<td>8</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**TABLE-2**

PERCENTAGE OF LIP PRINT TYPES IN 134 FEMALES

<table>
<thead>
<tr>
<th></th>
<th>Q1 - UPPER RIGHT</th>
<th>Q2 - UPPER LEFT</th>
<th>Q3 - LOWER LEFT</th>
<th>Q4 - LOWER RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRINCIPAL</td>
<td>OTHER</td>
<td>PRINCIPAL</td>
<td>OTHER</td>
</tr>
<tr>
<td>I</td>
<td>48</td>
<td>64</td>
<td>39</td>
<td>56</td>
</tr>
<tr>
<td>I’</td>
<td>56</td>
<td>86</td>
<td>59</td>
<td>106</td>
</tr>
<tr>
<td>II</td>
<td>25</td>
<td>70</td>
<td>34</td>
<td>69</td>
</tr>
<tr>
<td>III</td>
<td>4</td>
<td>11</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>8</td>
</tr>
</tbody>
</table>

---

- 119 females were correctly diagnosed among 134 female subjects. (Table 3)
- and 85 males were correctly diagnosed among 124 male subjects. (Table 4)

**TABLE-3**

ACCURACY OF GENDER DETERMINATION AMONG 134 FEMALE SUBJECTS

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Diagnosed correct</th>
<th>Diagnosed wrong</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>11-20</td>
<td>39</td>
<td>4</td>
<td>43</td>
</tr>
<tr>
<td>21-30</td>
<td>36</td>
<td>5</td>
<td>41</td>
</tr>
<tr>
<td>31-40</td>
<td>15</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>41-50</td>
<td>18</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>51-60</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>61-70</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

- No changes in lip print were found after follow up of one year in all age groups.

**TABLE-4**

ACCURACY OF GENDER DETERMINATION AMONG 124 MALE SUBJECTS

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Diagnosed correct</th>
<th>Diagnosed wrong</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>11-20</td>
<td>26</td>
<td>16</td>
<td>42</td>
</tr>
<tr>
<td>21-30</td>
<td>38</td>
<td>14</td>
<td>52</td>
</tr>
<tr>
<td>31-40</td>
<td>10</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>41-50</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>51-60</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>61-70</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

- Other observations were as follows:
The most frequent pattern in all the males studied was type I’ (212)(42.74%) and the least observed pattern was type IV(3)(0.60%) irrespective of quadrant studied. Patterns in the order of frequency were I’, II, I, III, IV. The most frequent pattern in all the females studied was type I’ (239)(44.58%) and the least observed pattern was type IV(4)(0.74%) irrespective of quadrant studied. Patterns in the females in order of frequency were I’, I, II, III, IV. The most common single pattern in all the individuals studied was type I’. Type IV was the least common pattern found irrespective of the quadrant studied. All the four quadrants with same type of lip print patterns were predominantly seen in female subjects relative to males. Male subjects show presence of different lip patterns in a single individual. Same lip pattern in the three quadrants was the most commonly occurring trend in females as compared to males.

DISCUSSION

The possible identification of living or deceased persons using the unique traits and characteristics are the cornerstones of forensic science. Determination of sex of individual by forensic methodology is warranted in cases of heirship, marriage, divorce and rape. Lip print analysis is a process that provides both qualitative and quantitative results, thus its application in the forensic field should be widely accepted. Suzuki and Tsuchihashi analyzed the lip prints by using the photographic method and concluded that lip print varies from person to person.1,4,6,7,9 This is in accordance with our study. Keeping Suzuki’s classification as the base, we conducted this study and it was found that both among males and females common lip print pattern was type I and type IV was least common pattern. In our study, type I and I’ were found more commonly in females while type I’ and II were more common in males. Vahanwala and Parekh in their study in Mumbai found that type I pattern was seen most frequently.5–8 Sivapathasundharam, Parekh and Sivakumar studied on Indo-Dravidian population and noted that type III pattern was predominant.6,12 Manipady compared Indian and Chinese individuals and found that the incidence of type II was the highest among Indians. Annie, Somasekar, Umesh Babu studied the lip prints of people of Kerala and found that type III was most frequently observed. In the past some researchers have worked on lip prints with the idea of proxing gender differentiation. According to study by Sonal-Nayak type I and I’ patterns were found to be dominant in females and type III and IV patterns dominant in males. Study conducted by Preeti-Suushmita and Vanita, type I and I’ patterns were predominant in female and type IV in male. Results of female patients were in accordance with our study but in male patients it differed. However, these studies reveal that lip prints show racial difference which can be useful adjunct to identification of person.

According to Vahanwala-Parekh, subjects with all four quadrants having same pattern type were predominantly seen in females and different patterns in different quadrants in a single individual were males.6,8 This is in accordance with our study. According to our study, the accuracy percentage was low in identification of males while female subjects were identified more easily.

CONCLUSION

Along with other traditional methods, cheiloscopy can also serve as very important tool in the identification of a person. Lip prints are unique to an individual and can be used to fix the identity of person. They remain stable over time. Lip print beholds the potential of determination of sex.
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