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EVALUATION OF IMPACTED LOWER THIRD MOLARS ANGULATION EFFECT ON DENTAL ARCH CROWDING. SYSTEMATIC LITERATURE REVIEW.

Master's Thesis

Supervisor

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Kaunas, 2019

LITHUANIAN UNIVERSITY OF HEALTH SCIENCES
MEDICAL ACADEMY
FACULTY OF ODONTOLOGY
CLINIC OF ORTHODONTICS

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Master's Thesis

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(degree, name surname)

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Kaunas, 2019

EVALUATION TABLE OF THE MASTER'S THESIS OF THE TYPE OF SYSTEMIC REVIEW OF SCIENTIFIC LITERATURE

Evaluation:.....
Reviewer:.....
(scientific degree. Name and surname)
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No.	MT parts	MT evaluation aspects	Compliance with MT requirements and evaluation		
			Yes	Partially	No
1	**Summary (0.5 point)**	Is summary informative and in compliance with the thesis content and requirements?	0.3	0.1	0
2		Are keywords in compliance with the thesis essence?	0.2	0.1	0
3	**Introduction, aim and tasks (1 point)**	Are the novelty, relevance and significance of the work justified in the introduction of the thesis?	0.4	0.2	0
4		Are the problem, hypothesis, aim and tasks formed clearly and properly?	0.4	0.2	0
5		Are the aim and tasks interrelated?	0.2	0.1	0
6	**Selection criteria of the studies, search methods and strategy (3.4 points)**	Is the protocol of systemic review present?	0.6	0.3	0
7		Were the eligibility criteria of articles for the selected protocol determined (e.g., year, language, publication condition, etc.)	0.4	0.2	0
8		Are all the information sources (databases with dates of coverage, contact with study authors to identify additional studies) described and is the last search day indicated?	0.2	0.1	0
9		Is the electronic search strategy described in such a way that it could be repeated (year of search, the last search day; keywords and their combinations; number of found and selected articles according to the combinations of keywords)?	0.4	0.1	0
10		Is the selection process of studies (screening, eligibility, included in systemic review or, if applicable, included in the meta-analysis) described?	0.4	0.2	0
11		Is the data extraction method from the articles (types of investigations, participants, interventions, analysed factors, indexes) described?	0.4	0.2	0
12		Are all the variables (for which data were sought and any assumptions and simplifications made) listed and defined?	0.4	0.2	0

13		Are the methods, which were used to evaluate the risk of bias of individual studies and how this information is to be used in data synthesis, described?	0.2	0.1	0

14		Were the principal summary measures (risk ratio, difference in means) stated?	0.4	0.2	0
15	**Systemization and analysis of data (2.2 points)**	Is the number of studies screened: included upon assessment for eligibility and excluded upon giving the reasons in each stage of exclusion presented?	0.6	0.3	0
16		Are the characteristics of studies presented in the included articles, according to which the data were extracted (e.g., study size, follow-up period, type of respondents) presented?	0.6	0.3	0
17		Are the evaluations of beneficial or harmful outcomes for each study presented? (a) simple summary data for each intervention group; b) effect estimates and confidence intervals)	0.4	0.2	0
18		Are the extracted and systemized data from studies presented in the tables according to individual tasks?	0.6	0.3	0
19	**Discussion (1.4 points)**	Are the main findings summarized and is their relevance indicated?	0.4	0.2	0
20		Are the limitations of the performed systemic review discussed?	0.4	0.2	0
21		Does author present the interpretation of the results?	0.4	0.2	0
22	**Conclusions (0.5 points)**	Do the conclusions reflect the topic, aim and tasks of the Master's thesis?	0.2	0.1	0
23		Are the conclusions based on the analysed material?	0.2	0.1	0
24		Are the conclusions clear and laconic?	0.1	0.1	0
25	**References (1 point)**	Is the references list formed according to the requirements?	0.4	0.2	0
26		Are the links of the references to the text correct? Are the literature sources cited correctly and precisely?	0.2	0.1	0
27		Is the scientific level of references suitable for Master's thesis?	0.2	0.1	0
28		Do the cited sources not older than 10 years old form at least 70% of sources, and the not older than 5 years – at least 40%?	0.2	0.1	0
Additional sections, which may increase the collected number of points					
29	**Annexes**	Do the presented annexes help to understand the analysed topic?	+0.2	+0.1	0
30	**Practical**	Are the practical recommendations suggested and	+0.4	+0.2	0

	Recommen-dations	are they related to the received results?			
31		Were additional methods of data analysis and their results used and described (sensitivity analyses, meta-regression)?	+1	+0.5	0
32		Was meta-analysis applied? Are the selected statistical methods indicated? Are the results of each meta-analysis presented?	+2	+1	0
General requirements, non-compliance with which reduce the number of points					
33	**General require-ments**	Is the thesis volume sufficient (excluding annexes)?		15-20 pages (-2 points)	<15 pages (-5 points)
34		Is the thesis volume increased artificially?	-2 points	-1 point	
35		Does the thesis structure satisfy the requirements of Master's thesis?		-1 point	-2 points
36		Is the thesis written in correct language, scientifically, logically and laconically?		-0.5 point	-1 points
37		Are there any grammatical, style or computer literacy-related mistakes?	-2 points	-1 points	
38		Is text consistent, integral, and are the volumes of its structural parts balanced?		-0.2 point	-0.5 points
39		Amount of plagiarism in the thesis.	>20% (not evaluated)		
40		Is the content (names of sections and sub- sections and enumeration of pages) in compliance with the thesis structure and aims?		-0.2 point	-0.5 points
41		Are the names of the thesis parts in compliance with the text? Are the titles of sections and sub-sections distinguished logically and correctly?		-0.2 point	-0.5 points
42		Are there explanations of the key terms and abbreviations (if needed)?		-0.2 point	-0.5 points
43		Is the quality of the thesis typography (quality of printing, visual aids, binding) good?		-0.2 point	-0.5 points
***In total (maximum 10 points):**					

***Remark:** the amount of collected points may exceed 10 points.*

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SUMMARY

Objectives: The purpose of this systematic literature review was to evaluate impacted mandibular third molar angulation effect on the mandibular dental arch crowding.

Material and methods: The search of all chosen publications for the performed systematic review was done in three electronic databases including PubMed, Science Direct and Springer Link up to March 2019. Inclusion criteria were: full text articles, English language, studies only humans, patients presenting impacted mandibular third molars, studies including mandibular crowding measurements, studies not older than ten years. Study selection, risk of bias assessment, and data-extraction were performed.

Results: In total 286 scientific articles from database search was found. Out of 28 eligible full-text articles, 6 articles were included in the systematic review. In final studies included 5 articles were cross-sectional and one was longitudinal. Low to moderate level of scientific evidence was found after risk of bias assessment was done for the included studies, none of them were randomised controlled trials. Crowding of mandibular arch and impacted third molar angulation presented statistically significant differences between one another in two studies, and two studies found no statistical significant differences between the two variables. Mandibular dental arch crowding was assessed between genders where two studies found no statistically significant differences between males and females in crowding group.

Conclusions: Considering the results of the articles presented in this review, and based on the current findings, the angulation of impacted third molars had no significant effect on tooth crowding until proven by further well designed studies.

Keywords: third molars, wisdom teeth, impaction, impacted, mandibular crowding, crowding.

INTRODUCTION

The third molars have the highest impaction rate of all teeth in human dentition. [1] Tooth impaction is defined as any tooth that is being prevented to erupt into its normal functional position in the dental arch because of malocclusion, space deficiency or other obstructions. [2] Another definition provided by Peterson was that impacted teeth are those teeth that fail to erupt into the dental arch in an expected period of time. [3]

Prevalence of impaction of the third molar is being found in up to 73% of young adults in the Europe. [4] In addition, some authors also state that mandibular third molar impactions occur more frequently in females. [5]

Usually third molars are expected to erupt between the ages of 17 and 21 years. [6] It was found that the time of eruption varies between the races. For example, mandibular third molars may erupt as early as 14 years of age in Nigerians [7] and up to the age of 26 years in Europeans [5]. The average time for the eruption of mandibular third molars in males is around 3 to 6 months later than of in females. [8]

Akarslan stated, that the major causes associated with the tooth impaction are lack of space, limited skeletal growth, increased crown size and late maturation of the third molars [9]. Richardson discussed that proper mandibular third molar eruption highly depends on their favourable path of eruption. [10]

The third molar buds are angulated in mesial direction in the mandible at the time of the calcification [11]. Unsatisfactory angulation during completion of root formation may therefore be a common cause of third molar impaction. Increased tipping is also prevalent in the mandible since horizontal impactions occur in approximately 3% of mandibular cases [3].

Long term observational studies show that the patients that have not undergone orthodontic treatment still does experience proper up-righting of the mandibular third molars during early adolescence [12, 13]. Approximately 43% of third molar impactions may be classified as mesial in the mandible [3].

One of the contributing factors that may cause mandibular dental arch crowding may be the impaction of mandibular third molar. It is argued that the lack of space in dental arch may be aggravated by an impacted tooth that is pushing other teeth mesially. If this is the reason, it stands

that an erupting mesio-angularly or vertically impacted third molar with insufficient retromolar trigone space could produce greater mesial force that would aggravate the crowding. [14, 15].

One of the theories provided by Southard [16] was that proximal contact tightness of bilaterally un-erupted third molars can have influence on mandibular teeth, however they came to the conclusion that the removal of un-erupted mandibular third molars does not significantly relieve the proximal contact tightness. In support to that Okazaki [17] have concluded that an erupting third molar did not affect the total proximal contact tightness and that an increase in that may be an indication of relapse in mandibular anterior crowding.

Different conditions of third molars (presence, impaction or agenesis) have been argued to correlate or cause the crowding in the mandibular dental arch, however no clear relationships have been found [15].

The relationship between impaction and mandibular dental arch crowding has been not highly discussed between the authors and more studies about these two variables are needed for the proper assessment of the causality. Therefore the aim of this systematic review was to discuss possible impacted mandibular third molars angulation effects that are present in several studies up to this date related to the mandibular dental arch crowding.

The hypothesis of this systematic review was that impacted mandibular third molars does not cause mandibular dental arch crowding.

The main aim was to discuss the effects of impacted mandibular third molars angulation on mandibular dental arch crowding.

Tasks

1. To assess the effect of mandibular dental arch crowding in relation to impacted third molar angulation.
2. To assess the differences of mandibular dental arch crowding between males and females with retained or impacted mandibular third molars.

SELECTION CRITERIA OF THE STUDIES.
SEARCH METHODS AND STRATEGY

Materials and methods

Search strategy

The Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines were used to monitor the results for this systematic review.

An extensive online literature search up to January 5th, 2019 were conducted using three data bases: PubMed, Science Direct, Springer Link to find studies that included impacted mandibular third molars together with the presence of mandibular crowding. Moreover, references of articles that were found during reviewing process were used and manually searched.

The selection criteria of the articles was used according to PICOS question (Table 1): (population, intervention, comparison, outcome, study designs). The search results were recorded in Table 2 for better visualisation.

Specific key words included in the search were: third molar, wisdom teeth, impaction, impacted, mandibular crowding, crowding.

Table 1. PICOS table

Patient Population Problem	Individuals with at least one impacted mandibular third molar presenting mandibular arch crowding
Intervention	Retention or removal of third molars
Comparison	Impaction and angulation of third molars
Outcome	Presence or absence of crowding in mandibular arch
Study design	Randomized and non-randomized controlled trials, clinical trials, prospective and retrospective articles.

The inclusion criteria

- Studies in which impacted third molars were present
- Studies in which mandibular crowding was discussed
- Studies not older than 10 years
- Studies including humans
- English language articles
- Prospective, restrospective, cross-sectional, longitudinal, randomized studies
- Full text articles

Exclusion criteria

- Not English language articles
- Studies that involved other teeth impaction than third molars
- Patients presenting congenital disorders;
- Patients presenting Class II, Class III malocclusions.
- No full text articles.
- Case reports, animal studies, discussions, abstracts.
- Studies not on humans

Table 2. Database search table.

Keywords	Database Search	Results	Date of search
third molar AND mandibular crowding AND impacted	Science Direct	71	2018.10.05
third molar AND angulation AND impacted	Science Direct	34	2018.10.05
third molar AND angulation AND impacted	Springer Link	127	2018.10.05
third molar AND mandibular crowding AND impacted	Springer Link	86	2018.10.05
(third molars OR wisdom teeth OR impacted molars) AND (mandibular crowding OR crowding)	Pubmed	174	2019.02.01
((third molars OR wisdom teeth OR impacted molars)) AND (angulation)	Pubmed	73	2019.02.01

SYSTEMIZATION AND ANALYSIS OF DATA

The review of selected publications and data extractions were performed following PRISMA flow chart guidelines (Figure 1). The initial identification result of articles from database search was 286. The first exclusion was done according to the relevance: 15 duplicated titles and abstracts were excluded. After records were screened of the remaining 271 articles result, 243 were excluded due to insufficient required details, articles without access, articles not presenting full-text, due to language (not in English), case reports and discussion articles. 28 full-text articles were assessed as eligible. Lastly, 6 articles were included in the systematic review. A flow chart of the selection process is presented in Figure 1.

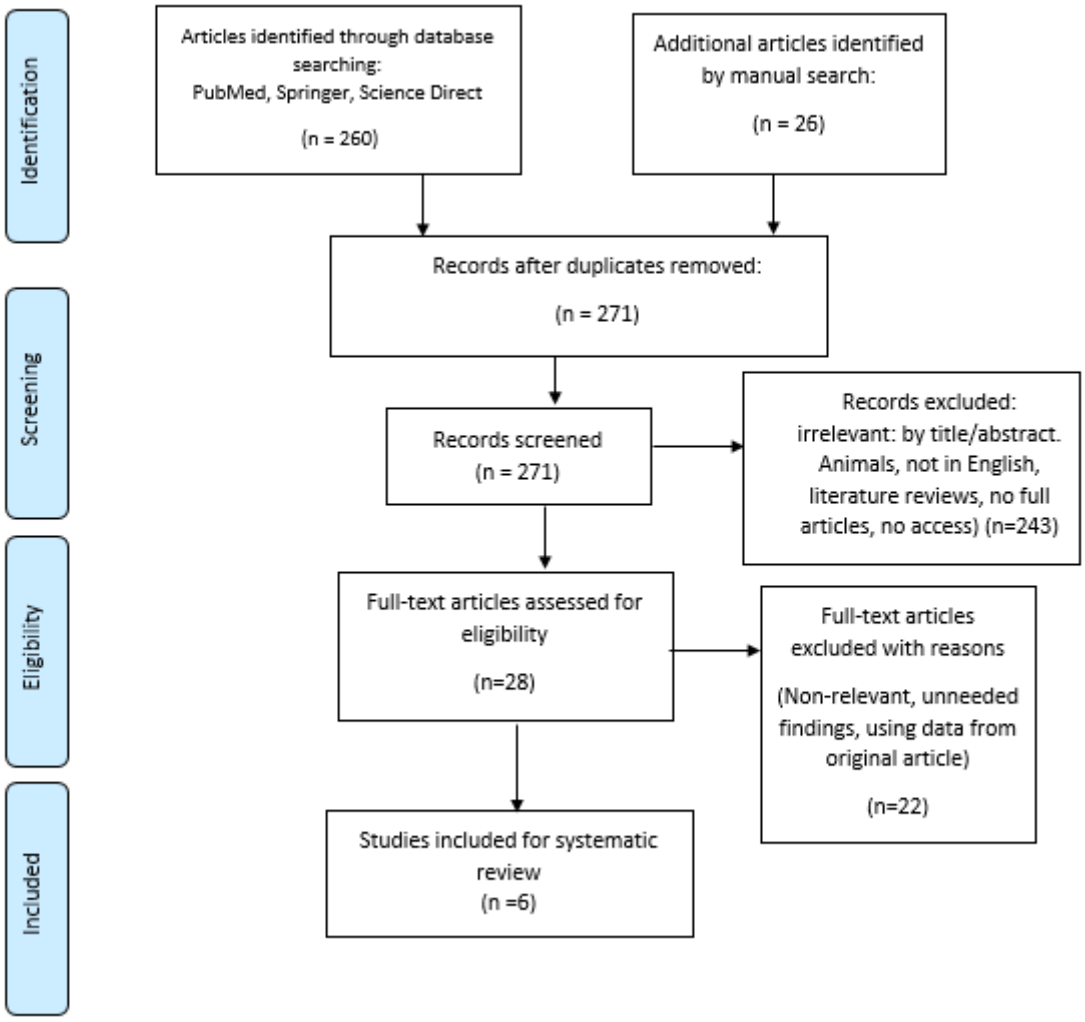

Figure 1. PRISMA flow chart for article selection

Methodological quality assessment

The quality of all included studies in this systematic review was assessed during the process of data extraction which included an evaluation of the methodological components that may had an influence on the outcome of each study selected (Table 3).

Table 3. Cochrane Risk of Bias table

	Random sequence generation and allocation concealment	**Blinding of participants and personnel**	**Blinding of outcome assessment**	**Incomplete outcome data**	**Selective reporting**	**Other bias**
Camargo 2016	?	?	?	+	+	+
Selmani 2016	?	-	?	?	+	+
Hasegawa 2013	?	-	?	+	+	-
Oksayan 2013	?	?	?	?	+	+
Lakhani 2011	?	?	?	?	+	+
Tan Chun Wei 2016	?	?	?	?	?	+

Categories: low risk of bias (+), unclear risk of bias (?), or high risk of bias (-)

The Cochrane Handbook for Systematic Reviews of Interventions was used to assess bias present in chosen studies [18].

According to the information provided in every study all possible risks of bias were classified into: low risk of bias (+), unclear risk of bias (?), or high risk of bias (-).

According to the Cochrane evaluation the selected studies have unclear risk of bias. The Cochrane evaluation for risk of bias is more appropriate for the randomized studies, however none of them were selected for this systematic review, only non-randomized (cross-sectional and longitudinal researches) were chosen. Hence most of the results were "unclear'', for a more desirable evaluation

of risks of bias additional evaluation was performed by using the methodological index for non-randomized trials (MINORS) tool with a minor modification (Annex 1) [19].

Quality assessment

Every study selected in the methodological scoring evaluation have presented moderate quality as the results show in Annex 1. Randomisation and blinding were not indicated in any of the studies.

RESULTS

Details of the measurements and characteristics of selected studies are summarized in Tables 4, 5 and 6.

Table 4. Characteristics of studies included in systematic review

Author & Year	Type of Study	Obs. Time	Number of patients	Age of patients	Analysis tools	Number (n) of impacted M3	Ortho treatment
Lakhani (2011) [21]	Cross-sectional	-	158 (45 male & 113 female)	15-28	Casts (crowd); OPG (M3 position)	n=107	Yes
Camargo (2016) [20]	Longitudinal retrospective cohort	5 – 10 years	26 (7 male & 19 female)	T0: 9-26 (14,9) T1: 14-32 (21,9)	OPG (T1 & T2) (M3 position)	n=49	Yes
Selmani (2016) [23]	Cross-sectional	-	120 (62 male and 58 female)	16-21	OPG (angul)	n=240	No
Tan Chun Wei (2016) [22]	Cross-sectional	-	54 (37 female & 17 male)	15- 25	OPG (angul); Cast (crowd);	n=108	NS
Oksayan (2013) [24]	Cross-sectional	-	48 (11 male & 37 female)	Mean 17 +/- 3.20 years	Ceph (depth) OPG (angle) Casts (crowd)	n=96	Yes
Hasegawa (2013) [25]	Cross-sectional	-	34 (20 female & 14 male)	Mean 21 (18.3-24. 1)	Ceph (angul) OPG Casts	n=68	No

Abbreviations: Obs. Time – observation time; T0 – results at the beginning of study; T1 – results at the end of the study; n – number; NS – not specified; OPG – orthopantomogram; Ceph – Cephalograms; Crowd (crowding); Angul – angulation; Ortho – Orthodontic, M3 – mandibular third molar.

Out of the six selected articles all were not older than 10 years [20-25] (Table 4). One study was longitudinal retrospective [20], five were cross-sectional studies [21, 22, 23, 24, 25]. Sample size ranged from 26 subjects (Camargo [20]) to 158 subjects (Lakhani [21]). Participant age ranged from 9 - 32 years old. In three studies subjects have undergone orthodontic treatment [20, 21, 24], two studies without orthodontic treatment [23, 25] and one not specified [22]. Analysis tools used were OPG [20-25], casts [21, 22, 24-25], cephalometric radiographs [24, 25].

Table 5. Crowding of all subjects in mandibular dental arch and most frequent mandibular third molar angulation.

Author & Year	Crowding of all subjects together	M3 angulation	Angulation measures	Crowding measures
Lakhani (2011) [21]	61%	MA=68.2 %	Winter's classification	Carey's analysis
Camargo (2016) [20]	30%	T0: MA=67.3 % T1: V=40.8%.	Winter's classification	NS
Selmani (2016) [23]	50%	M3 to MP: Right crow: 45.5° Right norm: 75.5° Left crow: 41.5° Left norm: 79°. M3 to M2: Right crow: 88.5° Right norm: 32.5° Left crow: 87.5° Left norm: 33.5°	Mean angle of M3 to MP; Mean angle of M3 to M2.	Carey's analysis
Tan Chun Wei (2016) [22]	87%	MA = 68.52%	Winter's classification	Little's index
Oksayan (2013) [24]	100%	Group 1: Right:7.28° Left: 7.98° Group 2: Right: 33.36° Left: 32.68° Group 3: Right: 30.68° Left: 28.01°	Mean angle of M3 to OP	Hayes-Nance analysis
Hasegawa (2013) [25]	59%	M3 to MP: Norm: 54.4° Crow: 64.5° M3 to OP: Norm: 50° Crow: 55.7°	Mean angle of M3 to MP; Mean angle of M3 to OP.	Little's index

Abbreviations: MP – Mandibular Plane; M3 – mandibular third molar; M2- mandibular second molar; MP – Mandibular plane; OP- occlusal plane; NS – not specified; V- vertical; MA- mesio-angular; DA – disto-angular; H –horizontal; T0 – results at the beginning of study; T1 – results at the end of the study; Norm – normal group (non-crowding); Crow – crowding group.

Angulation of impacted third molars was classified according to Winter's classification (Annex 2) in [20, 22], angulations according to vertical (V), mesio-angular (MA) , disto-angular (DA) and horizontal (H) positions in [21], mandibular third molar angulation to the base of the mandible and occlusal plane [23-25] (Table 5).

Most frequent angular position in [21] was MA (n=73); in [20] at T0: MA=67.3 % and at T1: V=40.8%; in [22] MA = 68.52% (n=74).

The mean angle was identified in three studies [23, 24, 25]. In one study [23] the angle of mandibular third molar to mandibular base was measured, and angle of mandibular third molar to mandibular second molar in crowding and in non-crowding groups. In one study [24] angle of mandibular third molar was measured in three different groups. In one study [25] mandibular third molar angle was measured in relation to mandibular plane and additionally to occlusal plane in crowding and in non-crowding groups.

One longitudinal study [20] indicated changes of impacted mandibular third molar angulations over a period of time.

Crowding was measured using Little's irregularity index [22, 25], Carey's analysis [21, 23], one not specified [20], Hayes – Nance analysis [24].

Crowding was present in 61% of subjects (n=97) in [21], 30% in [20], two studies 100% [22, 24], 59% in [25], 50% in [23].

Table 6. Crowding in mandibular dental arch between males and females with impacted or retained mandibular third molars.

Author & Year	Retention of M3	Gender differences in crowding	Results between gender
Lakhani (2011) [21]	Retained	NS	-
Camargo (2016) [20]	Extracted	NS	-
Selmani (2016) [23]	Retained	55% females; 45% males	No difference
Tan Chun Wei (2016) [22]	Retained	89% females; 82% males.	Females present more crowding
Oksayan (2013) [24]	Retained	100% in both	No difference
Hasegawa (2013) [25]	Retained	50% females; 71.43% males	No difference

Abbreviations: M3- mandibular third molar; NS- not specified.

The number of impacted mandibular third molars in two studies were 100% of total subjects with impacted mandibular molar assessed [24,25], one study (n=108) [22], one study (n=107) [21], one study 51.9% [20], not specified in one study [23] (Table 6).

Extractions of impacted third molars were performed in one study [20], and in five studies it was not done [21-25].

Mandibular crowding was categorised as absent or present [20-23, 25], mild to moderate crowding [24].

Crowding was assessed separately according to gender where 89% females and 82% males of total population presented crowding [22], 55% females and 45% males [23], 100% in both females and males [24], 50% females and 71% males [25] and in [20,21] gender differences were not assessed.

Crowding and impacted third molar angulation presented statistically significant differences between one another in two studies [20, 23], and two studies [24, 25] found no statistical significant differences between the two variables.

DISCUSSION

Mandibular third molars have been debated as one of the causative factors contributing to lower dental arch crowding that appears after permanent dentition completion during adolescent age because it is a common clinical problem with which orthodontists are facing [24, 27].

The hypothesis of present systematic review was that impacted mandibular third molars does not cause mandibular dental arch crowding. Results obtained from all the selected articles are in favour to support this statement.

Only two out of six studies [20, 23] have found statistical significant differences between the angulation of impacted mandibular third molars and crowding of mandibular dental arch and in two studies dental arch crowding was more prevalent in females than in males with impacted third molars, however no statistically significant differences were found [23,25].

Angulation of Mandibular Third Molar and Crowding

In a longitudinal study of Camargo [20] the changes were indicated of impacted mandibular third molars angulation over at least of 5 year period of time. Crowding was found in 30% in the end of follow-up period and 60.3% of third molars that initially were mesio-angulated became vertically positioned of which 40.8% were impacted. Significant correlation ($p < 0.05$) was found between dental crowding in the beginning of the study and angulation.

Similarly in study of Selmani [23] two groups of participants were assessed: one presenting dental arch crowding and another non-crowded group. 50% of participants were presenting mandibular dental arch crowding with mean age of 18.5. The angulation was assessed by measuring the angle between third molar and mandibular plane. The angle was smaller in crowded group compared to non-crowded group showing significant difference ($p<0,001$). In addition angle between third molar to second molar was higher in the crowding group than in the normal group with significant difference ($p<0,001$). The third molars in crowded group were angulated mesially. Angulation of mandibular third molars were significantly greater in patients presenting crowding.

Oksayan [24] assessed patients presenting mild to moderate crowding. He has found no statistical significant difference between left and right mandibular third molar angulation and the crowding results performed to the left and right quadrants ($p > 0.05$).

In study of Hasegawa [25] 59% had dental arch crowding. No statistically significant difference ($p>0.05$) was found between angulation of mandibular third molar and crowding measures. It is of importance to notice that the number of mandibular third molars was relatively low (n=14) and higher sample is needed for the proper assessment.

In study of Lakhani [21] crowding was present in 61% of the participants. Total of 107 impacted mandibular third molars were assessed for the position of angulation. The highest percentage 68.2% of all teeth were in mesio-angular position. No assessment of correlation between crowding and angulation was undergone.

In study of Tan Chun Wei [22], 87% of patients were presenting crowding. Most frequent angulation was in mesio-angular position with 68.5% for the whole sample. Percentage for each impaction position was given in crowded groups with vertical position presenting 90.48%, mesio-angular 83.78%, horizontal, disto-angular, bucco-lingual were 100%, however no assessment of correlation between crowding and angulation was undergone.

Crowding in Females and Males with Retained/Impacted Third Molars

One of the theories why women might present crowding more frequently than men is that males have a significantly longer and wider dental arch dimensions compared to the females. In study of Stanaitytė et al. [26] females have showed decreased values in all arch dimensions, however the differences were not statistically significant in comparison to males. This data support the results obtained in current systematic review.

In study of Selmani [23] 62 males and 58 females were assessed. Mandibular third molars were retained and 50% of patients presented dental arch crowding. Out of them, females were presenting more crowding 55% compared to the males 45%. Nevertheless to the different percentage obtained, there was no statistically significant differences found between males and females for the crowding group and non-crowded group.

Similarly in Hasegawa's study [25] 14 males and 20 females were chosen for the sample. All mandibular third molars were impacted and retained with total sample size crowding of 59%. Crowding in females 50% was smaller compared to males 71% and no significant differences were found between males and females in crowded and non-crowded group. However, a significant gender difference was seen for Little's index in both groups.

Tan Chun Wei [22] evaluated 37 females and 17 males with total of 108 impacted third molars. 89% of females and 82% of males were presenting dental crowding. However, the numbers of crowding and gender differences were not statistically assessed.

In support to the assumption that retained third molars can influence the lower arch crowding Niedzielska [27] found that subjects with retained third molars showed increase in tooth crowding in relation to the Ganss ratio (the ratio between the third molar width and the retromolar space). In addition Richardson [28] in a 5 year follow-up period have assessed patients with impacted and non-impacted third molars. She has reported, that those cases with third molars being impacted had tendency to have more tooth crowding.

Results obtained for the evaluation of impacted third molar effect on dental arch crowding between genders were not directly correlated between each in all the studies. We can only assume that the presence of retained mandibular molars might have caused the increased crowding either more in females or in males. Different study models and more clear studies should be done for the correct conclusions to be made and also to reduce any interpretation errors.

However, many of the studies included “high” and “unclear” bias scoring during the quality assessment procedure, therefore, the lack of evidence found could also be related to the low quality of the trials. Nevertheless, it must be outlined that the only study which scored highest amount of “low” bias scoring reported significant correlation ($p < 0.05$) between dental crowding in the beginning of the study and the impaction of mandibular third molar [20].

The objectivity of present systematic review is low due to lack of newly published scientific studies with similar aims, therefore clear study models are in high demand for the evaluation of the problem.

CONCLUSIONS

1. Angulated impacted mandibular third molars does not cause crowding in mandibular dental arch.
2. Impacted and retained mandibular third molars did not show significant differences in crowding compared to males and females.

PRACTICAL RECOMMENDATIONS

Wisdom teeth are the last teeth to erupt in dental arch and they are 98 % of all impacted teeth. Taking into account that there is a high prevalence of complications that they can cause the follow-up of mandibular third molar position during period of the eruption is important to prevent them if any.

Evaluation of pre-treatment radiographs and study models of the patient could facilitate in prediction of favourable mandibular third molar angulation and impaction as the highest amount of mesio-angular positions were observed in studies which not always become favourably angulated for the proper eruption.

Prediction of dental arch crowding could be assessed separately for males and females taking into account that the dimensions between genders differ.

In addition, growth and mandibular development of the arch should be followed to assess possibility of dental arch crowding, together with evaluation of retro-molar space size that is available for the mandibular third molar eruption should be taken into account.

Improvement of dental arch crowding could be facilitated by pre-molar extraction allowing more space of mandibular third molar eruption.

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ANNEXES

Annex 1: Risk of bias assessment: MINORS with modification

	Camargo 2016	Selmani 2016	Hasegawa 2013	Oksayan 2013	Lakhani 2011	Tan Chun Wei 2016
clearly stated aim	2	2	2	2	2	2
inclusion of consecutive patients	2	2	1	2	2	2
prospective collection of data	1	1	2	1	2	2
endpoints appropriate to the aim of study	2	2	2	1	2	2
unbiased assessment of the study endpoint	0	0	0	0	0	0
follow up period appropriate to the aim of the study	2	0	0	0	0	0
loss of follow up less than 5%	1	1	1	1	1	1
prospective calculation of the study size	1	1	1	1	0	0
Statistical Analysis	1	1	2	2	0	0
Total	12	10	11	10	9	9

The items scored 0 (not reported), 1 (reported but inadequate) or 2 (reported and adequate). The total ideal score = 16.

Annex 2: Winter's Classification

TYPE	**DESCRIPTION**
Vertical	Long axis of the 3rd molar parallel to the 2nd molar.
Horizontal	Long axis of the 3rd molar perpendicular to the 2nd molar.
Mesio-angular	Long axis of the 3rd molar inclined in mesial direction to 2nd molar.
Disto-angular	Long axis of the 3rd molar inclined in distal direction to 2nd molar.