Caroline Karin Michaeli

5th, OF Group 15

Two-Implant-Supported Mandibular Overdenture –

A systematic review of the most prevalent complications associated with different types of attachments

Master’s Thesis

Rimantas Ožiūnas
Lecturer, Rimantas Ožiūnas

Kaunas, 2017
Caroline Karin Michaeli

5th, OF Group 15

Apatinio žandikaulio "overdenture" plokštėlės
ant dviejų implantų –

Sisteminė apžvalga apie dažniausiaišs komplikacijas naudojant
skirtingus užraktų tipus

Master’s Thesis

Rimantas Ožiūnas

Lecturer, Rimantas Ožiūnas

Kaunas, 2017
LITHUANIAN UNIVERSITY OF HEALTH SCIENCES
MEDICAL ACADEMY
FACULTY OF ODONTOLOGY
ORTHOPEDIC CLINIC

Two-Implant-Supported Mandibular Overdenture -

A systematic review of the most prevalent complications associated with different types of attachments

Master’s Thesis

The thesis was done by student

..................................................
(signature)

..................................................
(name surname, year, group)

.......................... 20.... (day/month)

Supervisor

..................................................
(signature)

..................................................
 ....................... (degree, name surname)

.......................... 20.... (day/month)

Kaunas, 2017
### Evaluation table of the master’s thesis of the type of systematic review of scientific literature

**Evaluation:**

**Reviewer:** 

(Scientific degree, name and surname)

**Reviewing date:**

<table>
<thead>
<tr>
<th>No.</th>
<th>MT parts</th>
<th>MT evaluation aspects</th>
<th>Compliance with MT requirements and evaluation</th>
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<td>Yes</td>
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<tr>
<td>1</td>
<td>Summary</td>
<td>Is summary informative and in compliance with the thesis content and requirements?</td>
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<td>Are keywords in compliance with the thesis essence?</td>
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<td>3</td>
<td>Introduction, aim and tasks (1 point)</td>
<td>Are the novelty, relevance and significance of the work justified in the introduction of the thesis?</td>
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<td>4</td>
<td></td>
<td>Are the problem, hypothesis, aim and tasks formed clearly and properly?</td>
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<td>Are the aim and tasks interrelated?</td>
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<td>Is the protocol of systemic review present?</td>
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<td>Were the eligibility criteria of articles for the selected protocol determined (e.g., year, language, publication condition, etc.)</td>
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<td>8</td>
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<td>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?</td>
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<tr>
<td>9</td>
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<td>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)?</td>
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</tr>
<tr>
<td>10</td>
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<td>Is the selection process of studies (screening, eligibility, included in systemic review or, if applicable, included in the meta-analysis) described?</td>
<td>0.4</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Is the data extraction method from the articles (types of investigations, participants, interventions, analysed factors, indexes) described?</td>
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<td>Question</td>
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<td>Are all the variables (for which data were sought and any assumptions and simplifications made) listed and defined?</td>
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<td>Were the principal summary measures (risk ratio, difference in means) stated?</td>
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<td>15</td>
<td>Is the number of studies screened: included upon assessment for eligibility and excluded upon giving the reasons in each stage of exclusion presented?</td>
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<td><strong>Systemization and analysis of data (2.2 points)</strong></td>
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<td>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?</td>
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<tr>
<td>17</td>
<td>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)</td>
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<td>18</td>
<td>Are the extracted and systemized data from studies presented in the tables according to individual tasks?</td>
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<td>19</td>
<td><strong>Discussion (1.4 points)</strong></td>
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<td>Are the main findings summarized and is their relevance indicated?</td>
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<td>20</td>
<td>Are the limitations of the performed systemic review discussed?</td>
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<td>Does author present the interpretation of the results?</td>
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<td><strong>Conclusions (0.5 points)</strong></td>
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<td>Do the conclusions reflect the topic, aim and tasks of the Master’s thesis?</td>
<td>0.2</td>
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<td>23</td>
<td>Are the conclusions based on the analysed material?</td>
<td>0.2</td>
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<td>24</td>
<td>Are the conclusions clear and laconic?</td>
<td>0.1</td>
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<tr>
<td>25</td>
<td>Is the references list formed according to the requirements?</td>
<td>0.4</td>
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<tr>
<td>26</td>
<td>Are the links of the references to the text correct? Are the literature sources cited correctly and precisely?</td>
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<td>27</td>
<td>Is the scientific level of references suitable for Master’s thesis?</td>
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<td>28</td>
<td>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%?</td>
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<td></td>
<td><strong>Additional sections, which may increase the collected number of points</strong></td>
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<td>29</td>
<td><strong>Annexes</strong></td>
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<td>+0.1</td>
</tr>
<tr>
<td>30</td>
<td><strong>Practical Recommendations</strong></td>
<td>+0.4</td>
<td>+0.2</td>
</tr>
<tr>
<td>31</td>
<td>Were additional methods of data analysis and their results used and described (sensitivity analyses, meta-</td>
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<td>+0.5</td>
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</table>
Regression)?

<p>| | | |</p>
<table>
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<tbody>
<tr>
<td>32</td>
<td>Was meta-analysis applied? Are the selected statistical methods indicated? Are the results of each meta-analysis presented?</td>
<td>+2</td>
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</tbody>
</table>

**General requirements, non-compliance with which reduce the number of points**

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<table>
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<tbody>
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<td>33</td>
<td>Is the thesis volume sufficient (excluding annexes)?</td>
<td>15-20 pages</td>
<td>&lt;15 pages</td>
</tr>
<tr>
<td>34</td>
<td>Is the thesis volume increased artificially?</td>
<td>-2 points</td>
<td>-1 point</td>
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<tr>
<td>35</td>
<td>Does the thesis structure satisfy the requirements of Master’s thesis?</td>
<td>-1 point</td>
<td>-2 points</td>
</tr>
<tr>
<td>36</td>
<td>Is the thesis written in correct language, scientifically, logically and laconically?</td>
<td>-0.5 point</td>
<td>-1 point</td>
</tr>
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<td>37</td>
<td>Are there any grammatical, style or computer literacy-related mistakes?</td>
<td>-2 points</td>
<td>-1 points</td>
</tr>
<tr>
<td>38</td>
<td>Is text consistent, integral, and are the volumes of its structural parts balanced?</td>
<td>-0.2 point</td>
<td>-0.5 points</td>
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<tr>
<td>39</td>
<td>Amount of plagiarism in the thesis.</td>
<td>&gt;20% (not evaluated)</td>
<td></td>
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<tr>
<td>40</td>
<td>Is the content (names of sections and subsections and enumeration of pages) in compliance with the thesis structure and aims?</td>
<td>-0.2 point</td>
<td>-0.5 points</td>
</tr>
<tr>
<td>41</td>
<td>Are the names of the thesis parts in compliance with the text? Are the titles of sections and subsections distinguished logically and correctly?</td>
<td>-0.2 point</td>
<td>-0.5 points</td>
</tr>
<tr>
<td>42</td>
<td>Are there explanations of the key terms and abbreviations (if needed)?</td>
<td>-0.2 point</td>
<td>-0.5 points</td>
</tr>
<tr>
<td>43</td>
<td>Is the quality of the thesis typography (quality of printing, visual aids, binding) good?</td>
<td>-0.2 point</td>
<td>-0.5 points</td>
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</tbody>
</table>

*In total (maximum 10 points):*

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

Purpose
To analyze information about the importance, function, risk factors and complications of an implant-supported overdenture by primarily concentrating on a two-implant-supporting system and different types of attachments in the mandible in fully edentulous patients and to additionally provide dental practitioners with practical advices.

Objectives
1. To filter information about the importance of an implant-supported overdenture.
2. To analyze functional aspects of an implant-supported overdenture.
3. To deal with possible complications an implant-supported overdenture can bring with.
4. To concentrate on a two-implant-supported overdenture in the edentulous mandible.
5. To compare different attachment types (bar, ball, magnet, Locator).
6. To evaluate patient satisfaction.
7. To evaluate survival rate.

Planned methods of the review
The PubMed, PubMed Central, NCBI, Embase, Cochrane, Science Direct and Web of Science were planned to search.

The author is planning to include only articles and studies relevant to the topic by carrying out an electronic and manual search with aid of specific inclusion and exclusion criteria.

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Studies on humans</td>
<td>1. Studies on animals</td>
</tr>
<tr>
<td>2. Published in English, German</td>
<td>2. Abstracts</td>
</tr>
<tr>
<td>3. Scientific articles</td>
<td>3. Case reports</td>
</tr>
<tr>
<td>4. Original articles</td>
<td>4. Author debates</td>
</tr>
<tr>
<td>5. Two implants</td>
<td>5. Summaries</td>
</tr>
<tr>
<td>6. Not older than 10 years</td>
<td>6. Systematic review</td>
</tr>
<tr>
<td></td>
<td>7. Older than 10 years</td>
</tr>
</tbody>
</table>

Keywords: prosthodontics, denture, implant, support system, two implants, mandible, complications, attachments
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1. Abstract

**Purpose:** To analyze information about the importance, function, risk factors and complications of an implant-supported overdenture by primarily concentrating on a two-implant-supporting system and different types of attachments in the mandible in fully edentulous patients and to additionally provide dental practitioners with practical advices.

**Material and methods:** PubMed, PubMed Central, NCBI, Embase, Cochrane, Science Direct and Web of Science were searched according to the PRISMA statement by filtering human articles and using a 5- and 10-year filter, to identify qualified studies. Data based on mandibular two-implant overdentures, complications and related survival/failure rates were evaluated.

**Results:** Assessment for eligibility of full-text articles was performed for 94 articles, out of which 25 studies were included in the qualitative assessment. 19 studies were excluded, consequently six were finally included. Three out of six studies were clinical studies, one study has been considered to be a retrospective radiographic analysis, one long-term, retrospective study and one prospective randomized clinical study were included.

The most but not significant related complications were found amongst others in dehiscence, overloading, bone resorption, alveolar ridge loss and failure in anatomical overdenture construction leading to rotational movements.

**Conclusion:** Even though complications coming along with implant-supported overdentures were seen, the survival rate is still ranking between high numbers, 87,1%-100%.

Amongst the tested types of attachments (bar, ball, magnet, Locator), Locator attachments were the most successful ones, showing the lowest rate of complications. Thus, mentioned complications do not interfere with the term ‘satisfaction’.
2. Introduction

Quality of life can be affected by multiple factors, one of them, being a poor health outcome, derived from edentulism.

The majority of edentulous people are wearing conventional dentures, but those carry a lot of problems and disadvantages along with them, like patient complaints and dissatisfaction.

To overcome those problems, treatment of edentulous jaws with implants has become a well-established and approved clinical choice of treatment [Espositto M et al., 1998]. Nowadays, especially a two-implant supported overdenture for the mandible is the primary treatment method, when mostly complaining about lack of stability [Thomason JM et al., 2009].

While standard dentures, or also known as conventional complete dentures, are the most affordable option to replace a full set of teeth, they do have disadvantages that can negatively affect a patient’s quality of life.

Standard dentures often slip and shift in the mouth. They show an increased mobility instead of stability, which can be bothersome in social or public life. Since lower dentures are more mobile compared to upper ones, caused by tongue movements for example, there is a higher demand in fabrication of lower implant-supported overdentures. However, they can be placed in both jaws, upper and lower.

Conventional dentures also may force the affected person, to pay a higher attention to his diet, by focusing on eating softer foods.

Summing-up standard dentures are painful, irritating, defacing, inconvenient and unstable. Those factors could lead to serious problems over the years.

In comparison to conventional complete dentures, a two-implant supported overdenture should be more expensive [Takanashi Y et al. 2004]. As studies on implant-supported overdentures confirm, patients profit from those higher investments, since they bring more qualitative and satisfying aspects along with them, when compared to normal standard dentures.

However, seeing the financial aspect from a different angle, this method requires less implants, compared to other implant treatments, hence resulting in lower expenses, what in turn is beneficiary for the patient.
An implant-supported overdenture treatment replaces the patients missing teeth by a full dental set supported by dental implants. They manifest a high number of advantages, like not just resting on the gums and being anchored in the patients’ mouth by dental implants, leading to a decreased mobility and thus achieving an increased denture stability.

Overdentures supported by two implants in the area of the canine have been considered to be the most popular way to replace normal conventional dentures, since they present an affirmation of biomechanical success and psychological comfort [Melescanu Imre M et al. 2011].

The survival rates of implant-supported overdentures are meant to be very high. According to different studies, the number of survival after 5 years runs between 85.6% to 100% [Gotfredsen K et al. 2001].

Nevertheless, those greatly demanded overdentures supported by implants, come along with several complications, amongst others the need of component replacement, artificial tooth fracture, bone resorption, rotational movements, resin base fracture, overloading and several more.

But do those previously mentioned complications affect the highly promised success rates and the patients satisfaction?

Therefore the aim of the systematic review focuses on analyzing information about the importance, function, risk factors and complications of an implant-supported overdenture by primarily concentrating on a two-implant-supporting system and different types of attachments in the mandible in fully edentulous patients.
2.1 Purpose
To analyze information about the importance, function, risk factors and complications of an implant-supported overdenture by primarily concentrating on a two-implant-supporting system and different types of attachments in the mandible in fully edentulous patients and to additionally provide dental practitioners with practical advices.

2.2 Objectives
1. To filter information about the importance of an implant-supported overdenture.
2. To analyze functional aspects of an implant-supported overdenture.
3. To deal with possible complications an implant-supported overdenture can bring with.
4. To concentrate on a two-implant-supported overdenture in the edentulous mandible.
5. To compare different attachment types (bar, ball, magnet, Locator).
6. To evaluate patient satisfaction.
7. To evaluate survival rate.

2.3 Hypothesis
Unknown complications related to implant-supported overdentures as well as from the patient not expected risk factors, could lead to reduced patient satisfaction and reduced survival rates so that the high interest in implant-supported overdentures becomes less valuable.
3. Selection criteria of the studies, search methods and strategy

The PubMed, PubMed Central, NCBI, Embase, Cochrane, Science Direct and Web of Science were searched.

Based on data from the titles and abstracts of the retrieved studies and articles, the ones that met following inclusion criteria were selected:

1. Studies on humans
2. Published in English, German
3. Scientific articles
4. Original articles
5. Two implants
6. Not older than 10 years

Moreover articles and studies were included according to following exclusion criteria:

1. Studies on animals
2. Abstracts
3. Case reports
4. Author debates
5. Summaries
6. Systematic review
7. Older than 10 years

References of these articles and studies were screened and those related to the reviews topic were re-checked.

3.1 Structure of the review

The methodological quality of the articles and studies has to be evaluated according to the requirements of the PRISMA statement, which gives an indication about the strength of evidence that is being provided by the study, since faults in the design or scheme can result in bias.

3.2 Research in the online databases

For the research in the online-databases the keywords were chosen according to the above selected theme.
3.3 PRISMA 2017 Flow Diagram

Records identified through database searching
(see table 2-9)
(n = 8,851)

Additional records identified through other sources
(n = 0)

Records after using at least three keywords AND “Humans” filter AND “10 years” filter AND “5 years” filter
(see table 2-9)
(n = 1,933)

Records excluded at title screening
(n = 977)

Records screened
(n = 956)

Records excluded at abstract screening
(n = 862)

Full-text articles assessed for eligibility
(n = 94)

Full-text articles excluded:
1. Case reports (51)
2. Author debates (3)
3. Summaries (12)
4. Specific implant brands (3)
(n = 69)

Studies included in qualitative assessment
(n = 25)

Final amount of studies included in the systematic review
(n = 6)

Study exclusion after qualitative assessment according to:
1. Pre-defined data extraction form based on Cochrane
2. 6-point scale
(n = 19)
3.4 Results I

The first keywords used were “Prosthodontics AND Denture”. They showed 44.529 results. When using the filter “Humans”, 34.901 results were shown. After adding the time filter “10 years”, 857 hits were filtered. By changing the time filter “10 years”, into “5 years”, 1.483 scores appeared.

Table 1.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date of search</th>
</tr>
</thead>
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<td>Prosthodontics AND denture</td>
<td>No filter</td>
<td>44.529</td>
<td>22.09.2016</td>
</tr>
<tr>
<td>Prosthodontics AND denture</td>
<td>Humans</td>
<td>34.901</td>
<td>22.09.2016</td>
</tr>
<tr>
<td>Prosthodontics AND denture</td>
<td>Humans, 10 years</td>
<td>857</td>
<td>22.09.2016</td>
</tr>
<tr>
<td>Prosthodontics AND denture</td>
<td>Humans, 5 years</td>
<td>1.483</td>
<td>22.09.2016</td>
</tr>
</tbody>
</table>

After completing the first search, with only two general keywords, “Prosthodontics AND Denture”, the extent of found articles was too immense, to elaborate an accurate search. Further searches were initiated by using a third keyword (at least), to overcome this problem.
The filter “Humans” remained for the further research, since only human articles and studies were relevant for the theme.

In the next step, the keyword “Implant”, limited the research, without adding any time filter. 5.580 results were shown. When narrowing the research down, by using the filter “10 years”, 388 scores were manifested, whereas 679 scores were offered when using the filter “5 years”.

Table 2.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
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</thead>
<tbody>
<tr>
<td>Prosthodontics AND Denture AND Implant</td>
<td>Humans, 10 years</td>
<td>388</td>
<td>22.09.2016</td>
</tr>
</tbody>
</table>

Without removing the filter “Humans”, a new keyword “Support System” was added to the already existing keywords (“Prosthodontics” AND “Denture” AND “Implant”). 192 results were found without adding any time filter. By filtering the last 10 years, 26 results popped up. Filtering the last 5 years, 43 results popped up.

Table 3.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Support System</td>
<td>Humans, 10 years</td>
<td>26</td>
<td>15.10.2016</td>
</tr>
</tbody>
</table>
Once again the filter “Humans”, was not removed. The previously used keyword “Support System” has been exchanged by the keyword “Attachments”, which showed 368 results. After adding the filter “10 years”, 22 results came out, while adding a 5-year filter showed 44 results.

Table 4.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
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</thead>
<tbody>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Attachments</td>
<td>Humans, 10 years</td>
<td>22</td>
<td>15.10.2016</td>
</tr>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Attachments</td>
<td>Humans, 5 years</td>
<td>44</td>
<td>15.10.2016</td>
</tr>
</tbody>
</table>

During the following research the filter “Humans” was not removed. The keyword “Two Implants” was added, while the previous last keyword (“Attachments”) has been deleted. This procedure showed 1.322 findings. After using a time filter, “10 years” were showing 144 results, while the “5-year” filter was showing 258 results.

Table 5.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
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</thead>
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<tr>
<td>Prosthodontics AND Denture AND Implant AND Two Implants</td>
<td>Humans, 10 years</td>
<td>144</td>
<td>15.10.2016</td>
</tr>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Two Implants</td>
<td>Humans, 5 years</td>
<td>258</td>
<td>15.10.2016</td>
</tr>
</tbody>
</table>
The next research was based on the filter “Humans”. The keyword “Two Implants” remained and another keyword was added, “Mandible”. 682 results were shown, 75 results after using the filter “10 years” and 139 by using the filter “5 years”.

Table 6.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Two Implants AND Mandible</td>
<td>Humans, 10 years</td>
<td>75</td>
<td>30.11.2016</td>
</tr>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Two Implants AND Mandible</td>
<td>Humans, 5 years</td>
<td>139</td>
<td>30.11.2016</td>
</tr>
</tbody>
</table>
The upcoming research contains the keywords “Prosthodontics” AND “Denture” AND “Implant” AND “Two Implants” AND “Mandible” AND “Complications”. The filter “Humans” was repeatedly left intact for this search. 145 results were found. Again the filter “10 years”, which showed 20 results, whereas the filter “5 years” showed 47 results, modified the research.

Table 7.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
</tr>
</thead>
</table>
For the following search the filter “Humans” remained and the latest previous three keywords (“Two Implants”, “Mandible”, “Complications”) got replaced by a new word “Laboratory” as a keyword. 229 results were filtered, while only 8 results were shown after “10 years” and 20 remained after using the “5-year” filter.

Table 8.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Laboratory</td>
<td>Humans</td>
<td>229</td>
<td>22.09.2016</td>
</tr>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Laboratory</td>
<td>Humans, 10 years</td>
<td>8</td>
<td>22.09.2016</td>
</tr>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Laboratory</td>
<td>Humans, 5 years</td>
<td>20</td>
<td>22.09.2016</td>
</tr>
</tbody>
</table>

The last search was again set in motion with the “Humans” filter, using the keyword “Fabrication” this time. 333 results showed up. Filtering the past “10 years”, 8 results remained, while the past “5 years” indicated a number of 12 articles.

Table 9.

<table>
<thead>
<tr>
<th>Keywords</th>
<th>Filter</th>
<th>Results</th>
<th>Date search</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Fabrication</td>
<td>Humans, 10 years</td>
<td>8</td>
<td>22.09.2016</td>
</tr>
<tr>
<td>Prosthodontics AND Denture AND Implant AND Fabrication</td>
<td>Humans, 5 years</td>
<td>12</td>
<td>22.09.2016</td>
</tr>
</tbody>
</table>
Since the systematic reviews’ topic became too immense, the author decided to not include more than seven objectives and thus overcome the risk of making a dent of artificially extending the review. Therefore the latest used keywords “Laboratory” and “Fabrication” were no longer of importance.

According to the selected articles and studies, the researcher withdrew data referring to the year of publication (not older than 5-10 years), type of study, type of attachments, amount of implants, lower jaw dentures, fully edentulous patients, success rate, related complications and patient satisfaction.
4. Systematization and analysis of data

4.1 Data extraction and management

Data extraction for the systematic review was performed independently by the author. To record information from the articles and studies, a pre-defined data extraction form based on Cochrane was created and used by the author.

The author started the search by identifying an enormous number of articles and studies considering the issue, followed by excluding records according to eligibility criteria. By dealing primarily with the title and abstract, selected records were screened. If title and abstract were not sufficient, full text review was performed. Only articles and studies relevant to the topic were selected and included in the review. Besides that, the reviewer carried out a manual search by going through the references of the included articles.

4.2 Quality assessment of the studies

The quality of the studies was assessed by using a 6-point scale as followed: high quality, a total score of 5-6 points; medium quality 3-4 points; and low quality, a total score of 2 points or less.
4.3 Assessment of risk of bias in included studies

The articles’ and studies’ scientific quality has been assessed by using the Cochrane guide “Risk of bias“. As a part of the data extraction, the author performed the mentioned procedure independently.

Four specific domains were necessary for this review to select useful studies:

1. Random sequence generation
2. Allocation concealment
3. Incomplete outcome data
4. Selective outcome reporting

All studies were assessed by giving each domain a level of possible risk of bias (low, high, unclear). An overall study risk of bias has been evaluated as follows: a study was contemplated at a high risk of bias when at least one domain was assessed as a high risk of bias; a study was contemplated at an unclear risk of bias when at least one domain was assessed as an unclear risk of bias; a study was contemplated at a low risk of bias when all domains were assessed as a low risk of bias.

4.4 Statistical Analysis

A meta-analysis for used study results, related to the topic was planned. Assessment of heterogeneity was necessary for the author to decide whether a meta-analysis on this topic should be performed, or omitted from the review, since a meta-analysis might lead to inaccurate results easily.
4.5 Results II

When questioning and evaluating studies for heterogeneity, the author did not see any importance in undertaking a meta-analysis, since high heterogeneity result numbers were scored.

Table 11. Characteristics of included studies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study type</th>
<th>No. of patients at the beginning</th>
<th>No. of patients at the end</th>
<th>No. of implants in the mand.</th>
<th>Follow-up period</th>
<th>Jaw of OD placement</th>
<th>Attachment type</th>
<th>Main studied complications/ risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kremer U et al. (2016)</td>
<td>Retrospective radiographic analysis</td>
<td>101</td>
<td>51</td>
<td>2</td>
<td>11 ± 4,75 years</td>
<td>Mand.</td>
<td>Ball/Bar</td>
<td>Bone resorption</td>
</tr>
<tr>
<td>Cakarer S et al. (2011)</td>
<td>Clinical study</td>
<td>36</td>
<td>36</td>
<td>Unclear</td>
<td>41, 17 months</td>
<td>Max./Mand.</td>
<td>Ball/Bar/Locator</td>
<td>Replacement of attachment component, OD fracture, Implant failure, Mucosal enlargement, Attachment fracture, Peri-implantitis</td>
</tr>
<tr>
<td>Kappel S et al. (2013)</td>
<td>Prospective Randomized Clinical Study</td>
<td>78</td>
<td>46</td>
<td>2</td>
<td>3, 6, 12, 24 months</td>
<td>Mand.</td>
<td>Bar/Locator</td>
<td>Retention clip refixation, Clip change, Mand. denture relining</td>
</tr>
</tbody>
</table>

No., number; OD, overdenture; Impl., implant; Hyperpl., hyperplasia; Rel., relining; Mand., mandible; Max., maxilla; LIA, Locator implant attachment; LBA, Locator bar attachment; Loc., Locator
The above shown table represents specific characteristics of six studies that were considered as eligible for being included into the authors systematic review [Kremer U et al. 2016; Vercruyssen M et al 2010; Seo YH et al. 2016; Cakarer S et al. 201; Kimoto S et al. 2009; Kappel S et al. 2013]. As visualized, three of the selected studies have been clinical studies, one study has been a retrospective radiographic analysis, one long-term, retrospective study and one prospective randomized clinical study.

In three studies [Kremer U et al. 2016; Vercruyssen M et al 2010; Kappel S et al. 2013], the number of patients at the beginning of the study and the number of patients at the end of the study were different from each other (beginning > end). Reasons for that were amongst others death, hospitalization, medical reasons, not reachable, failed motivation, lack of bone amount and refusal of implantation.

The implant attachments used in the studies were either ball, bar, magnet or Locator attachments (Locator implant attachment, Locator bar attachment).

Ball and bar attachments were used in Kremer U et al.’s (2016) study. Vercruyssen M. et al (2010) were using ball and bar attachments as well as magnets. Locator implant attachments and Locator bar attachments were tested in Seo YH et al.’s (2016) study. The ongoing systematic review had no significant interest in bar attachments for establishing its final results, since bar attachments in this specific study [8] required more than two implants, that is why information about only Locator implant attachments were filtered.

Cakarer S et al. (2011) were using three attachment types (ball, bar, Locator), while Kimoto S et al. (2009) were working with only one type, the ball attachment. Bar and Locator attachments were implanted in Kappel S et al.’s (2013) study.

Five out of six studies were exclusively concentrating on the mandibular jaw, whereas one study [Cakarer S et al. 2011] included both jaws, mandible and maxilla. Again the author extracted information about the mandible mostly, in order to cope with the reviews purpose accurately.

Furthermore, four studies performed their analysis by using two implants. One study [Seo YH et al. 2016] used either two (Locator implant attachments) or four implants (Locator bar attachments). But since the author did not pay any attention to bar attachments, results about four inserted mandibular implants were not review relevant, what was in the purposes interest.

Each study recruited specific individuals that got placed their two implants in the mandibular symphysis area, or more precisely, in the area of each lower canine (33, 43).
5. Discussion

Several studies were compared to assess the question of unknown complications related to implant-supported overdentures as well as from the patient not expected risk factors that could lead to reduced patient satisfaction and reduced survival rates.

Vercruyssen M et al. (2010) carried out a study, concentrating on a mandibular overdenture, supported by two implants with magnet, ball or bar attachment and demonstrating outcome results, coming along with complications over 25 years.

For his study to be effective, 1051 implants were inserted, recruiting 495 patients. 28 out of 1051 implants failed before loading and 13 after loading was applied. The rest was stable over the years, what indicates a high survival rate.

Suzuki Y et al.’s (2011) study suggested comparable results. Higher implant failure rates and more complications were seen before loading was applied.

Reasons for failure before loading: smoking, immediate implant placement, dehiscence, bone quality, implant length, one-stage loading, bruxism, diabetes, history of periodontitis and implant surface type.

According to Suzuki Y et al.’s (2011) study, lack of osseointegration is considered to be an important complication factor, leading to implant failure as well (17 out of 201 inserted implants failed due to lack of osseointegration).

Karoussis IK et al. (2003) studied information about factors disturbing the denture survival rates. He concluded, that the survival rates are decreasing with increased biological irritations, especially in patients being edentulous due to chronic periodontitis influence. Other clinical studies confirmed the mentioned statement as well, such as Evian CI et al. (2004) and Mengel R et al. (2007).

Nevertheless, Vercruyssen M et al. (2010) concluded a higher failure rate (early and late) for a dehiscence complication, followed by immediate implant placement (overloading).

Mentioned possible complications in the present study, like bone quality and implant length had no mentionable effect on the decreased success rate of an implant. Vercruyssen M et al. (2010) confirmed that short implants (<8,5mm), in case of decreased bone height, are still able to achieve high success rates, due to adequate and sufficient overdenture support.
All in all, Vercruysen M et al.’s (2010) study showed a success rate of about 96% of implant-supported overdentures, after 23 years, what indicates, that associated and previously mentioned complications are less significant and mostly do not interfere with the term ‘satisfaction’. Possible factors for the huge implant survival rate could be two implants in the symphysis area and adequate follow-up procedures.

While Vercruysen M et al. (2010) mentioned complications and risk factors in a more general way, Kimoto S et al. (2009) concentrated his study on a more specific complication, rotational movements of a mandibular two-implant-supported overdenture using ball attachments.

He points out the importance of the attachments’ condition regarding to denture rotation. Stiff attachments might be a reason for rotational movements. Those movements in turn, allow food accumulations below the denture, hence leading to chewing disabilities, instability and patient dissatisfaction. Alveolar ridge loss has been mentioned to be a complication as well, producing rotational movements. Beresin VE and Schiesser FJ (1976) approved that predication.

To study information about the connection between implant-supported overdenture rotations, patient satisfaction and its associated responsible factors, 79 individuals wearing mandibular two-implant-supported overdentures and a maxillary standard conventional overdentures, were tested by Kimoto S et al. (2009).

Four classes were invented, according to which the alveolar ridge height was measured (category I >21mm; category II 16-21mm; category III 11-15mm; category IV <10mm).

42 out of 79 participants were detected of not experiencing any rotations, while 37 individuals reported a denture rotation. 16 patients had a class IV alveolar ridge height (<10mm) and therefore rotational movements, while on the other hand 12 patients of the same class did not suffer from any denture rotations after approximately 27 months.

The majority of individuals classified to category III (11-15mm), did not undergo any rotational experiences at all, even though affected patients are suffering from an increased bone resorption. But still, a connection between denture rotational movements and bone resorption has been identified.
Furthermore, some additional anatomical aspects of the overdenture itself were addressed by the study, for instance the relation between the tip of the anterior artificial teeth and the anterior inferior denture margin. The bigger the distance between those two mentioned points, the higher the rotation chance and the further the placement of the anterior mandibular teeth anteriorly to the ridge, the higher the risk for increased rotation as well. Contrary, when an increased denture length exists, the patients complaints about rotation were decreasing about 1,1 times (a longer denture means less load).

Kimoto S et al. (2009) confirmed previous observations [20,21], that there is a connection between the implant surface (matrix part) and the denture itself. An increased rigid relation produces stress. Friberg B & Jemt T (2008) were dealing with the implant surface type as well by stating an increased survival rate for eloxadized implant surfaces and a decreased survival rate for smooth or galvanized surfaces.

Kimoto S et al. (2009) concluded a high satisfaction rate among the tested patients, although 37 out of 79 implant-supported overdenture wearer experienced rotational denture movements, led to decreased chewing ability and 27 patients were in need of attachment part exchange and activation.

Complications coming along with attachments were discussed in Seo YH et al.‘s (2016) study. He performed his study to collect information about clinical findings and patient satisfaction by concentrating on Locator implant attachments and Locator bar attachments.

The ongoing systematic review had no significant interest in bar attachments for establishing its final results, since bar attachments in this specific study [8] require more than two implants, that is why information about only Locator implant attachments were filtered.

Seo YH et al. (2016) were using 16 patients for their study. 48 implants were placed. 16 Locator implant attachments were placed in eight patients (two per person). No complications were seen associated with the time of loading (between 12-48 months). Six complications were identified while using the Locator implant attachments. The Locator patrix had to be replaced in 9 out of 16 implants (> than the half).
For peri-implant inflammation, bleeding, plaque and calculus, no namable results were seen to be counted as disadvantages for Locator implant attachments.

But still, according to Heitz-Mayfield LJ (2008), periodontitis affection should be treated carefully with high precaution, since it might lead to peri-implantitis.

When comparing the tested factor ‘plaque’ to Akca et al.’s (2013) study, disagreements were found. In contrast to ball attachments, Locator attachments scored a higher percentage in plaque accumulation and bleeding. No related reasons for that were given by the author.

Altogether, Locator patrix complications had the highest hits in the current study [8]. But still, when comparing the amount of Locator patrix complications to the ones of the ball attachments, the Locators scored less, as concluded by Mackie et al. (2011).

Walton JN et al. (2001) stated a possible reason for the high numbers of patrix replacement necessity, being no parallel course of implant placement. A placement in the wrong position of an implant, might lead to an attachment system failure [27].

Only one case experienced an artificial tooth fracture, same with soft tissue hyperplasia, denture relining and cracks in the resin base, whereas five patients were suffering from sore spots.

Concluded, in spite of mentioned complications, a high rate of satisfaction was reached, considering esthetical issues, masticatory function and retentive aspects.

A different study, carried out by Cakarer S et al. (2010), was collecting information about attachments as well. They have been using ball, bar and Locator attachments.

Cakarer S et al.’s (2010) study included 36 patients on whom implants were placed over a period of five years. 8 patients out of 36 were chosen to test Locator attachments, 9 out of 36 were provided with bar attachments, while 19 out of 36 patients received ball attachments. Eight different complications have been tested on those individuals (soft tissue hyperplasia, component replacement, overdenture fractures, peri-implantitis, implant failure, hygiene problems, fracture of the attachment, abutment retention failure).
None of the mentioned complications applied to Locator attachments (0%), over a time period of five years, whereas the ball group showed a complication rate of 70.6% and the bar group a rate of 29.4%.

The main complication seen in the ball group was implant failure (4 out of 19 patients), while the one in the bar group was the replacement of an attachment component (3 out of 9 patients).

While Seo YH et al. (2016) identified 9 out of 16 cases (previously discussed study), which needed a patr ix replacement in Locator attachments, Cakarer S et al.’s (2010) surprisingly did not score a single result in the same attachment group with the same complication.

Concluding, the tested complications, attachments might have, which were tested in both studies [8,9], did not play any role in influencing the implant-supported overdenture’s success rate. Patient satisfaction has been highly achieved by the usage of Locator attachments, compared to ball and bar attachments when dealing with the studied rate of complications.

Further difficulties, such as the quality and quantity of bone and arch morphology, seem to play a more important role in affecting the implant survival rate and satisfaction [Büttel AE et al. 2009], which were partially brought up in the previous discussed studies.

Kremer U et al. (2016) induced a study, concentrating on bone quantity and quality, by questioning, if bone resorption is evenly distributed throughout the whole mandibular alveolar ridge.

Bone resorption is an important issue, caused amongst others by radical denture wearing and an incorrect distribution of loading, due to incorrect denture fitting [Campbell RL et al. 1960], leading to reduced chewing ability and food accumulation below the denture, since an increase in the distance between the alveolar ridge and denture base would be experienced, as well as rotational movements (confirmed previously by Kimoto S et al.’s (2009) study).
Kremer U et al. (2016) included 51 patients into his study for a time period of 11 ± 4.75 years. They were provided with either bar or ball attachments. Three mandibular parts were checked for bone resorption.

No signs of bone resorption after one year have been determined in the area of the mental foramen, near the inserted implant (±0). The posterior parts showed a slightly more increased bone resorption (-0.05mm to -0.06mm), whereas the distal corner of the denture flange indicated the highest amount of bone loss (-0.15mm to -0.18mm).

Kremer U et al. (2016) confirmed that bone resorption is not regularly smooth dispersed and no difference was found between the types of attachments used regarding this complication. Sennerby L et al. (1988) and Kordatzis K et al. (2003) gave a reason for less resorption in the implant area by stating that implants are able to spread the chewing force evenly throughout the mandibular bone.

A possible reason for the increased bone resorption, especially at the distal denture corner, might be the loose sitting denture base on the alveolar ridge, producing too much pressure, leading to underlying bone loss [6,29,32].

To prevent any rotational movements as well as to achieve a minimized bone resorption an adequate follow-up is needed, such as relining and rebasing of the incorrect fitting denture bases, overdenture component change, providing the patient with completely new dentures after a certain period of time, or simply using the right attachment system, such as Locator attachments, as previously discussed studies have proven [8,9,23].

All-in-one especially the distal flange of the mandibular implant-supported overdenture plays a huge role in producing bone resorption, while the area next to the implants is less susceptible to bone loss [6]. The authors’ [6] research lets the reviewer assume that additional implants in the posterior region would lead to a minimized bone resorption.

Other studies on the other hand, such as e.g. Branemark PI et al. (1977), Rosenberg ES et al. (1991) and Fugazzotto PA et al. (2001), affirmed overloading as a possible important factor, leading to implant marginal bone resorption. According to Akça K et al.’s (2013) study, in which the Locator attachment has been compared to the ball attachment, a reduced bone resorption was observed for the Locators.
Nevertheless, bone resorption had no significant influence on the high success rate and patient satisfaction [Kremer U et al. (2016) & Vercruysse M et al. (2010)].

Kappel S et al.’s (2013) prospective randomized clinical study intended to answer the question about immediate loading on two implants.

23 patients out of 46 were selected randomly to test 46 Locator attachments (two per person), while the other half was allocated to the bar group. 92 implants were inserted in total. All included individuals were provided by new mandibular implant-supported overdentures.

Five complications were observed during a mean time period of six months. Fracture of the Locator or bar, retention clip refixation, component exchange or activation, mandibular denture relining, loss of implant (three implants in two patients).

While a fracture of the Locator did not occur once, the bar group experienced one fracture. Clip activation or change was observed three times in both groups, thus being the complication with the highest rates. This was confirmed previously by Seo YH et al. (2016).

The amount of the other four mentioned complications were the same except the necessity for relining. While the bar group had two relining cases, the Locator group had only one.

A total number of five complications were seen in the Locator group, whereas the bar group portrayed seven complications.

After a 1-year observation period, the Locator group indicated a survival rate of 93.4%, while the bar group succeeded a rate of 87.1%.

In total, 23 out of 23 recruited patients were highly satisfied with their treatment outcomes using Locator attachments, whereas the bar treatment revealed a slight smaller number concerning satisfaction as well as survival.
Table 12. Risk factors and complications of included studies as an overview

The following table gives an overview of all mentioned possible risk factors and complications. Not all of the shown complications were seen amongst the tested patients but still, they could be an outcome of portrayed risk factors a patient might come along with. They need to be considered and consulted before treatment begin.

The following illustrated relations between risk factors and complications were established by the reviewer.

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Load application (early/late)</td>
<td></td>
</tr>
<tr>
<td>2. Smoking</td>
<td></td>
</tr>
<tr>
<td>3. Hygiene problems</td>
<td>3. Peri-implantitis</td>
</tr>
<tr>
<td>4. Immediate implant placement/loading</td>
<td>4. Attachment fracture, Retention clip refixation, Component exchange or activation, Denture relining, Implant loss</td>
</tr>
<tr>
<td>5. Dehiscence</td>
<td>5. Implant failure (e.g. implant instability, implant loss)</td>
</tr>
<tr>
<td>6. Poor bone quality</td>
<td>7. Abutment retention failure</td>
</tr>
<tr>
<td>8. Decreased bone quantity</td>
<td></td>
</tr>
<tr>
<td>9. Implant surface type (resilient attachments)</td>
<td></td>
</tr>
<tr>
<td>10. Alveolar ridge loss</td>
<td>10. Rotational movements → leading to food accumulation below the denture, chewing disabilities, instability</td>
</tr>
<tr>
<td>11. Incorrect laboratory denture fabrication</td>
<td></td>
</tr>
<tr>
<td>12. Implant length</td>
<td></td>
</tr>
<tr>
<td>14. Bruxism</td>
<td>14. Pressure application → leading to underlying bone resorption</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td>15. Lack of osseointegration</td>
<td>15. Implant failure (e.g. implant instability, implant loss)</td>
</tr>
<tr>
<td>17. Bleeding, Plaque, Calculus</td>
<td></td>
</tr>
<tr>
<td>18. Pressure from loose sitting denture base, Radical denture wearing, Incorrect load distribution, Bad-fitting dentures</td>
<td>18. Sore spots, Soft tissue hyperplasia, Bone resorption → Bone resorption leads to a decreased chewing ability, food accumulation below the denture, rotational movements</td>
</tr>
<tr>
<td>19. No parallel implant placement</td>
<td>19. Attachment component replacement/failure</td>
</tr>
<tr>
<td>20. Diabetes</td>
<td></td>
</tr>
</tbody>
</table>

Remark: An arrow indicates possible connections between risk factors and complications. A risk factor might lead (→) to a complication.
6. Conclusion

Due to the evaluated content of the included studies, the ongoing systematic review can conclude following:

- The most namable complications and risk factors associated with two-implant-mandibular overdentures in fully edentulous people were dehiscence, overloading, immediate loading, bone resorption, bone quality and quantity, alveolar ridge loss and failure in anatomical overdenture construction leading to rotational movements, incorrect angle of implant placement and attachment component exchange.

- The number of complications occurred was extremely low. If complications were occurring, they were arising with a low severity, thus neither influencing the satisfaction of the patients, nor the highly guaranteed survival rates. A high interest in implant-supported overdentures is persistent.

- Survival rates of implant-supported mandibular overdentures, by concentrating primarily on two inserted implants in the mandible, were ranking between 87,1% and 100% in a time period of 1 to 23 years. (Kappel S et al. (2013) concluded a Locator attachment survival rate of 93,4% and a bar attachment survival rate of 87,1% after a 1-year observation. Cakarer S et al. (2011) confirmed a Locator attachment survival rate of 100% after a time period of 5 years. No complications (0%) were applied to Locator attachments, while ball group showed a complication rate of 70,6% and the bar group a rate of 29,4%. Vercruyssen M et al (2010) achieved a rate of 96% after 23 years.).

- When comparing all types of studied attachments (bar, ball, magnet, Locator), Locator attachments were the most successful ones, showing the lowest rate of complications.
7. References


Evaluation form of the Master’s Thesis for the member of defence committee

Graduate student ______________________________ ,
of the year ______, and the group _____ of the integrated study programme of Odontology

Master’s Thesis title:
A systematic review of the most prevalent complications associated with different types of attachments.

<table>
<thead>
<tr>
<th>No.</th>
<th>MT evaluation aspects</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
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<td></td>
<td></td>
<td>Partially</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>Has the student’s presentation lasted for more than 10 minutes?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Has the student presented the main problem of the Master’s thesis, its aim and tasks?</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Has the student provided information on research methodology and main research instruments?</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Has the student presented the received results comprehensively?</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Have the visual aids been informative and easy to understand?</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Has the logical sequence of report been observed?</td>
<td></td>
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<tr>
<td>7</td>
<td>Have the conclusions been presented? Are they resulting from the results?</td>
<td></td>
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<tr>
<td>8</td>
<td>Have the practical recommendations been presented?</td>
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</tr>
<tr>
<td>9</td>
<td>Have the questions of the reviewer and commission’s members been answered correctly and thoroughly?</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Is the Master’s thesis in compliance with the essence of the selected study program?</td>
<td></td>
</tr>
</tbody>
</table>
Remarks of the member of evaluation committee of Master’s Thesis

____________________________________________________________
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Evaluation of the Master’s Thesis:

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Member of the MT evaluation committee:

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 scientif degree)  (name and surname)  (signature)
Caroline Karin Michaeli

5th, OF Group 15

- Additional Annex -

Two-Implant-Supported Mandibular Overdenture –

A systematic review of the most prevalent complications associated with different types of attachments

Kaunas, 2017
Reason for having an additional annex

At the time the author of the systematic review started to plan the work (beginning of August 2016), the author was sure that the work should be guided in the direction of fabrication (laboratory steps) of implant-supported overdentures and complications coming along with implant-supported overdentures.

For better visualization and to gain a deeper insight into attachment systems and implant-supported overdentures, the reviewer decided to fabricate an implant-supported overdenture herself. The focus was set on the following keywords:

1. Prosthodontics
2. Denture
3. Implant
4. Support system
5. Fully edentulous
6. Two implants
7. Mandible
8. Locator
9. Complications
10. Laboratory
11. Fabrication

According to those mentioned keywords, the overdenture was fabricated. A fully edentulous patient was found. Two implants were inserted in the mandibular symphysis area, or better in the area of each lower canine (33,43). Locator attachments were used.

After the laboratory work has been completed and after a long research period for eligible articles, the author realized that there is a lack in articles, or studies dealing with the desired master thesis’ topic.

Since the systematic reviews’ topic became too immense, not well-arranged and there was no relation found between the terms “Complications of implant-supported overdentures” and “Fabrication of implant-supported overdentures”, the author decided to not concentrate on the fabrication of implant-supported overdentures. Two keywords were deleted (“Laboratory” and “Fabrication”) to overcome the risk of making a dent of artificially extending the systematic review.
The reviewer was still concentrating on finding indicated articles, or studies based on the remaining keywords, according to which the denture was fabricated (prosthodontics, denture, implant, support system, fully edentulous, two implants, mandible, attachments, complications).

Deductively, after not including any laboratory part of implant-supported overdentures in the systematic review, there is still a connection seen between the fabricated overdenture and the review. Both were using the same keywords to limit their outcomes and results, except of the keyword “Locator”, which was exchanged by the keyword “Attachments”.

A laboratory fabrication in a precise and correct way leads consequently to increased survival and success rates. As cited in the author’s systematic review, incorrect denture fitting may lead to bone resorption, thus resulting in a reduced chewing ability, food accumulation below the denture and rotational movements [Kimoto S et al. 2009; Campbell RL et al. 1960].

Another important laboratory factor, mentioned in Kimoto S et al.’s (2009) study is the relation between the tip of the anterior artificial teeth and the anterior inferior denture margin. The bigger the distance between those two mentioned points, the higher the rotation chance and the further the placement of the anterior mandibular teeth anteriorly to the ridge, the higher the risk for increased rotation as well.

Contrary, when an increased denture length exists, the patients complaints about rotation were decreasing about 1,1 times (a longer denture means less load) [10].

The following project focuses on the steps of laboratory fabrication of a two-implant-supported overdenture, designed with two Locator attachments in mandibular fully edentulous patients. This additional work was performed by the author of the systematic review to gain a deeper insight into attachment systems and implant-supported overdentures as well as to relate possible complications due to better visualization, than pictures are able to provide.
Steps of laboratory fabrication of a two-implant-supported overdenture, designed with two Locator attachments in mandibular fully edentulous patients

(each step is described in form of pictures on p. 7-14)

Step 1:
The technician receives two alginate impressions (upper and lower jaw) and produces diagnostic casts out of both (soft gypsum type).

Step 2:
Since the lower jaw needs an implant-supported overdenture, he fabricates an individual tray for the dentist to take a functional impression.

Step 3:
The technician receives the functional impression with the caps inside (matrix part) which were placed by the dentist on the attachments before taking the functional impression. He screws the actual implants (patrix part) to the matrix located in the functional impression. (A second pair of implants themselves are always delivered by the implant company for technical use.)

Step 4:
The technician pours a hard gypsum model out of the functional impression (working model). After the setting of the hard gypsum, impression removal from the model follows. The matrix (caps) stays inside the impression and the implants are now located in the working model.

Step 5:
Removal of the matrix out of the impression and placement onto the patrix (attachments) located in the model.

Step 6:
Now the diagnostic cast of the upper jaw and the working model of the lower jaw have to be articulated into an articulator by the help of a bite registration the dentist took.

Step 7:
Fabrication of occlusal wax rims out of baseplate wax on the working model.
Step 8:
Plastic acrylic resin teeth alignment into occlusal wax rims (color A3 – by Vitapan). Wholes are drilled into the button of the acrylic teeth for better retention. The dental arch is arranged in static position according to upper dental arch and individualized occlusal plane. After teeth alignment is completed, their anatomy is adapted by a bur so that they will occlude properly with the upper jaw.

Step 9:
The technician sends the occlusal wax rims with the aligned teeth to the dentist for a try-on in the patient’s mouth.

Step 10:
After trying the wax implant-supported overdenture on, the wax base is changed into an acryl base. For this procedure several methods are possible. Which method is used, has to be decided by the technician independently. In this case a hot polymerization method was used by the aid of an impression like silicone.

1. The wax denture is placed back onto the working model.
2. Silicone is mixed and placed over the entire denture so that the acrylic teeth and a part of the working model are covered. The lingual wax part of the denture is kept free of any silicone.
3. Wait until the set of the silicone.
4. The silicone impression is removed from the denture.
5. Get all the acrylic teeth out of the wax rim.
6. Since wax and acryl do not bind, all the teeth and the working model have to be placed into hot water to make sure that all wax particles are molten away to prevent any bad outcomes.
7. Place each acrylic tooth onto its place on the previously taken silicone impression by fixating them using superglue.
8. Place the silicone with the fixated teeth back onto the working model and place isolating material (Isolit) on it as well as on the silicone inner part.
9. Mix the acryl (Paladur) and place it on the isolated working model, enclosing the teeth fixated to the silicone. Form the acryl with your fingers as long as it is still formable, to make space for the tongue and to not have a lot of work removing acryl after its final set.
10. Place the working cast, with the silicone and the acryl in a vacuum closed hot water pot (pressure cooker) for about 20 minutes at a temperature of 55°C for polymerization.
11. Take it out of the water and check if no free space is left.
Step 11:
The almost finished two implant-supported overdenture needs to be technically prepared by a fraise (to get its final form) and gummed.

Step 12:
Now polishing needs to be performed. Therefore wet Bimstein with brushes is used. (Bimstein allows polishing without burning the acryl).

Step 13:
After the regular polishing, a high polish should be applied by using brushes with a special high polishing paste.

Step 14:
The technician sends the finished mandibular two-implant-supported overdenture, designed with two Locator attachments to the dentist.
Each step described in pictures

Step 1:

Step 2:

Step 3:

Step 4:
Step 5:

Step 6:

Step 7:
Step 8:

Step 9:
Step 10:

1. ![Image 1]

2. ![Image 2]

3. ![Image 3]

4. ![Image 4]
Step 11:

Step 12:

Step 13:
Step 14: