DIAGNOSTIC AIDS FOR OROFACIAL CLEFT DEFECTS

Abstract

Orofacial clefts also known as cleft lip and palate these are the birth defects occurring due to improper development and fusion of tissues from each side of the head towards the center of the face creating a disjunction between tissues causing defects post natally. These incomplete slits or spaces can be small as hairline clefts in the lips or palate or can lead to the absence of a part or complete hard or soft palate, alveolus, lips etc. These defects often cause problems like ear infections and altered teeth eruption or malocclusion. Presence of orofacial clefts can also hamper speech and hearing. These orofacial clefts need treatment for the better functioning of an individual. They can be diagnosed with routine transabdominal ultrasound as early as 13 to 18 weeks of pregnancy. However certain types of clefts like submucous cleft palate, bifid uvula etc. might not be diagnosed until later in life. For this very purpose recent modalities of orofacial cleft detection were introduced which are the modification of the pre-existing ultrasound these newer diagnostic aids are - colour Doppler ultrasonography, angled isolation and 3D ultrasound, 2D ultrasonography with 3Drivers face view. Foetal MRI can also be used for the same purpose. With the advent of these recent diagnostic aids precise detection of cleft anomalies are practicable which would further aid in communicating the cleft related birth defects to the expecting parents giving them a better inside of the condition of their growing foetus.

Keywords: Orofacial, Ultrasonography

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I. INTRODUCTION

Medical diagnosis is the process of identification of the nature of illness by the examination of the elicited signs and presented symptoms. There are 4 types of diagnosis for detection of a disease or an anomaly- the principal diagnosis, provisional diagnosis, subtypes and specifiers, the diagnostic criteria, and descriptors. Till date imaging forms an integral part of diagnosis of dental diseases and orofacial defects. Intra oral imaging techniques are the non-invasive diagnostic aids in the detection of dental caries and alveolar bone changes but are unable to detect orofacial anomalies due to their limited to no access to the site of interest. Due to which intrauterine ultrasonographic techniques are considered novel for the orofacial cleft defects.

Figure 1

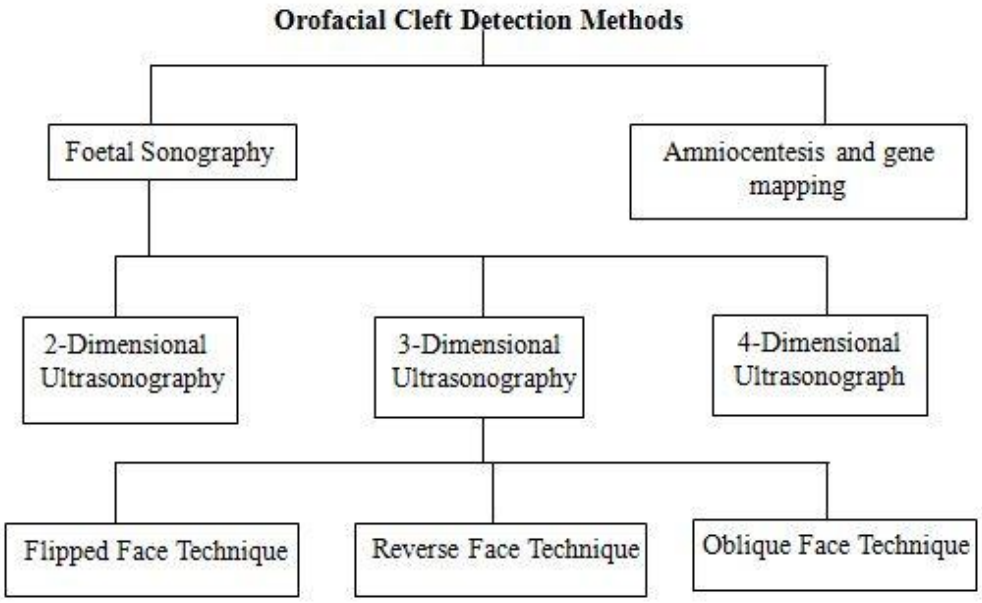
II. HISTORY OF FOETAL FACIAL SONOGRAPHY

Two-dimensional foetal ultrasonography for cleft detection started in the year 1981. This was introduced by Christ and Menger in the year 1981. This mode of detection was popular amongst the physicians during the 80s. But had some limitations ie, the defect was detected in only two planes, thereby the depth of the defect and the volumes of tissues involved often remained unrecognised.

Thereafter in the year 1984 Kazunori Baba invented the 3dimentional ultrasonography using 2 dimensional images. The advantage of this technique was the volume detection. But the defects like cleft soft palate and cleft uvula were still difficult to detect due to their anatomical placement.

Figure 2

III. CLASSIFICATION OF OROFACIAL CLEFT DETECTION METHODS



IV. 2D ULTRASONOGRAPHIC TECHNIQUE

1. **Techniques:** 2-dimensional ultrasonography- Works on the principle of sound waves. when the sound wave strikes an object, it bounces back or echoes. The wavelength of this echo is measured to determine the size , shape and consistency of an object

   A transducer is used for both transmission as well as to receive the sound waves. These waves while echoing back tend to produce all small details about the depth and direction of the structures. These in turn provides the information about orofacial cleft defects.

2. **Indications**
   - Two dimensional USG is the primary investigation done to establish a pregnancy
   - For the detection of hypoechoic defects in heart, extremities, and face

- Detection of orofacial deformities and cleft defects (cleft hard palate)

3. Limitations

- Defects in lip, soft palate, uvula are undetectable
- Minor defects in alveolus can sometimes be missed
- Depth and volume of orofacial clefts cannot be detected

Sound	Frequency
Adult audible range	15 – 20'000 Hz
Range for children's hearing	Up to 40'000 Hz
Male speaking voice	100 – 1'500 Hz
Female speaking voice	150 ' 2'500 Hz
Standard pitch (Concert A)	44 0 Hz
Bat	50'000 – 200'000 Hz
Medical Ultrasound	2.5 – 40 MHz
Maximum sound frequency	600 MHz

Table 1: Common Sound Frequencies and Frequency Ranges

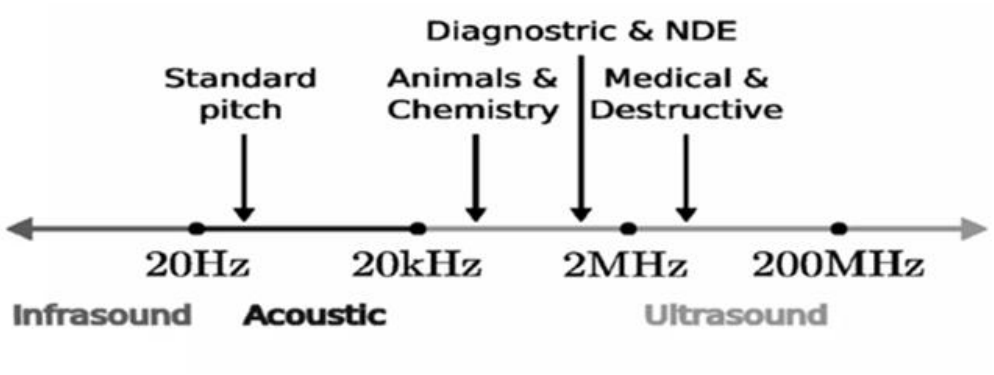


Figure 3: Approximate Frequency Ranges of sound

V. 3D ULTRASONOGRAPHIC TECHNIQUE

1. **Technique:** 3d ultrasonographic imaging technique- in the year 1984, Kazunori baba invented 3-dimensional ultrasonic imaging technique. Two dimensional images were obtained and arranged to achieve 3 dimensional figures. these pictures were obtained in all possible angles to be arranged in three distinguished planes namely, x axis, y axis and z axis. this planar arrangement allowed the radiologist/ sonographer to obtain better volumetric images in 3 dimensions.

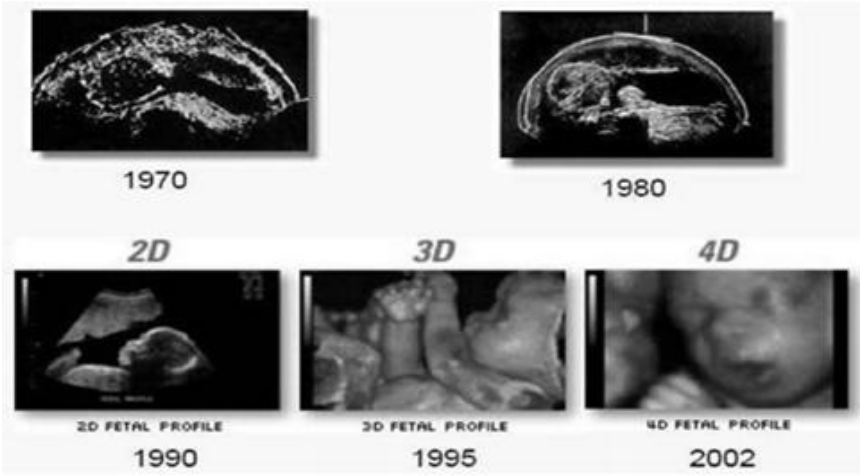


Figure 4: Development of the B-mode Ultrasound Image quality

(Figure 4-This image represents the view of the foetus with the changing trends in ultrasonographic imaging technique with due course of time)

2. **Indications**
   - To confirm the presence of an orofacial cleft defect when 2 dimensional images are misleading.
   - To confirm the degree or extent of the cleft defect into the hard tissue like palate.
   - To achieve the volume of the tissue involved in the orofacial disjunction.

3. **Limitations:** Detection of soft tissue defects like cleft soft palate and cleft uvula were still contentious due to their anatomic placement.

So various modifications of 3d ultrasonographic imaging technique are introduced for the detection of anomalies involving secondary palate

Reverse face technique (Campbell et al.)
Flipped face technique (Platt et al.)
Oblique face technique

4. **Reverse Face Technique:** This technique was introduced by Campbell et al. in the year 2003. The view of the foetal face was gained using a 2-dimensional foetal profile and the volume box adjusted to enclose the complete outline. In 3d and 4d, high resolution images are obtained using 3d sweep or slow frame rate of 2.7Hz. The view bar was adjusted to achieve an eminent surface rendered image and oblique face view is rotated to obtain the frontal view of the foetal face. Echo graphically, the lips are observed which then leads to the alveolar ridge and palate. The palatal image formed is usually unstable and misleading. This error is therefore rectified by rotating the view of the foetal face by 180 degrees. This gives an uninterrupted view of palate, orbit and nasal floor. The whole length of the palate is then scrolled using the view bar.

A true coronal plane is achieved with the help of minor adjustments made to the axis of rotation. Reverse face technique provides the visualisation of lips , alveolar ridge and palate from inside out.

Figure 5

Figure 5 represents multiplanar USG images showing mid sagittal plane for volumetric acquisition. provided sweep angle 50-70 degrees. Hypoechogenic crescent of fluid is visible.

- **Indications**
  - Detection of hard palatal defects
  - Visualisation of clefts involving orbital and nasal floor
  - To attain depth of the defect pertaining to the alveolar bone

- **Limitations**
  - Detection of cleft soft palate and uvula.
  - Detection of the surface area covered by the defect, although a rough estimate of the anomaly being broad or narrow can be reported.

5. **Flipped Face Technique:** This technique was introduced by Platt et al. in the year 2004. This technique requires the foetus to swallow fluid, which would allow better visualisation of tongue and palate by providing a crescent sonolucent area between the two structures. In the mid sagittal section, the view of the foetal face is rotated through 90 degrees which is done to obtain axial planes of the secondary palate. In this view the foetal face is scrolled from the chin to the nose in the same rendered surface.

To compensate for the palatal curvature, there happens to be a modification made to this technique by curving the view bar around the palate. Coronal plane was considered as the plane of reference in the multiplanar imaging for upper and inferolateral limits and for upper and posterolateral limits, sagittal plane became the plane of reference.

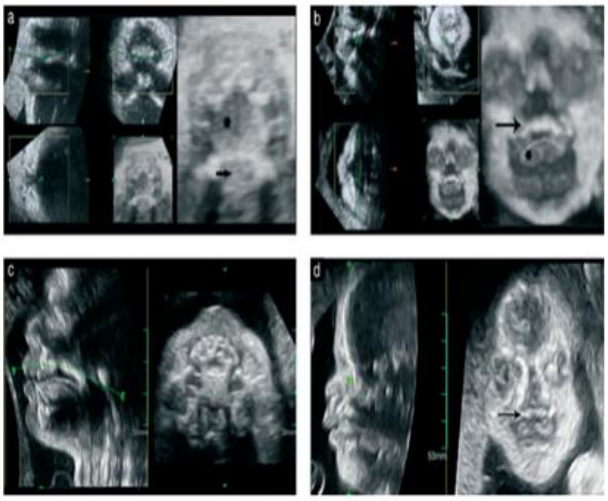


Figure 6

- **Figure 6 shows,**

➢ **Flipped Face Technique:**
Plane a initial volume acquisition with rotated facial Pro file to 90 degree and view bar curving in the shape of hard and soft palette
Plane b Coronal plane with curved review bar following the shape of hard and soft palette
Plane c Actual plane at the nasal septal level

➢ **Reverse Face Technique with Multiplayer Images**
Plane a initial volume acquisition with rotated 90 degree of facial profile the view bar is situated from inside out facial sweep.
Plane b coronal plain of face
Plane c Play not laser septal level showing orbit nasal bone hard palate and tongue

➢ Oblique face technique with view of the foetal face and the curved view bar following the shape of the pallet projecting upper lip maxilla hard palette this plane is perpendicular to the curved axial plane which also includes lip maxilla alveolar foramina and hard palate.

➢ Oblique face technique with view bar positioned anterior to posterior to traverse the hard palate.

- **Indications**
  - ➢ To diagnose defects related to hard and soft palate.
  - ➢ To detect the volume of tissue involved in the orofacial cleft anomaly

- **Limitations:** Process is technique sensitive, to yield positive outcome, the sonographer must be trained personnel

6. **Oblique Face Technique**: In this technique the volume of the face is obtained in mid sagittal plane. An arbitrary plane is postulated, which composes of lip, alveolar ridge, and palate. Post which an axial plane perpendicular to this arbitrary plane is obtained which also encloses the palate. And according to these 3 pre-determined planes a foetal face is outlined in cranio-caudal direction. This outlined foetal face then provides the sonographer with a coronal plane which can be scrolled in all the directions and can also be rotated in all the planes, through the entire length and width of the palate.

- **Indications**
  - To detect the hard and soft tissue defects related to orofacial disjunction
  - To detect defects involving soft palate, uvula.

- **Limitations:** Process is technique sensitive, to yield positive outcome, the sonographer must be trained personnel

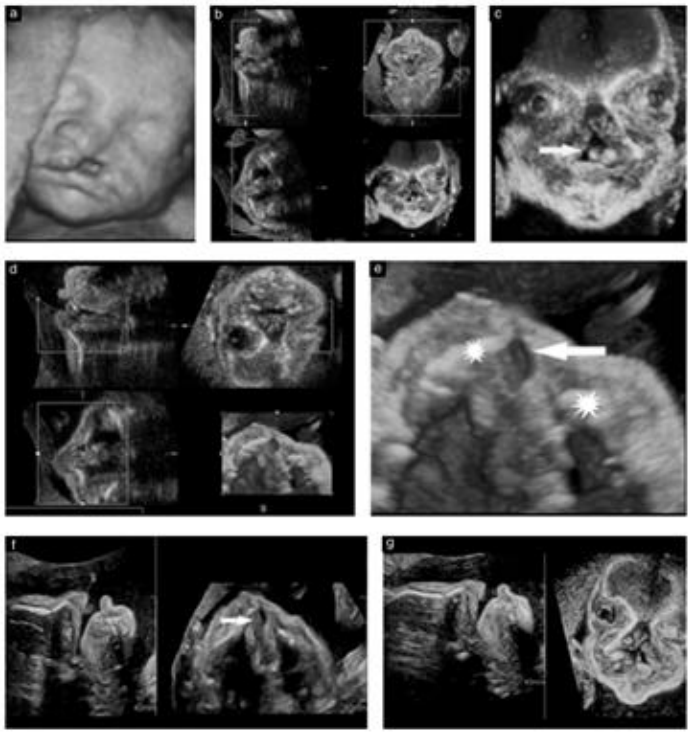


Figure 7

- **Figure 7 Represents**

- Surface rendered image of 27 weeks gestation projecting unilateral cleft lip and palate. Presence of a nasal asymmetry a deviated nasal septum and flattening of the alar cartilage

- **Multi Planner Images Post Reverse Face Technique**
  A-plane initial volume acquisition with rotated 90 degree of phase profile and volume box situated from inside out facial sweep
  B-plane coronal plane of the face

C- plane axial plane at the level of nasal septum

- Coronal plane viewing the orbit palette and communication between the oral and nasal cavity

- **Multi Planner Images Post Flipped Face Technique**
  A plane initial facial volume with rotated profile at 90 degrees with the view box covering to follow the hard and the soft palette
  B plane coronal plane of the face curving towards the hard palette
  C plane Arjun plain at the level of major Septum

- Surface image of axial plane with unilateral left in maxilla which gives rise to lateral incisor

- **Oblique Face Technique:** View bar is curved to follow the shape of the pallet showing upper lip maxilla heart palate

- **Oblique face technique:** View bar is position anterior to posterior to traverse the hard palette showing orbit nasal bone and defect on the side of the maxilla

VI. 4-DIMENSIONAL ULTRASONOGRAPHY TECHNIQUE

Four-dimensional ultrasonography provides 3-dimensional view along with capturing the video of the foetus. Still images can be scrolled and saved. With the help of these 4-dimensional ultrasonographic imaging, potential smiling and yawning can be visualised. Similarly, the defects in all 3 planes can be anticipated due to the videographic form of presentation.

1. Indication

- For visualisation of hard and soft tissue defects
- For better parent education towards the developing foetus
- For communication purpose amongst surgeons, paediatricians and pedodontists.

2. Limitations

- Exposure of the foetus to higher megahertz sound can cause heating up of the maternal soft tissue leading to the formation of tiny blebs within the body/ amniotic sac, which can potentially be dangerous for the child.
- The heat generated can also be the cause of birth defects.

VII. DISCUSSION

Conventional viewing of multiplanar images have several limitations and the most important one being the suboptimal image resolution in the reconstruction planes and to avoid these, it becomes crucial to obtain higher volume images as the structure of interest is small, curves and often shadowed by maxillae.

Orofacial clefts just like any other congenital birth defect causes discrepancies in an infant’s life. Difficulty in feeding, impaired or complete hearing loss, speech disturbances,

missing or malformed teeth, oroantral communications etc. In Asia alone, the incidence rate of cleft anomalies are around 2 in every 1000 live births. Child birth being the most critical phase of life for the parents, cleft anomalies have a much higher impact on the mental health of both the partners. But antenatal diagnosis using the ultrasonographic imaging techniques prepare the parents psychologically as to what the condition of their growing foetus is.

VIII. SUMMARY

With the advent of newer modalities of ultrasonographic imaging, it has become easier for the doctors and surgeons in terms of better communication of the defect. Three dimensional ultra sonographic imaging technique, has reduced the uncertainty of volumetric defects in all 3 planes by providing a better picture, as to how the orofacial cleft must be visualised and treated. The introduction of 3D and 4D imaging techniques, have certainly helped the newer parents to understand the status of their growing foetus and the parent education has improved towards the cleft defects. This not only helps the doctors for treatment plan but also the parents to cope up with situation psychologically and to be prepared for the near future. These newer modalities of cleft detection also help to build a better physician parent relationship for the ease of the procedure, also the healthy and safe recovery of the child.

IX. POINTS TO REMEMBER

1. Three dimensional ultra sonographic imaging technique is useful for the detection of orofacial clefts involving deeper volumetric planes.
2. Detection of cleft soft palate and cleft uvula becomes easier with oblique face technique
3. Three dimensional ultra sonographic imaging technique are adjuvants for the conventional 2 dimensional ultra sonographic imaging technique and are only to be used for the defects which are difficult to assess with 2D USG.
4. Three dimensional and four dimensional USG are not supposed to be taken as memories of the unborn, but should only be used as diagnostic aids for anomaly detection.

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