Orthognathic Surgery: A Review of Articles Published in 2014–2015

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Abstract

Objectives We did a retrospective study and reviewed some of the orthognathic surgery related papers that were published between January 2014 and December 2015 in a leading International Maxillofacial Surgery Journal. It was conducted to ascertain the trends of articles being published.

Method A total of around 57 articles were reviewed, of which most of the full length articles were on post operative outcomes and obstructive sleep apnoea.

Results Bulk of the studies were retrospective, and less interest was shown onto experimental researches.

Conclusion A thorough review and analysis thus gives an impression that there is a high requirement of well designed clinical studies.

Keywords Orthognathic surgery · Maxillofacial surgery · Obstructive sleep apnoea

Introduction

We did a retrospective analysis and reviewed some of the orthognathic surgery papers that were published between January 2014 and December 2015 in a leading International Maxillofacial Journal to ascertain the trends of articles being published, at the same time to reflect upon the scientific aspects of orthognathic surgery, that is being covered and provided to readers. Between this period of 2 years, of the 57 articles that were reviewed related to orthognathic surgery, 37 were full length, 9 were technical notes and short communications each,. The number of full length articles were found to be high when compared to reviews on orthognathic surgery, published in 2009–2010 (26 full length articles) and 2011–2012 (28 full length articles) [1, 2], showing that there is a gradual increase of interest in this speciality of maxillofacial surgery.

Method

A retrospective observational study was conducted for the articles published between January 2014 and December 2015.

All the articles were hand searched and were assessed and analysed.

Results

A total of around 57 articles related to orthognathic surgery were retrieved and reviewed. The number of related articles reviewed were 30 in 2014 and 27 in 2015, with the number of Full length publication related to orthognathic surgery being 62.96% in 2015, 66.66% in 2014 (Table 1).

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Table 1 Type of study design between 2014 and 2015

	2015	2014	Total [2014 + 2015]
Total publications	27 (100)	30 (100%)	57 [100%]
Full length articles	17 (62.96%)	20 (66.66%)	37 [64.91%]
Outcomes/complications	6 (22.22%)	9 (30%)	15 [26.31%]
Operative planning	2 (7.40%)	1 (3.33%)	3 [5.26%]
New/other techniques	2 (7.40%)	4 (13.33%)	6 [10.52%]
OSA	4 (14.81%)	4 (13.33%)	8 [14.03%]
Reviews	3 (11.11%)	2 (6.66%)	5 [8.77%]
Others	10 (37.03%)	10 (33.33%)	20 [35.08%]
Technical notes	6 (22.22%)	3 (10%)	9 [15.78%]
Short communications	4 (14.81%)	5 (16.66%)	9 [15.78%]
Letter to editor	0	2 (6.66%)	2 [3.5%]

The majority of the study designs in both the years under Full length publications were Outcomes/Complications related to the orthognathic surgery 6 in 2015 and 9 in 2014, followed by articles on Obstructive Sleep Apnoea, 4 each in 2014 and 2015.

Most of the full length articles in both the years were retrospective studies with 9 [52.94%] in 2015 and 7 [35%] in 2014, while the number of prospective studies were 7 (35%) and 3 (17.6%) (Table 2). Other research, observational studies and reviews were almost equal in both the years.

Full-Length Articles

Operative Planning

We found three articles dealing with the prediction and planning of the orthognathic surgery focusing mainly on the precision of work and to achieve desired post-operative outcome. In assessing the accuracy and reliability of linear measurements before conducting a Leforte I osteotomy, Gaia et al. [3] compared the process of physical measure with that of data derived from volume rendering Dolphin imaging software version 11.5.04.35. Generating 3D images of 11 dried skulls using CBCT, 2 radiologists derived linear measurements based on craniometrical anatomical landmarks independently using the software and compared

it with derivations of a third radiologist who used digital calipers, and concluded that the measurements should be done using Dolphin imaging prior of a Leforte I osteotomy as some marginal errors such as in the pterygoid area may be critical for linear measurements. Emphasizing on the post operative outcome and managing patient's expectations, Ullah et al. [4] described the use of 3dMD Vultus and concluded that it is able to give stable predictions of the soft tissue morphology post Leforte I advancement osteotomy. Using CBCT of 13 patients taken immediately before and 6 months after surgery they did virtual repositioning of maxilla and mandible with the 3dMD Vultus and showed that the difference of value between the actual position and the predictive value was less than 3 mm which was clinically satisfactory. In this era of technological advancement the prime importance is to develop technique which allows accuracy with ease in the field of work. Wang et al. [5] thus show their experience in using surgical navigation technology for the recontouring of faces of patients having maxillofacial fibrous dysplasia. They did a virtual planning using preoperative CT scans and fixed a rigid digital reference frame on the patient's forehead. Using a pointing device, the consistency of the extent of resection with the preoperative planning was monitored.

Post Surgical Outcomes and Complications

One of the important factors which helps in the estimation of the success of an orthognathic surgery in the long run, is its stability. 7 articles were published centering around the subject of stability after different types of orthognathic surgery. Bhatia et al. [6] did a prospective study on 32 patients who were treated with Leforte I maxillary osteotomies with advancement of at least 1 cm, and found no significant relapse till 1 year of the surgery. On the other hand Lee et al. [7] in a retrospective study of 29 patients who had undergone bi-maxillary surgery for skeletal Class III deformities, evaluated the bony remodeling in the anterior region of maxilla

Table 2 Trends amongst full length publications between 2014 and 2015

	2015	2014
Retrospective	9 (52.94%)	7 (35%)
Prospective	3 (17.64%)	7 (35%)
Epidemiological/RCT	0	2 (10%)
Reviews	3 (17.64%)	2 (10%)
Observational/research/animals	2 (11.76%)	2 (10%)

by taking 3 sets of CBCT images, preoperatively, immediately and 6 months post-operatively and keeping nasopalatine canal as a reference point. They concluded that bony resorption was apparent and post-operative change in the point A is affected by operative movement as well as by relapse and remodeling. In a 12 month follow up study Kim et al. [8] retrospectively studied 37 subjects undergoing surgery first approach intraoral vertical ramus osteotomy (IVRO) for correction of Class III deformity. By comparing Cephalometric tracings of 2 days, 6 and 12 months post-operatively he found out an anterior mandible relapse was <1 mm, and proper post-operative planning would compensate the increased superior relapse. Rocha et al. [9] in their study concluded that there are significant long term changes with counterclockwise rotation of the maxilla-mandibular complex and mandibular advancement procedures, but these were clinically acceptable as they were found to be <2 mm, while Ohba et al. [10] state that there was reliable stability of both the maxilla and mandible after maxilla-mandibular osteotomy with physiological positioning in patients with mandibular prognathism. It was showed by conducting cephalometric analysis, pre-operatively, immediately, and more than 1 year after maxillomandibular osteotomy. There were two comparative studies, of which in one van Bakelen et al. [11] compared the long term stability between a biodegradable and a titanium fixation system following BSSO advancement and found no significant differences amongst the two, while Lee et al. [12] compared the post-operative stability following advancement genioplasty using biodegradable screw to that of metal plates. Though there was not much clinical difference between the two, yet biodegradable screws could be advantageous as no second surgery for its removal would be required.

Any type of orthognathic surgery directly affects the overlying soft tissues, changing the facial aesthetics of the person, hence the treatment planning should be done accordingly so that a pleasant aesthetic outcome is achieved. O'Donovan et al. [13] in their study compared the anterior soft tissue projection of the maxillomandibular complex relative to the forehead after Leforte I advancement for correction of maxillary hypoplasia with that of a local reference group chosen by lay assessors. They found that the orthognathic group had a more anterior mandibular projection relative to forehead than the female reference group, while in men though the mandible was positioned anteriorly, It was acceptable, concluding that the projection of the mid and lower face of the local reference group to the forehead should be a guide to pre-operative planning. Further Ghassemi et al. [14, 15] compared two groups of patients who underwent maxillary advancement, of which one group had advancement of more than 6 mm while the other had <6 mm. It revealed that there was a mark improvement in the esthetics around the nasolabial and

submental regions of the patients who had maxillary advancement of more than 6 mm, on the other hand there was no significant changes of the same region in which it was <6 mm. Adding to it in a different study he compared the effect of the mandibular setback on the aesthetic outcome between two distinguished groups, one with <5 mm setback while other having more than 5 mm, and showed that the cervical length decreased significantly in the latter. Their observations concluded that lip-chin-throat angle, length of lower and upper lips from the aesthetic should be considered during treatment planning as it differed significantly between both the groups. Edentulous cases and cases with atrophic ridges are also very commonly presented for orthognathic surgery and have their own challenges. Teng et al. [16], described, evaluated and showed that ridge-splitting and simultaneous implantation combined with ridge expansion osteotomy and sandwich bone augmentation is a reliable technique for narrow edentulous ridges in the aesthetic zone. 31 appropriate patients were treated with the procedure and 41 Bicon implants were placed collectively with no significant complications. Rezaeetalab et al. [17], evaluated and signified the effect of bimaxillary orthognathic surgery on the airway resistance and lung volumes by doing a research on 21 patients with class III malocclusion. Through Plethysmography it was showed that there is significant increase in airway resistance, residual volume, total lung capacity, thus caution should be maintained in pre-existing respiratory diseases. Distraction osteogenesis is widely practiced in conjunction with orthognathic treatment. Wery et al. [18], in their study of 10 patients with syndromic craniosyntosis who were treated with Leforte III procedure followed by placement of an external frame, evaluated the 3D effect using computed tomography. The Comparison between pre and post operative CT data indicated significant amount of midface advancement.

Post surgical complications are a very integral part of the whole treatment procedure. Avoiding and/or overcoming the complications depends a lot on the knowledge and skills of the surgeon. In this era of technological advancement, predicting and avoiding the complications are getting easier day by day, as shown in the 2 articles that were published on post surgical complications of orthognathic surgery. In the retro-spective analysis of 4127 patients over a period of 42 years, Verlinden et al. [19], came across 2 patients developing symptomatic venous thromboembolism post orthognathic surgery or distraction osteogenesis. Thus they state that in a low to moderate risk patients for a short hospital stay, there is low risk of developing a thrombosis and thromboprophylaxis should be limited to high risk patients only. On an other aspect of avoiding post operative complications, Shirota et al. [20], judge the effectiveness of piezoelectric surgery in reducing

surgical complications after bilateral sagittal split osteotomy. Amongst 59 patients, for 29 patients piezosurgery, while for the rest Lindeman bur was used, and they came across no significant difference in intra-operative bleeding and neurosensory differences between the two sets of patients.

New Operative Techniques/Researches

There were in total 6 articles discussing about new techniques or researches regarding orthognathic surgery. Digitalization being the prime area of focus there were 3 articles stating about the influence of computer assisted orthognathic surgery. Riu et al. [21], found significant differences in the alignment of the lower intrinsic point, mandibular sagittal plane and centering of the dental midlines between 2 groups of facial asymmetry patients being treated either by classical or computer-assisted corrective jaw surgeries. Baek et al. [22], in their study compared defects of different shapes being created on mandibles of 6 guineapigs between a conventional drill and piezoelectric osteotome guided by a surgeon on one side and, a robot guided Er-YAG laser osteotome. They found that on the basis of view of the workflow, ergonomics and safety with ease of use, the robotic laser osteotome case be used in operation theatres. In an accuracy study Lin et al. [23], showed and said that in comparison with the resolution of the CT machines commonly used, cone-beam CT machines having a relatively smaller voxel size allow the calibrations of natural head position and centric relation of the mandible which helps in the evaluation of the maxillofacial region more accurately. Shqaidef et al. [24] assessed the accuracy of rapid prototyping of virtual wafers derived from laser scanned dental models using CAD-CAM software and found them to be able to orientate the upper and lower dental models with an absolute mean error of 0.94 mm. Discussing about new operative techniques, Ohba et al. [25], tested the method of short lingual osteotomy with physiological positioning over 18 patients with skeletal mandibular prognathism. It was regarded to be as a new alternative to conventional orthognathic surgery and confirmed both skeletal and dental stability to be excellent using this technique. Similarly Tang [26] used new horizontal v-shaped osteotomy for correction of zygoma and zygomatic arch protrusion in 27 patients and found it to be satisfactory. Its advantages were said to be convenient multishifting, better results and lesser complications.

Obstructive Sleep Apnea (OSA)

8 articles were published in these 2 years on the subject of Obstructive sleep apnea consisting of predicting the

outcomes and effects of orthognathic surgery on it, and other factors having an impact on OSA. Conveying about the effect on upper airway, Hsieg et al. [27], assessed the changes in the caliber of the upper airway and the surrounding structures after maxillomandibular advancement (MMA) for OSA. By conducting polysomnography and CT scans on 16 patients, it was concluded that MMA increases the volume in the upper airway and reduces its length and the scale of improvisation depends on the extent of anterior movement of maxilla, soft palate, and hyoid. In a similar conclusive study, Bianchi et al. [28], conducted an analysis and show that there are significant linear relations between increased absolute upper airway volume and improvement in the AHI (Apnea-hyperpnoea Index) after MMA and also demonstrate that the clinical improvement in AHI reach a plateau after 70%. Islam et al. [29] aimed to evaluate in their study whether the severity of pre-operative OSA has potential predictive value for the clinician assessing patients referred for MMA surgeries. 31 patients were divided into two groups based on their AHI scores, namely, mild-moderate (AHI < 30) and severe (AHI > 30) and comparison was drawn on the surgical outcome, and it was seen there was no significant difference. Islam et al. [30] tried to size the subjective perception of facial appearance by patients after maxillofacial surgeries for OSA and to figure the correlation between satisfaction and surgical outcome. Assessment of facial appearance before and after surgeries were done using Visual Analogue Scale (VAS) and the AHI score and Epworth sleepiness scale (ESS) to analyse association with facial appearance. Through the study it was indicated that most patients amongst the 26 included, were satisfied with their appearance while the facial aesthetics was independent of surgical outcome. In a one of its kind study Islam et al. [31], evaluated the relationship between preoperative Mallampati score and surgical outcome after bimaxillary advancement for OSA, and in the analysis of 50 patients they suggest that the Mallampati classification is less useful for the prediction of surgical outcome after MMA surgeries. Furthermore Islam et al. [32], in a retrospective study of 44 patients have showed that MMA for OSA improves the systemic blood pressure, particularly in those with established hypertension. The data shows that the surgery effectively lowers the systemic blood pressure more than other treatment modalities. A pilot study was conducted by Seehra et al. [33], to describe the craniofacial characteristics of patients whose symptoms of OSA were successfully treated with MMA splints and who were considered for subsequent MMA surgery. The study was based on 2 previous studies published, and suggested that patient whose symptoms improved with the splints may have some unique craniofacial features like bimaxillary retrusion with a shorter maxilla and mandible, and a greater class II skeletal

tendency, though they do mention that this aspect need extensive study in future. In a decisive study, and commenting on the underuse of maxillofacial techniques for it, Islam et al. [34] confirm that bimaxillary advancement results in a high rate of success in patients with OSA, as they conduct a retrospective study of 51 patients of United Kingdom and compare their pre and post operative AHI, ESS and lowest oxygen saturation score.

Review Articles

There were 5 review articles published within the span of the 2 years of 2014–2015. Goodson et al. in their articles reviewed all the orthognathic surgery related papers and oral surgery related papers published in BJOMS between 2011 and 2012 in two separate articles [3, 35]. Oluwajana et al. [36] reviewed studies on the psychology of orthognathic surgery as to what is actually done, why and what kind of patients seek this treatment etc. Cobb et al. [37] wrote on the surgical management of Treacher Collins syndrome. In a retrospective study and review of literature, Verweij et al. [38] analysed the need to remove osteosynthesis material because of associated complaints and showed that fixation with bicortical screws after BSSO is associated with a low rate of removal of osteosynthesis material.

Other Articles

Short Communications

9 short communications were published between 2014 and 2015, of which around 6 were case reports on complications following orthognathic surgeries [39–47].

Technical Notes and Letters to Editor

9 technical notes were published covering topics on technique modifications, new or modified instruments and other techniques. Jung et al. [48] wrote about modification of intra-oral vertical ramus osteotomy, while Tauro et al. spoke about a new technique of Oblique sagittal split sliding genioplasty [49, 50]. Amery et al. explained about Stop-hole osteotomy technique [51]. Triaca et al. stated about a technical modification of Chin wing osteotomy for the correction of hyperdivergent skeletal class III deformity [52]. Kang et al. discussed about a CAD/CAM engineered maxillary repositioning wafer assembly [53]. Lee et al. illustrated guided cutting of bone for intraoral vertical ramus osteotomy with a freer marking technique [54]. Matsushita et al. introduced a new device for palatal

expansion in conjunction with the Le Forte I osteotomy and in another article described that wide-bladed mandibular channel retractor efficiently secures surgical man-oeuvres during ramus osteotomy [55, 56]. Nillson et al. narrated development of workflow for recording virtual bite in the planning of surgery [57]. 2 letters to editor were written in 2014 while none were in 2015 [58, 59].

Discussion

Corrective jaw surgery also known as, Orthognathic surgery has been practiced for many years now. It enhances the aesthetic beauty of the patient as well as rendering functional correction. It is also widely incorporated in treating other medical conditions like migraines, Obstructive sleep apnoea etc. Majority of the articles published were based on the outcomes of the procedure or were related to OSA. This signifies that OSA in due course of time has evolved as a disease of modern civilization, which used to be sub-diagnosed earlier. Holty et al. [60] in their review and meta-analysis of articles orthognathic surgery as a treatment for OSA have studied around 53 related articles and concluded that the overall health of the patients showed considerable improvement after the Maxillo-mandibular advancement surgery with no such major complications. According to the reports, the post surgical success and cure were 86 and 43.2% respectively, while the minor and major complications were approximately 3.1 and 1% respectively with no complications of death. It also signifies that the other areas of the procedure need attention and research. In one other clinical review of 40 patients, Riley et al. [61] have tried to evaluate the efficacy of maxillary, mandibular and hyoid bone advancement as a treatment option for OSA and landed at some of the indications for MMO surgeries which are severe OSAS, morbid obesity, severe mandibular deficiency, and failure of other forms of treatment. In the review it was found out that the maxillofacial surgeries gave results as good as CPAP (continuous positive airway pressure), which is the common mode of treatment for OSA.

A very few number of articles related post surgical complications were published in this time span, adding up to a total of only 2. Major and minor complications go hand in hand with surgeries and are a subject of great planning and consideration before conducting surgeries. Jędrzejewski et al. [62] reviewed around 44 articles related to the varied complications following orthognathic surgeries and stated it's the responsibility of the team of surgeons and orthodontists to prevent and minimize all such difficulties post operatively. Sousa et al. [63] in another review of 23 articles related to post operative complications found out some of the common ones—nerve damage (12.1%),

infection (3.4%), problems with fixative materials (2.5%), temporomandibular joint disorder (2.1%), undue fracture (1.8%), scarring problems (1.7%), and hemorrhage (1.4%). Here as well the authors conclude that a multi-disciplinary approach of an experienced team would be able to resolve and attenuate the pre, intra and post op complaints and difficulties.

Table 2 represents that there was a predominance of retrospective studies. Prospective studies, Experimental researches contributed to a very minor portion of the publications. Hence there seems to be a requirement to diversify the resources and workflow as well as to test the strength of imagination with the appropriate knowledge and cutting edge technology of the field for revolutionizing the work culture.

Conclusion

The prime objective and purpose of this review was to ascertain the kind of study and research being conducted over the globe on the aspect of Orthognathic Surgery. Through the review we were able to provide a broad aspect of the types of research and the subtopics of Orthognathic surgery that are of prime importance amongst the maxillofacial surgeons.

We need to impart more attention to this field of speciality and focus on proper channeling of the knowledge and resources for expansion.

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Compliance with Ethical Standards

Conflict of interest No conflict of interest.

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