REVIEW ARTICLE

Airway Centric Orthodontics : A View Point

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Abstract

Airway Centric Orthodontics is a philosophy which trumps everything else in contemporary Orthodontics. The philosophy focuses on practice of clinical orthodontics aimed at achieving ideal jaw relationship, establish normal oral function and performance, optimal proximal and occlusal contact of teeth. The central aspect of function and performance is airway and breathing which in fact is hierarchically the most important function for humans. Ideal health and ideal facial development is dependent on correct tongue posture and nasal breathing. Therefore contemporary protocols be it Preventive, interceptive or corrective orthodontics should factor upper airway improvement in addition to improving smile and facial appearance. Today Orthodontic profession is crucial and integral part of the interdisciplinary team in the management of upper airway sleep disorders, thus well poised to become a part of mainstream health profession. The paper would revisit the decision making process in orthodontics and discuss orthodontic strategies to improve the vital human airway which is essential for good health, longevity, and well-being.

Keywords: Airway, malocclusion, orthodontics

Introduction

The specialty of Orthodontics was finding it difficult to define "Malocclusion and Orthodontics" in the era when health was defined as mere absence of "disease or infirmity". It is only when World Health Organization (WHO)'s broader concept of "health as a state of complete physical, mental and social wellbeing" was largely embraced during late 1940's that specialties' like Orthodontics found inclusion in the health care profession. The expanded view of health as emerged an era in medicine and dentistry in which enhancement of quality of life (QOL) takes precedence over almost all other aspects of health[1]. Orthodontia being a specialty which aims at enhancing the dento-facial aesthetics, therefore has rightly found its place. With the emergence of specialty of Sleep Medicine, better understanding of evolutionary biology, evolutionary medicine; the jaw size and its spatial orientation has emerged as the key determinant of optimizing upper airway physiology. Airways, mode of breathing and craniofacial formation are so interrelated during growth and development that form can follow function and function can follow form[2]. So the specialty of orthodontics is well poised to normalize form and function both in children and adults so that the function is optimized for life.

Decision making in Orthodontics has largely depended on obtaining optimal proximal and residual contact of teeth and improve smile and facial appearance.

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All the inputs required for decision making like model analysis, cephalometric analysis, clinical examination has focused on ways to analyze space requirement for aligning teeth, assess growth pattern and envisage profile improvement. The protocol of analyzing the airway and the impact of orthodontic treatment on the upper airway dynamics is seldom factored during decision making process. Although Orthognathic surgery is the best option in skeletal malocclusion the percentage of cases that undergo this treatment modality is far less than desirable. Inadequate capacity and training to execute this treatment modality in our dental colleges and lack of insurance cover may be some of the issues restricting its practice[3].

Optimizing form in adults with skeletal malocclusion can be achieved only by orthognathic surgery or maxillo mandibular distraction osteogenesis and this modality indeed impacts function like respiration speech and mastication. So it is strongly felt that there is a requirement to review our decision making process in orthodontics and execution of orthodontic treatment so that the vital human airway which is hierarchically the most important function for human is improved and remains the central goal in addition to optimizing dento-facial esthetics[4]. The conventional orthodontics being practiced is primarily teeth aesthetics focused. The protocol, seldom addresses symptoms and airway is ignored. But airway centric orthodontics is aimed at physiologic adaptations and is muscle focused. Aesthetics is secondary and primarily treats causes and is airway conscious.

Decision Making Process in Orthodontics

The last 50 years has witnessed significant scientific and technological transformation in the specialty of orthodontics. However the fundamentals of orthodontics has largely remained the same and the goals of orthodontics treatment include[3]:

- Improvement in smile and facial appearance with the resulted improvement in Individual's QOL.
- Obtain optimal proximal and occlusal contact of teeth.
- Established normal oral function and performance.

In spite of mounting evidence that orthodontic procedures like functional jaw orthopedics, rapid maxillary expansionand surgical mandibular & maxillary advancement can enhance nasopharyngeal airway, it does not find a mention in the goals in most of the standard textbooks. It is strongly felt that improvement in upper airway functions and nasal breathing should be a goal of orthodontic therapy and the decision making should leverage orthodontic records like CBCT, cephalometric airway analysis, and acoustic pharyngometry for the same. Impact of retraction orthodontics on oral volume and post airway space merits consideration particularly in orthodontic conditions like bimaxillary dentoalveolar protrusion in the decision making process. Camouflage in skeletal Class II malocclusion not only would create dished-in profile but compromise on oral volume and upper airway space. So, decision to execute camouflage orthodontics should be taken only after patient is provided with the above input. Perception of dished-in facial appearance as acceptable overprotrusive appearance needs countering at all levels and forums, not only in view of suboptimal aesthetics but also its impact on airway function.

Factoring in craniofacial risk factors for upper airway collapsibility and sleep disordered breathing in the decision making in orthodontics is critical in contemporary orthodontic treatment. The human pharynx is unique in animal kingdom in terms of its size, shape and predisposition to collapsibility. The tongue in humans occupies significant part of oropharynx unlike other mammals where tongue is restricted to the oral cavity. This can be further appreciated by virtue of the facial skeleton in humans directly below the frontal bone while in other mammals it lies protruded away from the frontal bone. Due to bipedalism and erect posture in humans, the spatial position and orientation of jaws become important for head posture, breathing, phonation, deglutition and mastication. Keeping in view the peculiarity of human pharynx many craniofacial risk factors have been identified which predisposes humans to sleep disordered breathing (SDB). Some of the craniofacial risk factors are mandibular retrognathism/ hypoplastic mandible, inferiorly and posteriorly placed hyoid bone, high arched palate, maxillary deficiency, long face problems/ syndrome, large, mandibular tori, edentulism and neck size of over 16 inches[5,6,7,8,9]. Some of the clinical signs which should be taken as clue for investigation of upper airway compromise are :

- Lip incompetency with oral breathing
- Puckering of chin
- Adenotonsilitis
- Airway grading of Mallampatti more than grade III

- Allergic shiners
- Enlarged uvula
- Severe clockwise rotation of mandible
- Small nares and high and narrow nose
- Enlarged and crenated tongue

Orthodontic Clinical evaluation should incorporate airway grading. Polysomnography merits consideration in cases of mandibular hypoplasia particularly ones which is as a result of TMJ ankylosis, narrow maxillary arch with deep palatal vault. Imaging for upper airway includes Cephalometric radiography, CT scans, MRI and acoustic imaging technique. Cephalograms are true lateral radiographs of skull recorded using cephalostats at end expiration. There are various Cephalometric analysis for evaluation of airway. A comprehensive Cephalometric analysis can provide a fairly good idea of risk factors and collapsibility of airway[9,10,11,12]. Though cephalograms are cost effective, easily available, routinely done in dental practice have disadvantage of being two dimensional and recorded in erect position. MRI is useful in volumetric analysis of airway and helps in assessing the dimensions of airway in various planes.

Acoustic Reflection Technique

This is a newly introduced chair side evaluation method where in minimum cross sectional area of airway can be measured using reflection of sound waves[13]. Acoustic pharyngometry is a non-invasive procedure based on acoustic reflection technology which is akin to sonar technology used in ships. Sound waves are projected down the airway and reflected back out in such a way that the pharyngometry software can analyze and quantify changes in the airway cross sectional area. It allows users to quickly and easily measure a patient's pharyngeal airway size and stability from the oral pharyngeal junction to glottis. This test has been introduced in Orthodontic department of Armed Forces Medical College and has been found to be promising. In the years to come other centers in India are likely to follow suite.

Airway Centric Approach to Preventive and Interceptive Orthodontics

Significant component of craniofacial development occurs in first 4 yrs of life. 90% of craniofacial development is complete by the age of 12 yrs, therefore it can be concluded that morphometric features that puts adults at risk of OSA or SDB are probably present as early as 12 yrs of age[14,15]. Hence addressing these features at an early age may significantly reduce SDB or prevent the same in the future. An important factor in optimum development of maxilla at a very early age is breast feeding. Breast feeding is an important orofacial exercise required for stimulating maxillary expansion which aids in achieving normal tongue posture and propels mandibular growth[16]. Use of bottle nipple or pacifier can interfere in proper contact of tongue and its distribution of force on palate. The vacuum created by strong sucking action can increase depth of palate. Proper swallowing pattern is seen in breastfed children and is crucial for optimum craniofacial development. Tongue thrust is likely to develop in bottle fed children. Importance of breast feeding should also be seen in light of its effects on craniofacial development and prevention of SDB. In a classical work Harvold and co-workers demonstrated, the obstruction of nasal airway significantly alters craniofacial growth[17,18]. Compromised / obstructed airway in children often results in craniocervical extension and forward head posture which is an adaptation for maintenance of patency of airway[19]. However this adaptation does not happen in sleep, thus risking the child to SDB. Adenotonsillar enlargement is one of the most common causes of airway obstruction in children leading to compromised breathing and altered craniofacial growth. Obstruction in the nasopharyngeal airway promotes oral breathing which is a sign of impending OSA. Adenotonsilectomy often improves nasal breathing, quality of sleep, enhancement in delta sleep which increases growth hormone secretion influencing craniofacial growth[20]. Recently the role of combined adenotonsilectomy and RME as the best sequence of the treatment was evaluated in prepubertal children who had OSA and adenotonsillar hypertrophy. In majority of such patients both therapeutic approaches were required to resolve OSA and the order of treatment does not appear to be significant[21]. In another landmark study by Pirelli et al in 31 children with narrow maxillae and absence of adenotonsilar hypertrophy showed a complete resolution of SDB in 6 to 12 months[22]. These studies suggest an important role of RME in treatment of OSA in children. Mandibular deficiencies in growing children are best addressed by functional orthopaedic appliances like activator, bionator, twin blocks etc. The functional appliances correct mandibular deficiency by growth modification improves tongue posture and optimises spatial maxillomandibular relationship. The

effect of functional appliances on oropharyngeal airway dimensions has been assessed by Ozbek M M and co-workers more than a decade back. They found that these appliances significantly increase the airway space at oropharyngeal and nasopharyngeal levels[23]. A randomized controlled trial reported in 2002 involving 7 yr old children with OSA treated by functional appliances observed a significant reduction in AHI from 7.1 ± 4.6 to 2.6 ± 2.2[24]. In a recent study normalization of AHI was demonstrated in retrognathic adolescents with SDB in absence of tonsillar hypertrophy treated with functional orthopaedic appliances[25].

Retraction Orthodontics and its Impact on Airway

Therapeutic extraction of premolar teeth is one of the common procedures in orthodontics for retraction of teeth and resolving crowding. However there are few studies and case reports which are suggestive of reduction of airway space and pharyngeal airway dimensions following extraction treatment[26,27]. Careful consideration must be given when resorting to retraction orthodontics as this could result in iatrogenic risk factor for upper airway compromise and SDB.

Airway Centric Orthognathic Surgical treatment

Maxillomandibular advancement surgeries basically meant to advance the skeletal bases which result in increasing the airway dimensions in all three planes namely sagittaly and transversely. Many of the syndromic cases like Pierre Robbins, Nager's, Pffifer's, Crouzan's and Apert's and post TMJ ankylosis characterised by severe mandibular deficiency resulting in reduced airway dimensions make them susceptible to OSA. Surgical mandibular advancements by orthognathic surgeries or by distraction osteogenesis are the only viable and predictable options. Mandibular skeletal advancement is generally done by Bilateral Sagittal Split Ramus Osteotomy (BSSRO). BSSRO is done with sagittal osteotomy through the ramus of the mandible and the advanced segments are fixed using titanium plates and screws. Effective advancement of 7mm - 10mm is possible with BSSRO but for larger discrepancies which are common in syndromic cases bilateral corpus distraction is the option. A recent Indian cephalometric based study on 20 patients has reported an increase in Posterior airway space, superior airway space, minimum airway space dimensions following Mandibular advancement by BSSRO in the ratio of 1:0.35, 1:0.34 and 1:024 respectively[28]. Hyoid moved superiorly and anteriorly by 2.1 and 2.8mm respectively. The authors concluded that surgical advancement of mandible in class 2 malocclusions even without symptoms of sleep disordered breathing can be considered as first line of prevention with respect to OSA[28]. Distraction osteogenesis is a biological process of new bone formation between vascularised margins of osteotomised bone segments gradually separated by incremental traction.In the current practice scenario the corticotomy is done distal to the last molar and distracters are fixed across the corticotomy with the help of titanium screws. The distracters are placed parallel to each other and predetermined vector determined by esthetic requirement of patients. Following the latency period of 5 to 7 days the regenerate is incrementally stretched at the rate of 1 mm per day. The regenerate is moulded during distraction using intraoral elastics in various patterns in order to achieve occlusion and to optimize maxillomandibular relationship[29,30]. Distraction osteogenesis of maxillomandibular skeleton has the advantage of tissue histiogenesis which minimizes post treatment relapse. Successful correction ranging from 10mm - 45mm has been reported in literature[31,32,] Though tracheostomy is cited as permanent cure for severe OSA with severe mandibular retrognathism, the mandibular advancement by distraction osteogenesis provides 80%- 90% improvement[32]. Mandibular advancement also improves the position of hyoid bone. Genial advancement is often integrated with mandibular advancement or is done as isolated procedure which not only achieves chin prominence but stretches the suprahyoid muscles to correct hyoid position resulting in optimizing tongue position. Maxillary advancement is done by LeFort I osteotomy or by midface distraction using intraoral or extraoral distraction. Maxillary deficiency is a common feature of cleft maxillary hypoplasia associated with OSA and maxillary advancement not only helps in improving esthetics but also improves airway in the velopharyngeal region. Literature cites maxillomandibular advancement as treatment option in severe OSA even if the jaws are optimally placed[33]. The genioglossus advancement procedure by rectangular osteotomy of symphyseal region is also reported to provide beneficial results in select cases. High arched palate with narrow maxilla in adults often lead to SDB due to lowered tongue posture and

mandibular rotation. Surgically assisted rapid palatal expansion is currently proposed as treatment option in these cases. In a landmark pilot study by Cistulli et al on 10 adult patients who underwent surgically assisted rapid palatal expansion concluded major reduction in snoring, OSA and hyper somnolence[34]. Maxillary expansion increases oral space, optimizes tongue posture, increases nasal width reducing nasal resistance and in turn improves the airway and nasal breathing.

Conclusion

Airway centric Orthodontics is a protocol which factors upperairway dimensions and inputs when instituting orthodontic treatment .Impact assessment of orthodontic treatment on upper airway dimensions is considered a key aspect of decision making. The protocol encourages mimicking what the nature intended i.e. by finding room for all the teeth early enough by promoting breast feeding, habit breaking therapy, RME, and functional jaw orthopedics. Maxillomandibular advancement surgeries are known to enhance the upper airway dimensions in addition to improving dento-facial aesthetics drastically. But the percentage of cases who are undergoing this beneficial modality is far less in view of the need felt. This equation has to change and more capacity to provide this treatment modality must be built in our health care system. Prof Christian Guilliminault of Stanford University, a leading light in the field of neurobiology and sleep medicine has aptly summarized the emerging role of Orthodontia; "Although Orthodontia recognizes the importance of evaluating and treating upper airway sleep disorders, they are yet to realize how well positioned they are for prevention of sleep disordered breathing".

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