Review Article
Journal of Pierre Fauchard Academy (India Section), *Vol 33(1), DOI: 10.18311/jpfa/2019/23410, March 2019, p. 1-6*
ISSN (Print) : 0970-2199
ISSN (Online) : 2405-772X

Oral Health in India - Researchers' Perspective Part III: Malocclusion and Dentofacial Deformities

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Abstract

The research directions in oral heath in India have largely been deficient. The poor standard of research and its methodology is of grave concern. The applications of novel technologies and translating the newer researches for the benefit of community's diagnosis, prevention and treatment needs, must be a priority in years to come. As a part of three paper series, the present paper brings forth the burden, current research and future research directions in the field of malocclusion and dentofacial anomalies in India. Malocclusion effects nearly 45% of adolescents, 1/3 of which require orthodontic care. Although technological advances in material sciences and advanced digital technology has refined the appliances much less attention has been paid on etiology and biological basis of orthodontics. The congenital birth defects of face and other denfofacial deformities also require a deeper understanding of etiology and most appropriate treatment protocol. This Manuscript summarizes current research and proposes future areas of research in this field.

Keywords: Malocclusion, Cleft Lip and Palate, Stem Cells, Temporary Anchorage Devices

1. Prelude

Contemporary medicine, dentistry, and health sciences have inducted advanced and novel technologies to investigate the fundamental mechanism of aetiology and pathogenesis of diseases and to translate research into clinical applications[1–3]. The first two parts of the series on oral health research papers were limited to most prevalent dental diseases afflicting mankind, i.e. dental caries and periodontal diseases. The previous papers described issues of oral health in the context of countries with a developing economy, with a significant emphasis on the promotion of oral health, innovative strategies and low-cost oral hygiene products.

Malocclusion, facial deformities and congenital defects of face offer significant challenges in prevention and treatment[3,4]. Orthodontic treatment attempts to alleviate a part of the dentofacial deformity, namely the deformities of teeth, aberrant growth problems of jaws and facial deformities[4]. This paper is focussed on the burden of malocclusion, dentofacial deformities, and birth defects of the face encompassing current research and future research directions.

Burden and need for treatment

Facial appearance and oral functions are an integral part of the health[4]. Unesthetic smile, and poor appearance is known to be associated with psychological problems and compromise the oral health-related quality of life (OHRQoL)[4,5]. Management of malocclusion often involves multistage procedures and needs a relatively longer duration besides the high cost of treatment. Craniofacial deformities and associated malocclusion, are required to be treated, by multiple specialists in an integrated interdisciplinary approach[5].

A significant proportion of cases of malocclusion represent a variation in the arrangement of teeth, morphology of jaws, face, and cranium and not a disease in a real sense[4]. The mere presence of a trait(s) of malocclusion alone may be insufficient to call for

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orthodontic treatment. Desire and need for orthodontic treatment are influenced by several factors such as awareness, socio-economic status, ease and access to concerned experts, ethnic trends, social values, and functional aberrations caused by the malocclusion[6]. India, in recent years, there has seen a tremendous increase in patients recognising their malocclusions and seeking appropriate and efficient treatment including adults[7,8]. In addition to those seeking orthodontic treatment, untreated population and patients with special care needs, who suffer from malocclusion make a significant addition to the existing burden[9]. Children with congenital craniofacial anomalies such as cleft lip and palate, first branchial arch syndrome, Down Syndrome, Pierre Robin Syndrome, Treacher Collins Syndrome and similar conditions make a significant burden and demand for orthodontic treatment[10,11].

2. Prevalence of Malocclusion

Although there are a few studies in the literature describing the prevalence of malocclusion, only a few studies were conducted with robust methodology on sample selection, sample size calculation and objective criteria for recording the malocclusion[4]. The process of selection of the survey sample and size were not a true representative of the population group[6]. Relevant studies on the prevalence of malocclusion in India depict a varied range across geographic regions of the country[4–6]. In Trivandrum, the prevalence of malocclusion was 49.2% in children of age 12-15 years, and in Bangalore, it was 51.5% among the age group of 5-15 years[6]. The prevalence of malocclusion in 2400 adolescent school students across Karnataka was nearly 88%.[5] Kharbanda *et al.,* followed a robust methodology of sample selection, and sample size calculation besides calibration of examiners. Their sample size and locations of survey sites were a true representative of the school-age population of Delhi. The sample data (5554 children) were mainly presented in two major groups-mixed dentition group (5-9 years) comprising of 2817 children and late mixed/permanent dentition group (10-13 years) which had 2737 children[4]. This survey used WHO Dentofacial Anomaly assessment form and electronic data punching and analysis methods. In mixed dentition group, the prevalence of Class I molar relation was 91.6%, Class II molar relation was 6%, and class III molar relation was 2.4%. The prevalence of malocclusion was observed as 45% in late mixed dentition group which comprised of 26% with Angle's Class I molar relation, 15% Angle's Class II molar relation and 3.5% Angle's Class III molar relation.

A low prevalence of malocclusion has been reported in Himachal Pradesh, (12.5%)[8]. Jalili, Sidhu, and Kharbanda have reported a similar trend among tribal children in remote villages of Mandu in the central part of India. Tribal children of Mandu also exhibited a low prevalence of malocclusion of only 14.4%[4].

3. Orthodontic Treatment needs vs Prevalence of Malocclusion

The mere presence of malocclusion per-se may not indicate the burden of cases requiring the treatment. Therefore the current focus on epidemiological studies on malocclusion is directed to evaluate the "Treatment Needs" of a given population[4,5]. In a study in Mysore city, 20% of the studied subjects had a definite treatment requirement[5]. Dhar *et al.,* surveyed 1,587 school-going children (5-14 years), involving a total of 23 schools in Udaipur district[13] authors reported a need for treatment in 36.42% children (mild to moderate 29.74% and severe 6.68%).[13] There is a need to evaluate orthodontic treatment needs in India which should include ethnic correlates of esthetics and major functional components of the malocclusion.

Recommendations: The Index of Orthodontic Treatment Needs (IOTN) 8 can be adopted with modifications s for the Indian context.

4. Children with Special Care Needs

The children with special care needs tend to have poorer dental and periodontal health with a higher predisposition to dental caries. These children also have a higher orthodontic treatment need than comparable age population, but only a handful of such cases end up receiving proper orthodontic and supplemental dental therapy[8–11].

Recommendation: Innovative and simplified yet efficient means of delivery of orthodontic care to patients with special needs should be evolved.

5. Cleft of the Lip and Palate (CL + P)

Cleft of the lip and palate is common birth defects of the face. The estimated incidence of cleft lip and palate

is around 1.4/1000 live births in India, and for isolated cleft palate, it is 0.3/1000 live births[4,11]. It may exist in isolation (non-syndromic) or association with other systemic conditions. CLP is known to be associated with 350+ known syndromic conditions[11]. Only a small proportion of the population with CL+P patients receive comprehensive interdisciplinary care in India and Subcontinent. Consequently, many cleft children remain untreated, poorly treated, or partially treated. In particular, they receive suboptimum care for malocclusion, speech and hearing related problems. In India alone, approximately 35,000 new cleft children are born every year, and these add to the existing patient load. The increasing burden of care of cleft lip and palate patients is enormous and unmanageable[11]. The treatment of these patients spans across the first two decades of life and requires a multidisciplinary approach to attain optimum esthetics, reasonably intelligible speech, and functional occlusion[4]. In India, only a handful of cleft teams provide interdisciplinary cleft treatment. The international standards protocols are difficult to implement for such as a large caseload, due to financial constraints, lack of education, and non-availability of trained human resource and dedicated Cleft Care Centres[4]. The practical and logistical issues of implementation of multidisciplinary treatment are a challenging task. There is a need to develop treatment protocols for developing countries like India.

To assess the status of treatment and the challenges which need to be addressed, ICMR, in conjunction with Department of Orthodontics, Centre for Dental Education and Research at All India Institute of Medical Sciences initiated a Task Force project on "Dentofacial deformities and birth defects of the face including Cleft Lip and Palate (CLP)"[11]. The results of this study done across two public hospitals and one private centre across Delhi have shown some interesting findings-

1. There was a wide variation in age at the primary lip (2 to 18 months) and palatal surgery (3 to 228 months).
2. A significant percentage of cases require lip and nose revision surgery (36% and 35% respectively).
3. The post-surgical oro-nasal fistula was seen in 55% of cases.
4. Complex orthodontic treatment needs were seen in 77.5% operated cases of Unilateral CLP.
5. The hearing defects were observed in 44.7% of the patients with concomitant tympanic membrane afflictions (of one or more ear) also seen in 40% of the cases.
6. Clinically relevant speech intelligibility problems were seen in 49.7% of cases.

Recommendation: The data highlight the need to evolve the National Guidelines for cleft treatment and a national cleft registry.

6. Future areas of Research in Malocclusion

6.1. Molecular basis of Orthodontic tooth Movement

Acceleration of tooth movement and improved stability that may involve research related to stem cell technology, has the promise to offer clinically relevant outcome[13,14]. Enhancement of the rate of tooth movement in orthodontics through gene modulation has a high potential and relevance[16]. The role of mediator Osteoprotegerin (OPG), and Receptor Activator of Nuclear factor Kappa-B Ligand (RANKL) has been established in orthodontic tooth movement[17]. Recently, other molecules like Transient Receptor Potential (TRP) vanilloid 1 receptor (TRPV1) have also been proposed to alter tooth movement and relieve orthodontic pain[16,17]. RANKL gene transfer to the periodontal tissue and its resultant acceleration in orthodontic tooth movement, by approximately 150% in 21 days, has also been reported[14,17].

6.2. Growth Modulation using Genetic Engineering

Skeletal Class II and III malocclusions are associated with aberrant craniofacial morphology. A major clinical challenge lies in the prediction of ultimate facial form and extent of deformity that will emerge at adulthood[4,14]. The genetic and molecular markers of the growth potential of craniofacial form and their possible clinical applications could suggest prevention and or timely interventions, thus reducing the need for comprehensive treatment[14,15]. Experimental alteration of the mandibular growth at the histologic level is possible in animal models, but its application to the human models and its clinical relevance is yet to be proved[14–17].

6.3. Novel methods of Prevention of Malocclusion

It is evident that preventive modalities should be encouraged for the developing malocclusion. Preventive

modalities should explore the genetic patterns, and should least target the major malformations related occlusion problems[4].

6.4. Bone Regeneration using Stem cell Therapy

Stem cells are under investigation for their ability to regenerate bone and cartilage[14,18]. The current focus is moving to explore stem cells in orthodontics to generate and regenerate alveolar bone for facilitating the rate of tooth movement[18]. Alveolar bone regeneration using freeze-dried bone graft and mesenchymal stem cell culture is useful in alveolar bone regeneration in selected patients[18]. The bone and periodontal biology needs further application in relevance to orthodontic tooth movement.

6.5. Bio-engineering and Devices, Orthodontic Implants

6.5.1. Orthodontic implants

With the introduction of Temporary Anchorage Devices (TAD) and Skeletal Anchorage System (SAS) in orthodontic armamentarium, orthodontics has entered new era in the management of complex malocclusion and adult orthodontics[4]. The TADS and SAS have significantly enhanced the treatment outcome by offering absolute control of anchorage[19]. The anchorage control has also helped to treat borderline orthognathic cases to be successfully managed with orthodontics alone.

Fixed functional appliances anchored to Mini Screws Implants (MIS)/Skeletal Anchorage Systems (SAS) have shown faster and improved skeletal adaptations without dental adverse effects[4,19]. This field of orthodontics needs more research inputs to improve the design and to minimise surgical trauma and increase implant stability[19].

6.5.2. Orthodontic therapy without brackets and attachments

The alternate orthodontic devices (without brackets) are a major thrust area in orthodontics with enormous demand and possibilities. The versatility and control provided by fixed orthodontic brackets cannot be substituted by for orthodontic treatment with currently available options.[4] The challenge lies in developing innovative methods of orthodontic tooth movement without the use of brackets. Alternate clear alignment systems are being aggressively marketed, though in current systems the scope of tooth movement is limited, despite their huge cost. Future research may be directed towards devising newer systems that can perform complex tooth movements, are more straightforward to use and are cost effective[4].

6.5.4. 3-D virtual imaging and virtual treatment planning

6.5.3.1. Digital impressions

The process of impression taking and making plaster casts has already been replaced with the introduction of intraoral scanners[20]. The 3D virtual models are as accurate as plaster study models and have several advantages including possibilities of virtual treatment planning[20,21]. Digital models and patient records eliminate the need for extensive storage space required to store files and models of orthodontic patients[20]. Thus more data can be stored, effectively managed, communicated and transported when required. The need to develop in-house virtual software can help the profession and country in a big way[4].

6.5.3.2. Non-radiation imaging of face

Three-Dimensional Imaging, such as cone beam CT (CBCT) is fast becoming popular and at times, also being overused. Though considered relatively low radiation technology, it requires judicious use for orthodontic diagnosis and treatment planning[21]. Other modalities of 3D scanning in orthodontics include non-radiation 3D imaging of face, which need to be promoted and used for research on facial growth and treatment planning and outcome[20]. Such technology should be readily available shortly and affordable to be used in day-to-day practice.

The 3D ultrasound and MRI, spectroscopy offer excellent technological benefits of non-radiation imaging and should be used to research to understand muscle adaptations and Condyle-Glenoid Fossa complex (CGF) remodelling following the use of functional appliances and etiology of TMJ dysfunction syndrome[4,20]. The large sample studies can be conducted in India to know the aetiology and long-term effectiveness of therapeutic modalities, information on which is scarce[1].

6.5.4. Automation of Orthodontics records and analysis

Poor treatment planning with incomplete records, poor patient cooperation coupled with an inadequate quantum of orthodontist's effort is a significant contributor to suboptimum treatment outcome or to the extent of worsening the occlusion and leading to poor dental health[4]. A significant contributor to poor planning is linked to inappropriate attention to records analysis or no records at all[4,21]. Digital records which include virtual models, digital and computerisation of cephalometric analysis and on-screen photographic analyses have helped to resolve some of the issues. The automation in measurements of analysis also allows quick data capture with a click of the system. However, the decision making and process of implementation lie with the orthodontists[22,23].

Most patients with severe dentofacial deformities would require 3D evaluation with CBCT, virtual treatment planning. Manual onscreen marking of volumetric images is cumbersome and needs expertise and time. This difficulty is being resolved with advanced software capabilities[22,23].

Efforts on automation of 3D analysis have been successfully attempted in collaborative research work by Centre for Dental Education and Research (CDER), All Institute of Medical Sciences (AIIMS), New Delhi and Central Scientific Instruments Organisation (CSIO), Chandigarh. The algorithms have been developed which can eliminate human errors and save clinical time. The current imaging software should be updated to minimize distortion, reduce the magnification and overlapping of craniofacial structures. This can further aid in locating hidden anatomic structures and making accurate measurements[22,23].

6.5.4.1. Accelerating tooth movement

A myriad of surgical and nonsurgical approaches has been tested for accelerating the orthodontic tooth movement[14–17]. However, a practical, safe and universally accepted method, which can reduce the total duration of orthodontic treatment is yet to be developed.

7. Summary

The filed of malocclusion and dentofacial deformities is vast yet, much less less researched. Research in this field offers a myriad of challenges for scientists and clinicians. While the genetic basis of malocclusion and face is yet to be fully understood challenge also lies in instituting the treatment mechanism which can shorten the rate of orthodontic treatment. A variety of surgical and nonsurgical approaches have been tested for accelerating the orthodontic tooth movement however, a practical, safe and universally accepted method, which can reduce the total duration of orthodontic treatment is yet to be developed.

With 3-D scanning and 3-D printing being radially available for clinical uses, the orthodontic office should become paperless in the next decade. The challenge lies in the elimination of radiation devices and adopting non-radiation devices for orthodontic use and facial scanning. The use of Artificial Intelligence (AI) in orthodontic diagnosis and treatment planning is likely to be the most exciting field of research in orthodontics which will have direct clinical implications.

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