Antibiotic prophylaxis for preventing infectious complications in orthognathic surgery: Cochrane systematic review (protocol) (Protocol)

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ABSTRACT

This is the protocol for a review and there is no abstract. The objectives are as follows:

To assess the effects of antibiotic prophylaxis for preventing SSI in people undergoing orthognathic surgery.

BACKGROUND

Description of the condition

Orthognathic surgery (OS) is the surgical correction of a deformity of the jaw (ortho meaning 'straight', and gnath meaning 'jaws'). It is a general term that includes many elective surgical techniques to correct facial deformity, the associated malocclusion, and functional disorders related to the stomatognathic system (set of anatomical features in the head that focus on the mouth; functions of which include chewing, breathing, speech and swallowing) (Obwegeser 2007). The first orthognathic surgery was performed In 1847 by Hullihen (Hullihen 1849). The surgery involves carrying out total, or partial, osteotomies (cutting of bone) on the maxilla, mandible and other facial bones, to position the skeleton correctly and correct functional problems (Moore 2001).

According to the American Association of Oral and Maxillofacial Surgeons (AAOMS 2012), conditions that indicate the need for orthognathic surgery include: difficulty chewing or biting food; difficulty swallowing; chronic jaw or jaw joint (TMJ) pain and headache; excessive wear of the teeth; open bite; unbalanced facial appearance from the front or side; facial injury or birth defects; receding chin; protruding jaw; inability to make the lips meet without straining; chronic mouth breathing and dry mouth; and serious breathing problems while sleeping (sleep apnoea). The consequences of these conditions depend on the degree of deformity, and can vary from very mild to severe. Dentofacial deformities may provoke functional problems such as physical pain, physical disability, cosmetic dissatisfaction, and difficulties with speaking, breathing and chewing. Patients can improve significantly after orthognathic surgery with regard to their psychological discomfort, social disability and self-confidence, as when functional limitations decrease, there is an improvement in quality of life (Choi 2010; Lee 2008; Rustemeyer 2011).

Although there are few data to estimate the number of OS procedures performed each year around the world, statistics from oral and maxillofacial surgery training programs reported to the American Dental Association and American Association of Oral and Maxillofacial Surgeons show that there was a gradual increase in the number of these procedures between 1996 and 2007. In 2007 it was reported that a total of 8755 OS procedures were performed in the United States of America (Sullivan 2011). The average age of patients undergoing orthognathic surgery in 2008 was 26.7 years, and the great majority of the patients were between 15 and 30 years of age (Venugoplan 2012). Female patients represented 56.2% of those having the procedure (Venugoplan 2012). Whites constituted 71.9%, blacks 4.9%, Hispanics 12.6%, Asian/Pacific Islanders 5.6%, Native Americans 0.4%, and other groups 4.6% of the surgeries, respectively (Venugoplan 2012).

Specific postoperative complications related to orthognathic surgery include haemorrhage, temporary or permanent sensory and motor problems affecting the face and mouth (V2 and V3 nerve dysfunction), deviation of the nasal septum, bone infection (osteomyelitis), connection of the mouth to a sinus cavity (oroantral fistula), sinusitis, and loss or degradation of results obtained by surgery (postoperative relapse) (Chow 2007). In addition, patients can suffer more general surgical complications, such as pain, swelling and surgical site infection (SSI).

SSI are divided into incisional SSI and organ/space SSI (Horan 1992). Incisional SSI are further classified into those involving only the skin and subcutaneous tissue, and those involving deep soft tissues of the incision (called deep incisional SSI (e.g. fascial and muscle layers)). Organ/space SSI involve any part of the anatomy (e.g. organs or spaces), other than the incision, that was opened or manipulated during the operative procedure (Horan 1992). The SSI concerning OS are organ/space infections.

The proportion of patients developing SSI after OS is estimated to be about 7% (Alpha 2006; Barrier 2009; Chow 2007). The pathogens most commonly associated with SSI after OS are anaerobic bacteria, which has been observed in 50% of pus samples of SSI after OS, and Streptococci, which has been observed in 43% of the cases(Chow 2007). Studies show risk factors that may be associated with a higher incidence of SSI after OS include: length of surgery; type of antibiotic prophylaxis; extraction of a third molar during surgery; number of osteotomies performed; age; smoking status; poor oral hygiene; and a compromised immune system (Alpha 2006; Barrier 2009; Cheynet 2001; Chow 2007; Fridrich 1999; Laskin 2003; Manor 1999; Theodossy 2006). SSI following orthognathic surgery can cause localized pain, swelling, surface redness (erythema), pus formation, and restricted movement. Throughout the body these infections cause fever, swollen lymph nodes (lymphadenopathy), general discomfort, toxic reactions, and an elevated white blood cell count (Topazian 2002).

A multicentered, retrospective study assessed the cost and factors influencing orthognathic surgery, in a single region in the UK. The average total treatment cost for people who experienced complications after orthognathic surgery, including infected bone plates, was EUR 6815.94; whereas the cost for those who had no complications was EUR 5962.61. The average ward stay costs were EUR 1421.49 and EUR 1295.64, respectively (Kumar 2008).

Description of the intervention

Surgical antibiotic prophylaxis is defined as the use of antibiotics to prevent infections at a surgical site (Munckhof 2005).

The original experiments to evaluate efficacy were performed 40 years ago in animal models, and concluded that the most effective period for prophylaxis is within three hours of the time at which bacteria gain access to the tissues (Burke 1961). Since then, there have been many studies in people undergoing surgery, which have resulted in a wide acceptance of antibiotic prophylaxis as a part of surgical practice (Dellinger 1994). A non-systematic review of the literature indicated that intravenous antibiotic should be given ≤30 minutes pre-operatively for all categories of surgery except caesarean section (Mangram 1999).

A classification system that ranks procedures according to their potential risk for infectious complications guides the administration of surgical antibiotic prophylaxis. This system ranks surgical procedures as clean, clean-contaminated and contaminated. In clean-contaminated surgery the respiratory, digestive or genitourinary tract is penetrated, and thus, antibiotic prophylaxis is recommended. Orthognathic surgery is classified as clean-contaminated surgery, since the upper digestive tract is penetrated (Mangram 1999, Gottrup 2005).

Although researchers in the area have investigated the effectiveness of penicillin (Jansisyanont 2008), amoxicillin (Baqain 2004), clindamycin (Baqain 2004; Lindeboom 2003), a combination of amoxicillin and clavulanic acid (Jansisyanont 2008; Zijderveld 1999), and levofloxacin and cefazolin (Yoda 2000) against placebo and/or each other, there is currently no single antibiotic regimen recommended to prevent infections after OS; there is a lack of agreement regarding type of antibiotic, and also dosing schedule.

How the intervention might work

The aim of surgical antibiotic prophylaxis is to prevent SSI (Salmeron-Escobar 2006) in patients at greatest risk of infection, and/or when a clean-contaminated surgery and implant insertions is being performed (Munckhof 2005).

The risk of infection is increased in orthognathic surgery because of the use of titanium plates and screws to fix bones together. Bacteria and other microorganisms organize in thin, but robust, layers of mucilage that adhere to the surface of implants, such as plates and screws. Consequently, implants stimulate the adherence and multiplication of microorganisms, and increase infection rates (Mangram 1999).

The role of bacterial biofilms from the surface of implants on the development of SSI is well recognized (Costerton 1999; Deacon 1996; Lee 2011; Mombelli 2011; Murdoch 2001; Peel 2011; Southwood 1985). Many experimental studies confirm the pro-inflammatory and bone-remodeling effects of toxins present on orthopaedic implant surfaces, also capable of causing osteolytic (dissolving of bone) and immune responses (Bi 2002; Greenfield 2005; Gristina 1985; Ragab 1999; Xing 2006). Therefore, it seems reasonable to believe that the oral biofilm and its toxins, adhered to the surface of the titanium plates and screws used for stabilization of maxillary osteotomy segments, could be a source of local or regional infectious complications. In consequence, antibiotic prophylaxis could be useful for preventing these infections.

Many studies show that antibiotic prophylaxis may reduce the risk of infection in orthognathic surgery, but the best regimen of administration is still not clear (Baqain 2004; Bentley 1999; Danda 2004; Fridrich 1994; Jansisyanont 2008; Lindeboom 2003). Nonetheless, two main types of regimen can be differentiated: firstly short-term antibiotic prophylaxis administered any time before or after the surgery for up to 24 hours after the surgical intervention; and secondly, long-term antibiotic prophylaxis that is continued for more than 24 hours (SIGN 2008). In patients undergoing OS, prophylaxis with broad spectrum antibiotics has been recommended (Baqain 2004; Bentley 1999; Fridrich 1994; Zijderveld 1999).

Why it is important to do this review

The usefulness, and most appropriate regimen, of antibiotic prophylaxis in orthognathic surgery is still debated. Some authors advocate that perioperative morbidity can be kept to a minimum with general surgical principles (Fridrich 1994; Laskin 2003; Waddell 1994), that prophylactic antibiotics have a questionable value in preventing infection, and that their deployment could lead to the development of super-infections (infections resistant to antibiotics) (Kunitake 1986; Peterson 1976). On the other hand, it has been reported that the use of prophylactic antibiotics may significantly reduce the postoperative infection rate after orthognathic surgery (Zijderveld 1999). There have been many attempts to determine the effects of antibiotic prophylaxis in patients undergoing orthognathic surgery (Baqain 2004; Danda 2004; Jansisyanont 2008; Zallen 1971; Zijderveld 1999), which makes it necessary to summarize the literature in a systematic review to determine the beneficial and adverse effects of antibiotic prophylaxis for orthognathic surgery, in order to provide the best evidence to clinicians.

OBJECTIVES

To assess the effects of antibiotic prophylaxis for preventing SSI in people undergoing orthognathic surgery.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled clinical trials (RCTs) of any design conducted in people undergoing orthognathic surgery. Quasi-randomized and non-randomized trials, observational studies, narrative reviews, commentaries and letters to editors will be excluded.

Types of participants

People of any age undergoing orthognathic surgery in any setting.

Types of interventions

Intervention: any type of antibiotic (penicillin and its derivatives, cephalosporins, etc.), with any regimen, or mode of administration (short-term or long term; oral, endovenous or intramuscular; pre- or peri-operative regimen).
Comparison: placebo, or another antibiotic, or another regimen of antibiotic.

Types of outcome measures

Primary outcomes

Occurance of postoperative SSI (that is infection of organs/spaces in relation with orthognathic surgery) as defined by the CDC criteria (Horan 1992), or the authors' definition of SSI. We will not differentiate between superficial and deep-incisional infection.

Secondary outcomes

- Systemic infection: defined as a systemic inflammatory response syndrome associated to a postoperative SSI consecutive to orthognathic surgery. I added it as a secondary, not primary outcome because it is very unlikely to occur. OS is a scheduled procedure, and surgeons don't perform it in patients at such high risk of infection.
- Length of hospital stay (LOS) - defined as the number of days from the day of admission to the day of discharge of the patients undergoing orthognathic surgery.
- Participant health-related quality of life (QOL): measured using a standardised generic questionnaire such as EQ-5D (EuroQol 1990), SF-36 (Ware 1992), SF-12 (Müller-Nordhorn 2004) or SF-6 (Brazier 2002) or wound-specific questionnaires such as the Cardiff wound impact schedule (Price 2004). We will not include ad hoc measures of quality of life which are unlikely to be validated and will not be common to multiple trials

- Adverse effects (e.g. gastrointestinal complications and allergic reactions due to antibiotic administration).
Gastrointestinal adverse effects will be defined as any abnormal or harmful effect in the gastrointestinal tract, related to the use of the antibiotic prophylaxis. Allergic reactions will be defined as any hypersensitive reaction of the immune system related to the use of the antibiotic prophylaxis. Information regarding any other adverse effects reported by authors of the trials will be collected.

RCTs that evaluate any of these outcomes will be included, irrespective of the scale used for assessment. If possible, outcomes will be evaluated at one week, one month and up to three months after surgery.

Search methods for identification of studies

Electronic searches

We will search the following electronic databases to identify reports of relevant randomised clinical trials:

- The Cochrane Wounds Group Specialised Register;
- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*) (Latest issue);
- Ovid MEDLINE (1948 to present);
- Ovid EMBASE (1974 to present);
- EBSCO CINAHL (1982 to present)

We will use the following search strategy in The Cochrane Central Register of Controlled Trials (CENTRAL):

#1 MeSH descriptor Orthognathic Surgery explode all trees
#2 MeSH descriptor Orthognathic Surgical Procedures explode all trees
#3 MeSH descriptor Osteotomy, Le Fort explode all trees
#4 (orthognathic NEAR/5 surg*):ti,ab,kw
#5 ((maxillary NEXT osteotom*) or "Le Fort" or (mandibular NEAR/5 osteotom*) or (vertical NEXT ramus NEXT osteotom*) or genioplast*):ti,ab,kw
#6 (#1 OR #2 OR #3 OR #4 OR #5)
#7 MeSH descriptor Antibiotic Prophylaxis explode all trees
#8 MeSH descriptor Anti-Bacterial Agents explode all trees
#9 (antibiotic* or cephalosporin* or cefazolin or cefuroxime or amoxicillin* or amoxycillin* or clindamicin or clindamycin or penicillin* or levofloxacin):ti,ab,kw
#10 (#7 OR #8 OR #9)
#11 (#6 AND #10)
We will adapt this strategy to search Ovid MEDLINE, Ovid EMBASE and EBSCO CINAHL. We will combine the Ovid MEDLINE search with the Cochrane Highly Sensitive Search Strategy for identifying randomised trials in MEDLINE: sensitivity- and precision-maximising version (2008 revision) (Lefebvre 2011). We will combine the EMBASE search with the Ovid EMBASE filter developed by the UK Cochrane Centre (Lefebvre 2011). We will combine the CINAHL searches with the trial filters developed by the Scottish Intercollegiate Guidelines Network (SIGN 2011). We will not restrict studies with respect to language, date of publication or study setting. If an article in a language other than English is identified, we will make an effort to have all relevant data extracted by a translator.
We will search the following ongoing trials databases:

- Current Controlled Trials (http://www.controlled-trials.com/);
- ClinicalTrials.gov (http://www.clinicaltrials.gov/);
- WHO International Clinical Trials Registry Platform (ICTRP) (http://www.who.int/ictrp/en/)

Searching other resources

We will examine reference lists of relevant articles that were identified by the electronic searches for other pertinent articles to include in the review. We will also search in Scholar Google in order to detect unpublished or grey literature.

To account for any delay in indexing in the electronic databases mentioned above, we will also search the last six months of the following journals:

- *Journal of Oral and Maxillofacial Surgery*;
- *International Journal of Oral and Maxillofacial Surgery*;
- *British Journal of Oral and Maxillofacial Surgery*;
- *Journal of Craniofacial Surgery*;
- *Head & Neck: Journal for the Sciences & Specialties of the Head and Neck*.

Finally, we will handsearch the last five years of the online abstract indexes of the conference proceedings of the annual meetings of the *American Association of Oral and Maxillofacial Surgeons* and the *International Association for Dental Research*.

Data collection and analysis

Selection of studies

In a first screening, the title and the abstract of all potentially relevant articles will be listed and evaluated using a pre-established selection criteria form. This process will be done independently by two review authors who will follow instructions especially designed for this stage and will be widely inclusive. All the articles selected for full text screening by either review author will be retrieved. The full text of all articles that potentially meet the eligibility criteria will be assessed independently by two review authors. Disagreements will be solved by consensus, and, if no consensus is reached, a third review author will act as arbiter. We plan to include a study flow diagram, as recommended by the PRISMA statement (Liberati 2009), to illustrate the results of all searching activity and the process of screening and selecting studies for inclusion in the review.

Data extraction and management

Two review authors will extract the data from all the selected studies independently, using a Microsoft® Excel Office for Mac 2011 standardized form created for this purpose. Discrepancies between the data will be reviewed by the two review authors and, if needed, a third review author will act as arbiter.

Assessment of risk of bias in included studies

The risk of bias of the included studies will be evaluated using the Cochrane Risk of Bias tool (Higgins 2011a). All the domains of this tool will be used (sequence generation, allocation concealment, blinding of participants, personnel and outcome, incomplete outcome data, selective outcome reporting, and other sources of bias), and the instructions published in the Cochrane Handbook will be followed for assessing each domain and for doing the evaluation of the overall risk of bias. The evaluation will be performed by two review authors independently, based on the full text of the trials. Any disagreements between the review authors will be discussed and consensus will be reached in order to classify the articles as having low, high or unclear risk of bias. Since it has been shown that blinding to author and/or affiliation of the study is not associated with the overall results of the evaluations (Moher 1999), the review authors will not be blinded to these characteristics of the trials.

Measures of treatment effect

The measures of treatment effect that will be used for evaluating the outcome in each trial will be:

- SSI: rates of infection at the surgical site will be analysed as dichotomous, risk ratio (RR) and its 95% confidence interval (CI) will be calculated. Trials should define how the presence of SSI was evaluated, and two review authors with clinical expertise will determine whether this definition is in accordance with the CDC definition.
- Systemic infection: it will be analysed as dichotomous, risk ratio (RR) and its 95% confidence interval (CI) will be calculated.
- Length of hospital stay (days): will be analysed as continuous, mean difference (MD) with 95% CI. If the data are presented as median and likely skewed we will not consider pooling.
- Adverse events: where trials report adverse events in sufficient detail (e.g. the number of participants who experienced at least one adverse event) we will analyse these data dichotomously. Where it is unclear whether the denominator is the total number of adverse events, or the number of participants, we will report these data narratively.

We will contact authors of trials that do not report outcome data appropriately. If we cannot gather enough data from the authors to pool the results; the results will be reported in tables and text.

Unit of analysis issues

No unit of analysis issues are anticipated. If cluster RCTs are included and enough data is available, we will pool the results of these trials with the ones from the other trials using the Adjusted Mantel-Haenszel test (Donald 1987).

Dealing with missing data

If data for the outcomes of interest are missing, we will contact trial authors in order to obtain the information. A standard form

will be designed to request trial authors to provide the specific data needed for the review, and the fields required will be highlighted in each case.

Each trial will be analysed with regard to missing data, and if data are judged to be missing at random (e.g., missing data does not seem to have an association with the intervention or any other patient characteristic) only the available data will be used. For dichotomous data, if data are judged not to be missing at random, we will perform a worst-case scenario analysis by assuming that missing people from groups receiving antibiotic prophylaxis had the outcome of interest and missing people from groups receiving placebo or no treatment did not have the outcome of interest . For continuous data, if data are judged not to be missing at random, imputation of the missing data and accounting for the fact that these were imputed with uncertainty (e.g. multiple imputation, simple imputation methods with adjustment to the standard error) will be performed, as recommended in the Cochrane Handbook (Higgins 2011b)

Assessment of heterogeneity

The chi-square test will be used to determine the presence of statistical heterogeneity, using a level of significance of 0.1. Quantification of inconsistency across the studies will be done using the I^2 statistic, and its interpretation will be based on *The Cochrane Collaboration* recommendations (Deeks 2011): i.e. an I^2 between 0% and 40% might be considered as unimportant heterogeneity amongst the trials; 30% to 60% might represent moderate heterogeneity; 50% to 90% might represent substantial heterogeneity; and 75% to 100% might represent considerable heterogeneity. Clinical heterogeneity will be assessed qualitatively considering patients, setting and intervention characteristics with the help of experts. Methodological heterogeneity will be evaluated using the domains of the risk of bias tool (Higgins 2011a). Exploration of heterogeneity will be based on subgroup analyses (detailed below).

Assessment of reporting biases

Efforts will be made to detect reporting biases, if possible, in accordance with the recommendations of The Cochrane Handbook for Systematic Reviews of Intervention (Sterne 2011). Outcome-reporting biases will be explored by looking for published protocols of the trials included in the systematic review. If there are more than 10 included studies, publication bias will be explored using funnel plots for all outcomes, and tested using the Egger test (Egger 1997).

Data synthesis

We will present a narrative overview of the included trials. Where appropriate, we will present meta-analyses of outcome data using RevMan 5.1. The decision to pool data in a meta-analysis will depend on the availability of outcome data and assessment of between-trial heterogeneity. For comparisons where there is no apparent clinical heterogeneity and the I^2 value is less than, or equal to, 40%, we will apply a fixed-effect model. Where there is no apparent clinical heterogeneity and the I^2 value is greater than 40%, we will apply a random-effects model.

The main findings will be presented using a Summary of Findings table (Rosenbaum 2010).

Subgroup analysis and investigation of heterogeneity

There are two factors that we anticipate could cause heterogeneity across the results of the trials and these will be explored through subgroup analyses. The number of osteotomies is the predictor of greatest interest. Based on previous findings (Chow 2007), the a priori hypothesis for this factor is that trials in which patients had a lower number of osteotomies will show a higher treatment effect in favour of antibiotic prophylaxis than trials in which patients underwent a higher number of osteotomies. Other sources of heterogeneity that will be investigated, if possible, include: mode of administration of the antibiotic, and length of surgery.

Sensitivity analysis

In a sensitivity analysis, we will exclude trials with high risk of bias. Since the allocation concealment is the most critical risk of bias domain for this review, a trial will be classified as high risk of bias if either the allocation concealment domain or two or more other domains are judged to have high risk of bias. The same criteria will be applied to classify a trial as having unclear risk of bias. Otherwise, the trial will be classified as having low risk of bias.

If there is need for data imputation, we will perform a sensitivity analysis using only the data available and compare its results with the results from the meta-analysis with imputed data.

In addition, if a meta-analysis shows a trial with an effect importantly different to the others (outlier), and this trial has clinical features that make it different from the others, a sensitivity analysis will be performed excluding it from the meta-analysis.

Assessment of the quality of the evidence

After performing all this process, we will grade the quality of the evidence (confidence in the estimates) for each outcome (postoperative SSI; LOS, QOL; adverse events) using the GRADE approach. We will used the five criteria of this approach: limitations in study design of the studies that contribute to the outcome, inconsistency, imprecision, indirectness, and publication bias (Guyatt 2008). We will include a GRADE evidence profile in the results.

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* *Indicates the major publication for the study*

HISTORY

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CONTRIBUTIONS OF AUTHORS

Romina Brignardello-Petersen drafted the methods of the review, edited the background section and edited the final version of the protocol. She will be in charge of directing the screening process and the data abstraction, doing the statistical analysis and drafting the final manuscript.

Alonso Carrasco-Labra conceived the review question and assisted with the methods section of the protocol. He will assist in the statistical analysis and drafting of the final manuscript.

Ignacio Araya and Nicolas Yanine drafted the background section. They will perform the screening process and data abstraction.

Luis Cordova and Julio Villanueva are the content experts. All aspects of the background and methodology related to the clinical application of the results is supported by their expertise. They will assist in the screening and data extraction processes.

All authors approved the final version of the protocol and they will do the same with the final manuscript.

Contributions of editorial base:

Nicky Cullum: edited the protocol; advised on methodology, interpretation and protocol content.
Liz McInnes: approved the final protocol prior to submission.
Sally Bell-Syer: coordinated the editorial process. Advised on methodology, interpretation and content. Edited and copy edited the protocol.
Ruth Foxlee: designed the search strategy and edited the search methods section.

DECLARATIONS OF INTEREST

None of the authors has any conflict of interest to declare.

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