

Condylar Resorption After Orthognathic Surgery: A Systematic Review

Reabsorción Condilar Después de Cirugía Ortognática: Una Revisión Sistemática

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SUMMARY: The aim of this research was to evaluate the risk factors related to condylar resorption (CR) after orthognathic surgery. Was realized a systematic review with a search of the literature performed in the electronic databases PubMed, MedLine, Ovid, Cochrane Library for current evidence in the world literature as conducted, and relevant articles were selected in according to inclusion and exclusion criteria and the findings were compared. Eight papers, (follow-up 12 months to 69 months) were including. A sample of 2567 patient with mandible or bi maxillary surgery with an age range from 14 to 46 year old was observed. In 137 patients (5.3%) CR was observed, with a 97.6% (122) female. CR was related to 118 cases with mandibular deficiencies with high mandibular plane (advancement surgery). CR were present principally in bi maxillary surgery with a 103 cases (75.2%) and only two papers show any analysis to the relation with TMJ dysfunction. Current evidence in CR is poor but supports those female patients with mandibular deficiency and high mandibular plane angle submitted to bi maxillary surgery with change in occlusal plane (counterclockwise) are associated with condylar resorption after orthognathic surgery.

KEY WORDS: Condylar resorption; Orthognathic surgery; TMJ dysfunction.

INTRODUCTION

In 1978, Phillips & Bell first reported bilateral atrophy of the mandibular condyles after bilateral sagittal split ramus osteotomy (BSSRO) for mandibular advancement. Although a definitive cause could not be established, they hypothesized that a biomechanical phenomenon based on increased muscle tension was the most likely causative mechanism. The incidence of condylar resorption after orthognathic surgery is reported to range from 1% to 31% (de Mol van Otterloo *et al.*, 1993; Hwang *et al.*, 2000a; Hoppenrejis *et al.*, 1998; O’Ryan & Epker, 1984) and the first radiologic signs is present postoperatively in the 6th or posterior months (O’Ryan & Epker).

Condylar resorption (CR) or condylolysis can be defined as progressive alteration of condylar shape with a decrease in mass. As a result, most patients exhibit a decrease in posterior face height, retrognathism and progressive anterior open bite with clockwise rotation of the mandible.

CR may be described as osteoarthritis and can be subdivided into primary (idiopathic) and secondary (de Bont & Stegenga, 1993). The degenerative changes of secondary osteoarthritis are caused by joint afflictions, such as rheumatoid arthritis, or by alteration of joint anatomy following excessive traumatic loading of the temporomandibular joint (TMJ) with or without disc displacement (de Bont & Stegenga). They can also result from condylar resorption after orthognathic surgery.

In the past, many studies on this subject have been published (Phillips & Bell; O’Ryan & Epker; Arnett & Tamborello, 1990; Arnett *et al.*, 1996a, 1996b; Bouwman *et al.*, 1994; Merckx & Van Damme, 1994; Scheerlinck *et al.*, 1994). These papers have reported clinical and radiological features of condylar resorption and proposed contributing factors. This research show that predisposing patient factors are preoperative TMJ dysfunction, the age

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close range from 15 to 35 years, females presenting a high mandibular plane angle with mandibular hypoplasia and a small posterior-to-anterior facial height ratio (Hoppenreijns *et al.*; Kerstens *et al.*; Arnett *et al.*, 1996a, 1996b; Huang *et al.*, 1997; Hwang *et al.*, 2000b; Moore *et al.*, 1991). A posterior inclined condylar neck has been considered another contributing factor (Hwang *et al.*, 2000a, 2000b; Hoppenreijns *et al.*). For other hand, surgical factors how mandibular advancement, maxillary impaction, mandibular autorotation, and bi maxillary surgery can induce condylar resorption. In fact, the incidence of CR is significantly higher after bi maxillary osteotomy (Hoppenreijns *et al.*).

The aim of this study was a systematic review of the literature to evaluate the current evidence identifying risk factors on condylar resorption after orthognathic surgery.

MATERIAL AND METHOD

Search strategy. This search involved the online medical performed in the electronic databases PubMed, MedLine, Ovid and Cochrane Library from January 1978 to August 2010. The free text words and MeSH terms were used. The following keywords were used to identify relevant publications: condylar resorption, progressive condylar resorption, idiopathic resorption, condylar atrophy, dysfunctional remodeling, avascular necrosis, osteonecrosis and condylitis. The heading sequence of the MeSH terms used (“orthognathic surgery” [MeSH]) AND (“condylar resorption” OR “progressive condylar resorption” OR “idiopathic resorption” OR “condylar atrophy” OR “dysfunctional remodeling” OR “avascular necrosis” OR “osteonecrosis” OR “condylitis”) was selected. A search for previous systematic review or meta-analysis on the CR after orthognathic surgery yielded no result.

The abstract of each article was reviewed and full articles relevant to condylar resorption after orthognathic surgery were retrieved. A search of reference lists of the articles retrieved was also performed and any relevant articles were included.

Thirty four papers resulted from this search. Two independent observers (PHM and CMRB) reviewed the abstracts from all the paper initially selected; for final research was including the paper related to the following criteria: Full text in English language; human clinical trials; randomized, clinical trials, prospective multicenter articles, or prospective clinical trial; Retrospective studies aimed at identifying risk factors for resorption condylar; Follow-up of 1 year or longer; No individual or series case report, descriptive studies, opinion articles, or abstracts; articles with less than 10 patients were evaluated; and no syndromes or medically compromised patients, and no diseases.

The full text articles were obtained and analyzed by the same two independent observers. In this second revision were applied the inclusion and exclusion criteria again and a definitive list of papers was identified for extraction of data.

Articles considered worthy by both observers were included. Where only one observer supported inclusion, a decision was made based on discussion between the two observers considering the inclusion criteria. The results were compared and the data were analyzed using the index of inter-rater reliability (Cohen’s Kappa).

RESULTS

The search strategy resulted in 34 papers on condylar resorption after orthognathic surgery. After selection

Table I. Review of selected papers reporting CR after orthognathic surgery.

Authors	Year	Mandibular prognathism	Mandibular prognathism with open bite	Mandibular deficiency, low/normal mandibular plane angle	Relative mandibular deficiency	Absolute mandibular deficiency, high mandibular plane angle
Kerstens <i>et al.</i>	1990	14	20	76	47	49 (12 – CR)
Merkx & Van Damme	1994	U	U	U	U	7 (7 – CR)*
De Clerq <i>et al.</i>	1994	U	U	U	U	29 (9 – CR)
Scheerlinck <i>et al.</i>	1994	-	-	103 (8 – CR)**	-	-
Bouwman <i>et al.</i>	1994	134	76	549	108	158 (33 – CR)
Cutbirth <i>et al.</i>	1998	-	-	100 (10 – CR)**	-	-
Hoppenreijns <i>et al.</i>	1998	-	-	-	-	259 (40 – CR)
Hwang <i>et al.</i>	2004	U	U	U	U	39 (17 – CR)

U = Uninformed; F = Female; M = Male; BSSRO = bilateral sagittal split ramus osteotomy; WF = Wire Fixation; RF = Rigid fixation; NA = data on type of fixation not given.

Table II. Incidence of condylar resorption (CR) related to dentofacial deformity.

Authors	Year	Total patients with CR	Sex	Total patients in series	Bi Maxillary Surgery	Le Fort I Osteotomy	BSSRO	Osteosynthesis	Mean Follow-up (months)
Kerstens <i>et al.</i>	1990	12	U	206	11	-	1	WF	12
Merckx & Van Damme	1994	8	F	329	8	-	-	WF	36
De Clercq <i>et al.</i>	1994	9	F	93	9	-	-	RF	24
Scheerlinck <i>et al.</i>	1994	8	7F / 1M	103	-	-	8	RF	24
Bouwman <i>et al.</i>	1994	33	F	1025	32	-	1	WF-RF	12
Cutbirth <i>et al.</i>	1998	10	8F/2M	100	-	-	10	RF	36
Hoppenreijns <i>et al.</i>	1998	40	F	259	27	13	-	WF-RF	69
Hwang <i>et al.</i>	2004	17	F	452	16	-	1	WF-RF	24
Total		137		2567	103	13	21		

U = uninformed. * = The study presented 8 female with condylar resorption and one of them presented surgical correction of laterognathia. ** = All patients showed mandibular deficiency and were treated by bilateral sagittal split ramus osteotomy for advance.

according to the inclusion/exclusion criteria, 10 articles qualified (inter-rater K= 0.937) for the final review. However, the same patients compose 3 selected studies. In this case, only the study with longer follow-up was considered. Thus, a total of 8 papers were selected (Table I).

Follow-Up Period. The range of follow-up period was 12 months to 69 months. Two studies showing the minimum time of follow-up according to the inclusion criteria; two studies presented 24 months; two studies presented 36 months and one long-term follow-up (69 months).

Sociodemographic considerations. The total number of patients included in the systematic review was 2567. In 137 (5,3%) patients was observed CR. For each research, the sample size ranged from 93 to 1025 patients and the age ranged was between 14 and 46 years. Kertens *et al.*, (1990) did not specify the gender of the 12 patients with CR in his sample. However, considering the other seven researches was observed that the 97.6% (122) with CR was female. This suggests that female patients have a greater predisposition to CR.

Dentofacial Deformity. There was a significant correlation between the characteristic of dentofacial deformity and condylar resorption after orthognathic surgery. CR was observed in 118 (21.8%) of 541 patients with absolute mandibular deficiency (high mandibular plane angle); 18 (2.2%) of 828 patients with mandibular deficiency (low/normal plane angle) and one case with asymmetry (Table II).

Orthognathic Surgery. The CR patient was observed in three different groups. We found a higher prevalence of CR in 103 patients (75.2%) with bi maxillary surgery, followed by 21 cases with bilateral sagittal split ramus osteotomy (15.3%) and 13 cases (9.5%) with only Le Fort I osteotomy. For osteosynthesis relations, CR was found in patient with wire fixation and rigid fixation and some research presented patient with intermaxillary fixation for 4-6 weeks. For the patient analysis, it was observed that in 67 with wire fixation (9.9% of total patients with wire fixation) CR was present and in 56 patients with rigid fixation (13% of total patients with rigid fixation) CR was observed. For the record it was important that Hwang *et al.*, did not specify the osteosynthesis used in the sample of analysis (Table III).

Table III. Incidence of condylar resorption (CR) related to osteosynthesis.

Authors	Year	Wire Fixation	Rigid Fixation
Kerstens <i>et al.</i>	1990	206 (12 – CR)	-
Merckx & Van Damme	1994	329 (8 – CR)	-
De Clercq <i>et al.</i>	1994	-	93(9 – CR)
Scheerlinck <i>et al.</i>	1994	-	103 (8 – CR)
Bouwman <i>et al.</i>	1994	91 (24 – CR)	67 (8 – CR)
Cutbirth <i>et al.</i>	1998	-	100 (10 – CR)
Hoppenreijns <i>et al.</i>	1998	50 (14 – CR)	67 (13 – CR)
Hwang <i>et al.</i>	2004	U (9 – CR)	U (8 – CR)*
Total	-	676 (67 – CR)	430 (56 – CR)

U = uninformed. * = Bilateral sagittal split ramus osteotomy was treated by bicortical screws in 10 cases and monocortical screw / miniplate in 7 cases. Intraosseous wire fixation was used to stabilize the maxillary osteotomy in 9 cases and screw/ miniplates in 7 cases.

DISCUSSION

A lack of randomized clinical trials and prospective studies makes a meta-analysis study impossible. To increase the power of this systematic review, it would be necessary to include only randomized, clinical trials, prospective multicenter articles, or prospective clinical trial. The huge number of possible articles was reduced because of inclusion and exclusion criteria that were thought to promote the possible risk factors of condylar resorption after orthognathic surgery.

Sex and age variables. The incidence of condylar resorption after orthognathic surgery in this systematic review showed ranges from 3% to 15%. However, only two authors examine the incidence the CR in all types of dysgnathias with ranges from 3% to 6% (Kerstens *et al.*; Bouwman *et al.*). In two studies (Scheerlinck; Cutbirth *et al.*, 1998) only cases with patients with mandibular deficiency (low/normal mandibular plane angle) were examined showed ranges from 8% to 10%. Hoppenreijns *et al.* include only patients with absolute mandibular deficiency (high mandibular plane angle) showed 15% with CR. Other authors included in the systematic review (Merkx & Van Damme; De Clercq *et al.*, 1994; Hwang *et al.*, 2004) did not specify all types dentofacial deformity examined of the study, but reported CR between 3% to 10%.

The interpretation of the high proportion of females with condylar resorption following orthognathic surgery is controversial. Cutbirth *et al.*, found that sex did not have a statistically significant effect on the incidence of condylar resorption after mandibular advancement. They stated that more women showed resorption than men because more women underwent surgery. In others studies, however, the overwhelming majority of previously reported cases of condylar resorption following orthognathic surgery were females (Hoppenreijns *et al.*; Merkx & Van Damme). However, 2 studies in this systematic review showed male with CR, showing that CR is not only of female (Scheerlinck *et al.*; Cutbirth *et al.*). There was no correlation between CR and age of patient.

TMJ dysfunction variables. TMJ dysfunction has been study in different clinical situation and is a fact that an important part of patient with facial deformities present a TMJ pathology (Dujoncquoy *et al.*, 2010) and pre surgical TMJ dysfunction can contribute to the development of postoperative condylar resorption (Cutbirth *et al.*). In this direction, Wolford *et al.*, (2003) showed that a high percentage of patient with TMJ pathology after orthognathic surgery presented a significant worsening of the TMJ dysfunction.

In this systematic review, 2 studies showed preoperative TMJ dysfunction (Scheerlinck *et al.*; Cutbirth *et al.*) and other 3 studies no reported this issue. For Hoppenreijns *et al.*, there were no significant correlations between intensity of preoperative TMJ sounds and radiological condylar changes, or between mouth opening and condylar changes. However, an increased rate to TMJ dysfunction after orthognathic surgery has been reported in patients with mandibular hypoplasia and a high mandibular plane angle (Kerstens *et al.*; De Clercq *et al.*), although Hoppenreijns *et al.*, and Cutbirth *et al.*, reported that patients with large advancements and preoperative joint symptoms appear to be at risk for CR. The data obtained between TMJ dysfunction and CR is unable to draw definite conclusions.

Condylar remodeling is a physiologic process that aims to adapt the structure of the temporomandibular joint (TMJ) to meet the functional demands. It is based on an interaction between the mechanical forces sustained by the TMJ and the adaptive capacities of the condyle. Orthognathic surgery can sometimes be responsible for an excessive physical stress to the articular surfaces. In these cases, normal functional condylar remodeling shifts to the process of progressive condylar resorption.

Facial deformity and surgery variables. Facial deformity and condylar resorption after orthognathic surgery showed a significant correlation, specifically, the height of the mandibular plane. In 6 of 8 selected studies (Hoppenreijns *et al.*; Kerstens *et al.*; Bouwman *et al.*; Merkx & Van Damme; De Clercq *et al.*; Hwang *et al.*, 2004), 541 patients who have absolute mandibular deficiency (high mandibular plane angle), 118 (21.8%) showed CR. This correlation may be explained by the change of loading after the correction of this type dentofacial deformity. Mechanical loading during or after BSSO could limited the blood flow to the condyle and capsule, been contributing factors to the CR (Hoppenreijns *et al.*). The relative reduction in condylar vascular supply may trigger the course of events in some patients; however, 78.2% of the patients who have absolute mandibular deficiency showed no CR.

The mandible or bi maxillary surgery could modify the condylar position and be a factor for CR; in mandible surgery, statistical differences were not observed between the pre-surgical and post-surgical position of condyle (Ueki *et al.*, 2002; Fang *et al.*, 2009; Hackney *et al.*, 1989; Will *et al.*, 1984) but this difference could be a clinical significance in the postoperative condition. On the other hand, Baek *et al.* (2006) showed that in asymmetric movement (using

sagittal split ramus osteotomy) the condylar position was the same after and before of surgery but with differences in inclination of condylar head of major and minor movement; this situation can be an explanation for different load on the condylar head and consecutively bone reabsorption.

Six studies showed a higher incidence of CR in bi maxillary osteotomy (Hoppenreijns *et al.*; Kersens *et al.*; Bouwman *et al.*; Merkx *et al.*; De Clercq *et al.*; Hwang *et al.*, 2004), 103 (75.2%) patients with bimaxillary osteotomy developed CR. This osteotomy is generally used to correct deformities with high mandibular plane angle associated to change counterclockwise of occlusal plane. In this surgery, with the rotation of the mandible proximal segment rotation of the condylar head occurs (Hwang *et al.*, 2004). This leads to exposure of the less dense, previously unloaded anterior-superior condylar surface to compressive loads (O'Ryan & Epker). When the condylar neck is inclined posteriorly, the less loaded anterior-superior area of the condyle is more exposed to loading and subjected to resorption (Hwang *et al.*, 2004). However, the relationship between the change mandibular plane (MP) angle and CR is not sufficiently clear. On the other hand, in a systematic review, Bouwman *et al.*, reported no correlation

between intermaxillary fixation for a period of (4-6 weeks) and CR when wire fixation or rigid fixation was used.

Finally, we can conclude that condylar resorption following orthognathic surgery is a multifactorial phenomenon, and some of the risk factors are interrelated. In the present systematic review, risk factors were female patients with absolute mandibular deficiency and high mandibular plane angle submitted bimaxillary osteotomy associated with change in occlusal plane (counterclockwise). It is recommended the patients with these characteristics should be given explicit preoperative information on the risk of condylar resorption with skeletal relapse.

The application of this current review is limited by the heterogeneity of the study protocols and data analysis techniques adopted in the studies considered. More information about etiology and the natural course of condylar changes in untreated patients is desirable. Prospective studies are necessary to gain more insight into the pathophysiology of condylar resorption after orthognathic surgery. Further systematic reviews and a meta-analysis of the data from the various studies are desirable.

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RESUMEN: El objetivo de esta investigación fue evaluar los factores de riesgo asociados a reabsorción condilar (RC) posterior a cirugía ortognática. Fue realizada una revisión sistemática con una búsqueda de la literatura realizada en bases de dato electrónicos como PubMed, MedLine, Ovid, Cochrane Library buscando actual evidencia en la literatura mundial; artículos relevantes fueron seleccionados según los criterios de inclusión y exclusión, comparando sus resultados. Ocho artículos (tiempo de seguimiento de 12 a 69 meses) fueron incluidos. Se observó una muestra de 2567 pacientes con cirugía mandibular o bimaxilar con una edad de entre 14 y 46 años. En 137 pacientes (5,3%) se observó reabsorción condilar, siendo el 97,6% (122 casos) de sexo femenino. La RC fue observada en 118 casos de deficiencia mandibular con un plano mandibular alto (cirugía de avance mandibular). La RC estuvo presente principalmente en cirugías bimaxilares con 103 casos afectados (75,2%) y solo dos artículos evidenciaron análisis previo de disfunción de ATM. Actualmente la evidencia en RC es limitada pero fundamenta que mujeres con deficiencia mandibular y alto plano mandibular sometidas a cirugía bimaxilar con alteración del plano oclusal (giro horario) son asociadas a la reabsorción condilar después de la cirugía ortognática.

PALABRAS CLAVE: Reabsorción condilar; Cirugía ortognática; Disfunción de ATM.

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