Global Journal of Medical Research: J
Dentistry & Otolaryngology
Volume 17 Issue 1 Version 1.0 Year 2017
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

Malocclusion, Phonetics & Palatography: The Link Express

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Abstract- *Context:* A condition that has a stronger link to malocclusion is a forward resting posture of tongue. Correction of tongue function or posture facilitates correction of the lisp, or interdentalization of the /t/, /d/, /n/, and /l/ phonemes. A diagnosis is needed, that distinguishes learned behaviour from obligatory function due to physical deviation. Inquiry into these disorders identifies subgroups characterized by different combinations of functions, occlusion status, speech status, and forces obligating or predicting anterior tongue position.

Aim: To correlate role of phonetics in various malocclusions & evaluate the same palatographically.

Materials & method: The tongue was evenly painted with a thin mix of rubber base putty impression material & the speaker was prompted to say the target word. The entire pattern of contact is photographed / recorded palate graphically in different type of malocclusions.

Conclusion: When Palatography is correlated to different malocclusions, the aetiology of phonetic disturbance can be incurred.

Keywords: *malocclusion, phonetics & palatography.*

GJMR-J Classification: *NLMC Code: WU 440*

Strictly as per the compliance and regulations of:

Malocclusion, Phonetics & Palatography: The Link Express

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Key Messages: Palatography is correlated to different malocclusions & their exact aetiological location of phonetic disturbance is incurred.

I. Introduction

The multidisciplinary approach in diagnosing speech-language pathology and dentistry is associated with patterns of oral-facial-pharyngeal posture, function related to speech, occlusion & malocclusion. A condition that has a stronger link to malocclusion is a forward resting posture of tongue. Such chronic postures can interfere with eruptive sequence of dentition and lead to malocclusion[1].

Diagnostic attention is directed toward determining whether a tongue-thrust swallow and a forward tongue resting posture coexist in a given patient. When these conditions coexist, a greater link to malocclusion would be expected than from a tongue-thrust swallow alone[2-7]. There is evidence that a tongue-forward resting posture / tongue thrust swallow and lisping coexist [2-7]. Correction of tongue function or posture facilitates correction of the lisp, or interdentalization of the /t/, /d/, /n/, and /l/ phonemes.

A diagnosis is needed, that distinguishes learned behaviour from obligatory function due to physical deviation. Primary goal is to retrain labial and lingual resting and functional patterns[8-9]. Existing research is limited in quantity. Much research is flawed by the use of *ex post facto* methods of study. Inquiry into these disorders identifies subgroups characterized by different combinations of functions, occlusion status, speech status, and forces obligating or predicting anterior tongue position[8-9].

Information is needed about relationships among all of the following:

- Tongue morphology, position and movement;
- Lip morphology, position and movement;
- Oral-facial skeleton, including occlusion;
- Variables obligating tongue fronting;
- Biologic activity at the attachment apparatus of the teeth;
- Speech motor control;
- Oral adaptation and compensation; and
- Speech production

Aim of our study was to correlate role of phonetics in various malocclusions & evaluate the same palatographically.

II. Materials & Method

The palatographic techniques used in our study was similar to the one summarized by Ladefoged[10-12] 1997, 2003 & modified by Victoria B. Anderson[13-14] University of Hawaii at Mānoa 2008.

Step 1: A thin mix of rubber base putty impression material (Aquasil, Dentsply™) was used in our study. Chromatic alginate or an "edible paint" mixture of olive oil and powdered digestive charcoal can also be used. Although the speaker is meant to rinse out the mixture, i.e. entirely edible, and can be swallowed without danger.

Step 2: The tongue was evenly painted as far back as is comfort-able for speaker. Application on the tip of tongue was intended to record the speech sounds /t/, /d/ & application on lateral borders of tongue was intended for sounds /s/, /z/ & Th, sh, ch (voiced or voiceless).

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Step 3: Then the speaker was asked to return the tongue to a resting position inside the mouth, and keep her / his mouth relaxed and open so that no tongue-palate contact is made. Drooling may or may not occur; either is normal. The speaker was prompted to say the target word by giving its gloss. The palatography mirror was placed in her / his mouth to reflect the articulation, so that the entire pattern of contact can be seen (see figure 1) which is photographed / recorded.

Step 4: A sample of 10 patients each, belonging to different type of malocclusions were randomly selected from the department & the above procedure was carried out in all of them & the palatographic imprint of the same was recorded.

Table 1[15]*:* Phonetic type & related Dental problem

Speech sound	Phonetic Type	Target words used	Dental problem
/s/, /z/	Sibilant	Soup, City, Science, Box, Zoo, Xylophone	Lisp due to large gap b/w incisors, missing incisors, open bite
/t/, /d/	Lingoalveolar stop	Teeth, Toast, Button, Guitar, Boat, Coat	Difficulty in production related to irregular incisors, supernumerary teeth, tongue tie
Th, sh, ch (voiced or voiceless)	Linguodental fricative	Shop, Share, Chain, Cheese, Church, When, Why, Think, Thumb, This, That	Distortion related to severe open bite, missing incisors

III. Results

The point of contact of tongue to the palate varies for different speech types with differing malocclusal patterns. The same was recorded palatographically. Figure 2-4 represents phonetic speech type /t/, /d/ & phonetic speech type /s/, /z/ & Th, sh, ch (voiced or voiceless).

IV. Discussion

Evaluation of the structure, form and function of tongue is the first step in treatment planning. Sucking habits[16-19], when present, is usually eliminated before treatment for tongue thrust begins. Timing of treatment is following orthodontic treatment, but concurrent and pre-treatment is also common. Emphasis in treatment is on lingual and labial resting postures[8-9], but most approaches include a number of muscle retraining exercises, followed by instruction in handling and swallowing of solids, liquids, and saliva. Speech treatment is directed toward normalization of fronted lingual-alveolar consonants. Patients are seen for follow-up sessions for various periods but usually until completion of all orthodontic treatment. Length of treatment varies from 14 to 20 sessions or more, over 3 months to a year, depending on approach, age, and maturity of patient, and timing in relation to orthodontic treatment.

Palatography can be carried out either by a direct method or an indirect method. In the direct method described by Oakley Coles in 1872 he used gum Arabic & flour. During articulation, marking material is transferred to opposite articulator. This contact pattern is videotaped / recorded / photographed & then marked on the palatal cast. The indirect method first described by Kingsley in 1880, he prepared an upper plate of black Indian rubber & covered the tongue with a mixture of chalk & ethanol. The contacts seen on palatal rubber plate were then transferred on to cast as in direct method.

Static palatography (also known as direct palatography) is a way to collect articulatory records about speech sounds that can be used either in field or in the laboratory[13-14]. Palatography creates records of contact pattern of tongue on roof of mouth during an utterance, and when the actual dimensions of palate are known it can be a rich source of data about articulatory strategies. Movements of tongue depend on local conditions like malocclusion. Even though the tongue has an inherent capacity to compensate its position & movements based on the type of occlusion / malocclusion it inevitably causes some kind of disturbance / defect in phonetics.

Other methods of collecting data on speech articulations include *Dynamic palatography* (Hardcastle[20] et al. 1989) and *Portable ultrasound* (Gick[21] 2002).

Dynamic palatography, also known as electropalatography (EPG), uses a plastic retainer-like device implanted with electrodes and worn on palate, to sample information about contact patterns on palate over time. A drawback is that EPG cannot provide information about tongue configurations / size during an utterance.

Portable ultrasound provides information on tongue shape and position during an utterance, but since it tracks soft tissue rather than bone, it cannot show tongue's position with respect to various areas on roof of mouth.

Front most contact on roof of mouth in midline is a common metric for indexing place of articulation (Dart[22] 1991,). Since this measure reflects size of cavity in front of constriction, it is associated with spectral shape of bursts (Fant[23] 1960).

Phonological distinctions such as *apical* versus *laminal* lead us to expect differences among categories of speech sounds based on *length of contact* from front to back in midline. Acoustic correlates of contact length relate to relative size and mass of active articulator. Small tongue tip will make a short contact; broader blade will make a longer contact. Expect the tip to be a

quicker articulator than blade, because of its lighter mass and because, being on periphery of tongue, it is more independent of other areas of the tongue. The relative speed of active articulator can relate to voice onset time, amount of frication at burst release, and relative amplitude of bursts (Stevens[24] 1998).

While size of cavity in front of constriction can be expected to relate to spectral shape of bursts, *cavity in back of oral closure* can be expected to relate to formant transition loci at edges of neighbouring vowels (Fant[23] 1960). One index of oral cavity size behind the constriction involves measuring uncontacted region behind the constriction. The size of this space is affected by amount of raising of the sides of the tongue body, as well as the rear extent of midline contact; the more contact on the palate, the smaller this area will be.

V. Conclusion

Static palatography is a "field-friendly" technique that can provide valuable, detailed information about articulatory characteristics of speech sounds. However, the process is labor-intensive and time-consuming. When it is correlated to different malocclusions & thus the aetiology of the resulting phonetic disturbance / lisping can be incurred. The test can be repeated after the correction of malocclusion as a confirmatory process to know whether the aetiology has been removed or not.

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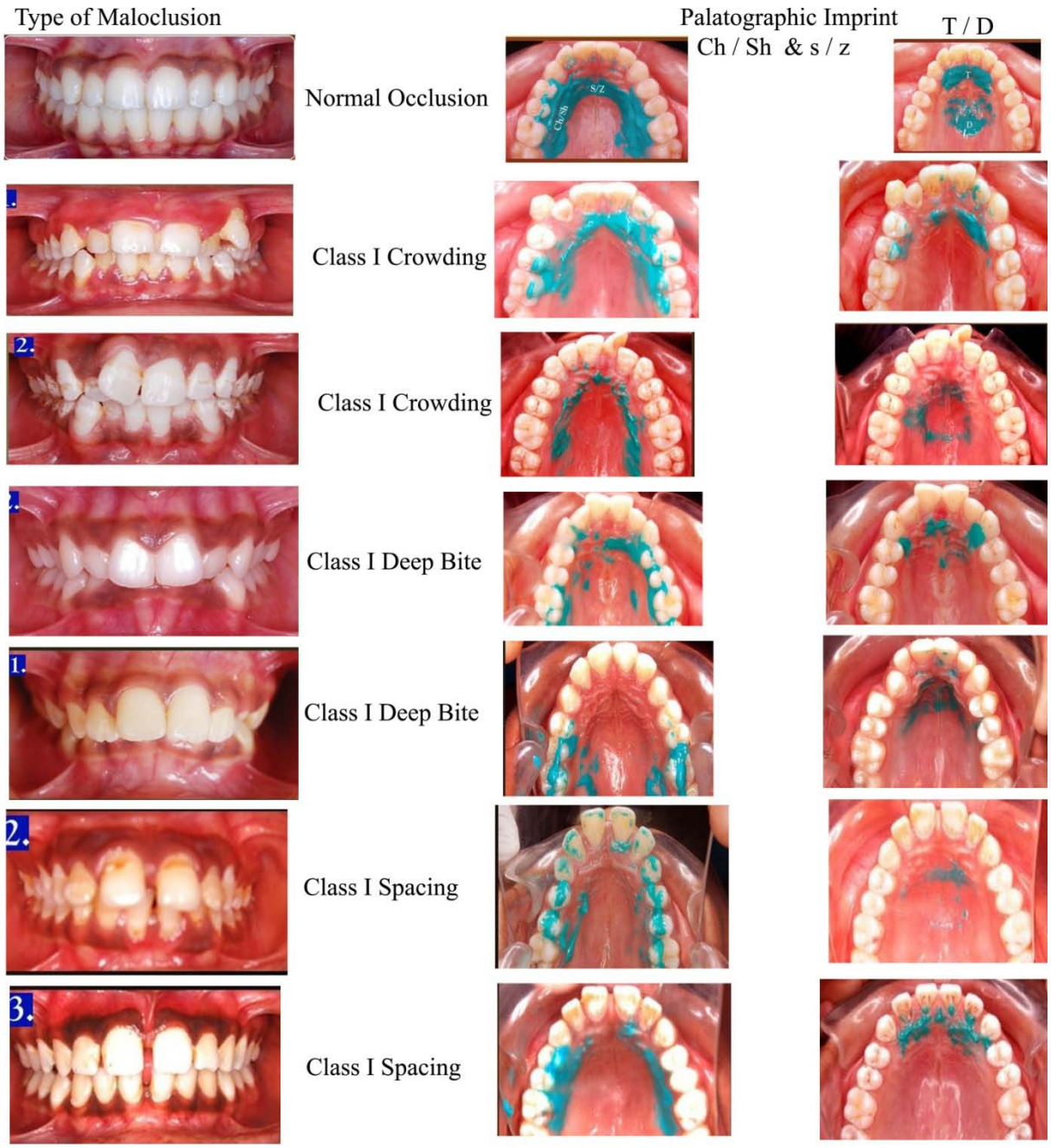
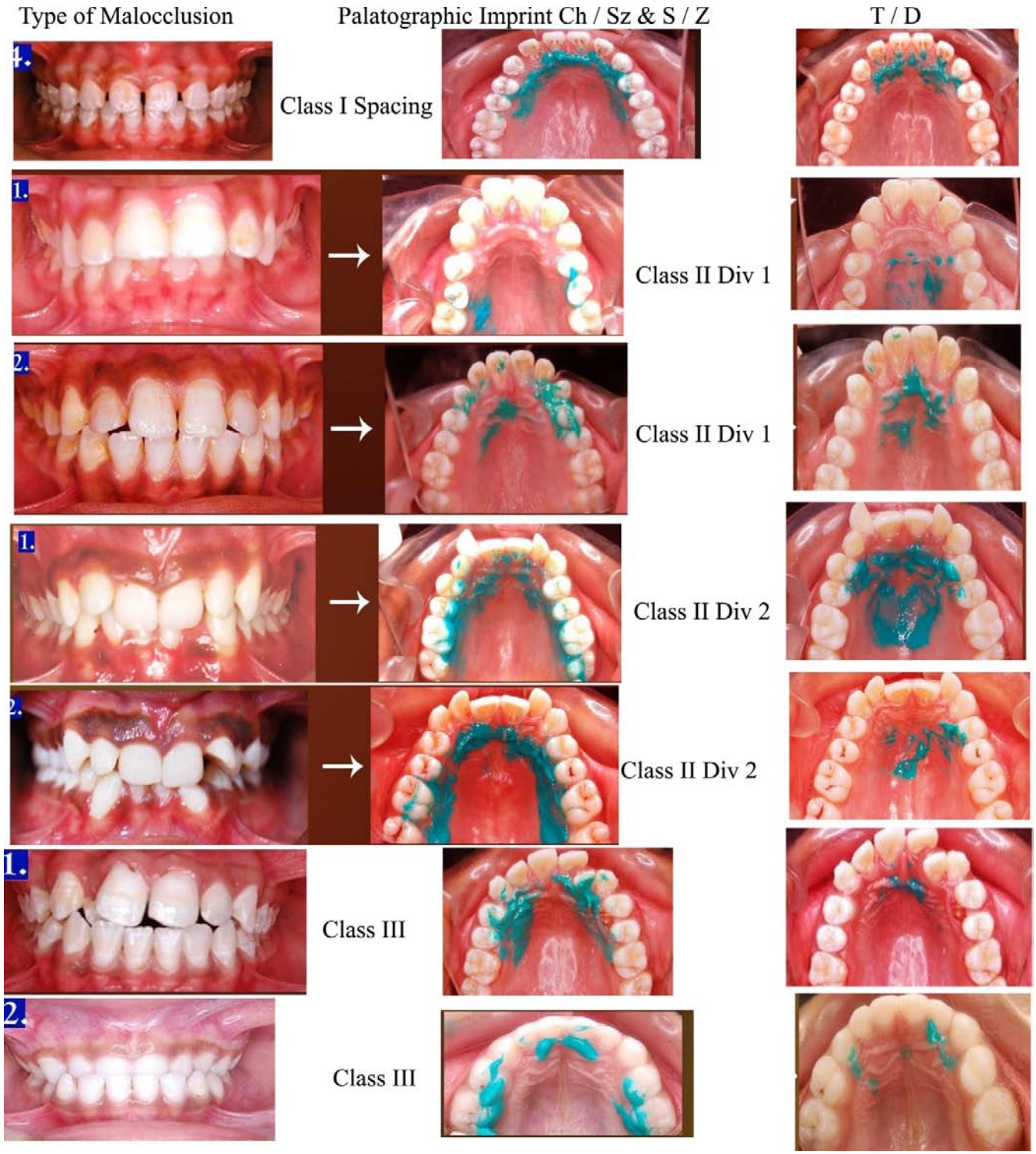
Figure 1: Palatographic image. Upper teeth shown at top are reflected in the mirror at the bottom





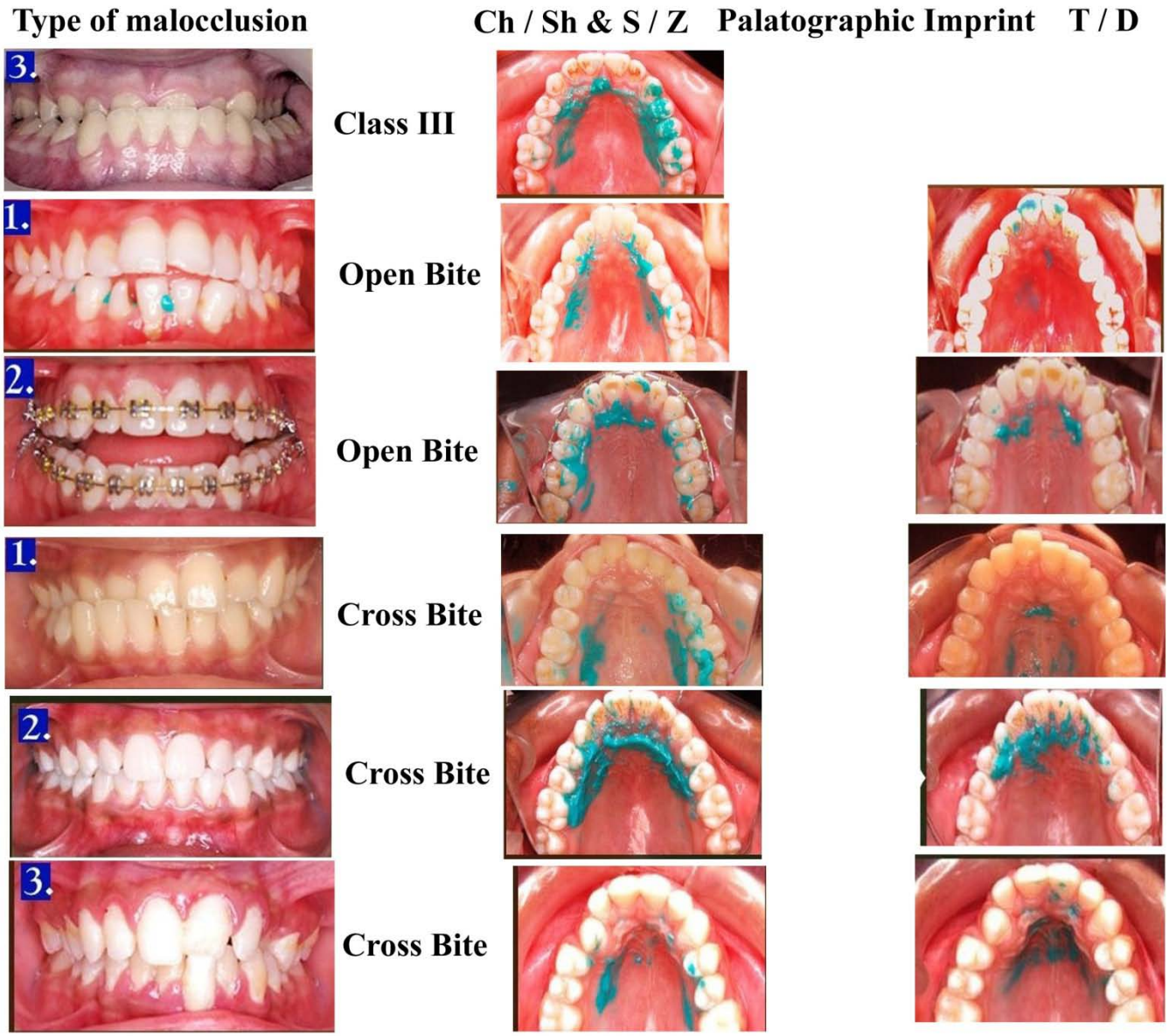


Figure 2-7: Different malocclusions & the corresponding phonetic types represented palatographically.

Palatographic image. Upper teeth shown at top are reflected in the mirror at the bottom

Different malocclusions & the corresponding palatographical imprints for phonetic sound type /t/, /d/ & /s/, /z/ & Th, sh, ch (voiced or voiceless).