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Evaluate the Efficacy and Morbidity of Biodegradable versus Titanium Osteosynthesis after Maxillofacial Trauma in Children: A Systematic Review and Meta-Analysis

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Abstract

Background and aim: the researcher decided to study the efficacy and morbidity of biodegradable versus titanium osteosynthesis after maxillofacial trauma in children through a systematic review and meta-analysis.

Method: Databases of PubMed, Scopus, Web of Science, EBSCO and Embase were searched for systematic literature between 2010 to August 2021. Newcastle-Ottawa Scale (NOS) used to assess quality of the cohort studies. For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included.95% confidence interval for risk ratio with fixed effect model and Mantel-Haenszel method were calculated. To deal with potential heterogeneity, random effects were used and I^2 showed heterogeneity. Meta-analysis was performed using Stata/MP v.16 software (The fastest version of Stata).

Result: In the initial review, duplicate studies were eliminated and abstracts of 226 studies were reviewed, the full text of 74 studies was reviewed by two authors, finally, eight studies were selected. Risk ratio of malunion (6-12 weeks follow-up) between biodegradable and titanium group was -0.67 (RR, -0.67 95% CI -3.79, 2.46); Risk ratio of infection (12 weeks follow-up) between biodegradable and titanium group was -0.53 (RR, -0.53 95% CI -1.68, 0.61). Risk ratio of Abscess (>12 weeks follow-up) between biodegradable and titanium group was 0.24 (RR, 0.24 95% CI -1.81, 2.28).

Conclusion: Based on the findings of the present meta-analysis, no significant differences were observed in the efficacy and morbidity of biodegradable versus titanium osteosynthesis after maxillofacial trauma in children.

Key words:biodegradable osteosynthesis, titanium osteosynthesis, children, maxillofacial trauma

Introduction

The gold standard used to treat maxillofacial fractures as well as orthognathic surgery are titanium osteosynthesis systems(1). Titanium osteosynthesis systems are currently the systems of choice in oral and maxillofacial surgery(2). This method also has advantages and disadvantages; touching, growth restriction, sensitivity to temperature changes, and interference with radiographic imaging

can be disadvantages(3). According to studies, about 33% of titanium plates and screws are removed(4, 5). One of the most common osteosynthesis systems is absorbable polymers such as polyDL-lactic acid. This procedure can reduce the removal of implants and therefore cost the patient less(6). It also does not have the previously reported disadvantages. Disadvantages include undesirable mechanical properties(7). In general, it is reported that biodegradable implants are removed in 17% of cases(8). Based on previous studies there is sufficient evidence to support the use or non-use of biodegradable osteosynthesis. No further comparative studies have been performed on titanium osteosynthesis and biodegradable osteosynthesis and no comprehensive results are available (9-11). Therefore, the researcher decided to study the efficacy and morbidity of biodegradable versus titanium osteosynthesis after maxillofacial trauma in children through a systematic review and meta-analysis.

Method

Databases of PubMed, Scopus, Web of Science, EBSCO and Embase were searched for systematic literature between 2010 to February 2022.Use the MeSH Database, to build searches in PubMed:
((((("Maxillofacial Injuries"[Mesh] OR "Maxillofacial Development"[Mesh] OR "Orthognathic Surgery"[Mesh] OR "Maxilla"[Mesh]) AND ("Biodegradable Plastics"[Mesh] OR "Absorbable Implants"[Mesh])) OR "Bone Plates"[Mesh]) OR "Bone Screws"[Mesh]) AND "Titanium"[Mesh]) AND "Treatment Outcome"[Mesh]) AND ("Child"[Mesh] OR "Adult Children"[Mesh] OR "Dental Care for Children"[Mesh] OR "Only Child"[Mesh]).
Key considerations PRISMA was the basis of the present study(12) and PIECO strategy to answer theresearch questions showed in Table1
.

Selection criteria

*Inclusion criteria: criteria:*biodegradable versus titanium osteosynthesis, only children, Clinical controlled trials, randomized controlled trials, and cohort studies, English language. Children with syndromic disorder, Case studies, case reports, and reviews were excluded from the study.

Table1. PICO strategy

PICO strategy	Description
P	Population: children treated for maxillofacial fractures
I	interventions: biodegradableosteosynthesis
C	Comparison: titanium osteosynthesis
O	Outcome: efficacy and morbidity

Study selection, Data Extraction and method of analysis

Studies data were reported by study, years, study design, age, and number of patients.
Newcastle-Ottawa Scale (NOS) (13) used to assessed quality of the cohort studies and case-control studies, This scale measures three dimensions (selection, comparability of cohorts and outcome) with

a total of 9 items. In the analysis, any studies with NOS scores of 1- 3, 4- 6 and 7- 9 were defined as low, medium and high quality, respectively. The quality of the randomized control trial studies included was assessed using the Cochrane Collaboration's tool(14). The scale scores for low risk was 1 and for High and unclear risk was 0. Scale scores range from 0 to 6. A higher score means higher quality.

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included.Prior to the screening, kappa statistics was carried out in order to verify the agreement level between the reviewers. The kappa values were higher than 0.80.

95% confidence interval for risk ratio with fixed effect model and Mantel-Haenszel method were calculated. To deal with potential heterogeneity, random effects were used and I^2 showed heterogeneity. I^2 values less than 50% indicate low heterogeneity and above 50% indicate moderate to high heterogeneity. Meta-analysis was performed using Stata/MP v.16 software (The fastest version of Stata).

Result

The review of the existing literature using the studied keywords, 285 studies were found. In the initial review, duplicate studies were eliminated and abstracts of 226 studies were reviewed. At this stage, 152 studies did not meet the inclusion criteria, so they were excluded, and in the second stage, the full text of 74 studies was reviewed by two authors. At this stage, 66 studies were excluded from the study due to incomplete data, inconsistency of results in a study, poor studies, lack of access to full text, inconsistent data with the purpose of the study. Finally, eight studies were selected (Figure1).

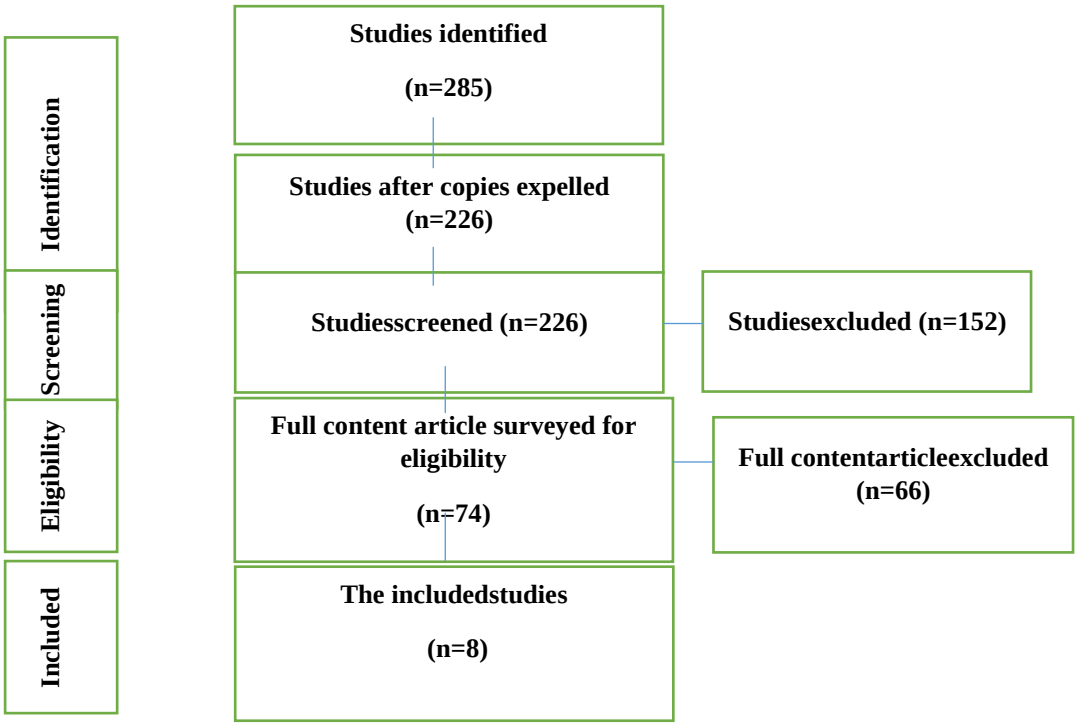

Figure 1. Study Attrition

Characteristics

Eight studies (four Retrospective, two Prospective cohort studies and two RCT studies) have been included in present article. The number of participants in biodegradable group and titanium group were 215 and 206, respectively and a total was 421 (Table2).

Table2. Studies selected for systematic review and meta-analysis.

Study. years	Study design	Sample size	groups	
			biodegradable	titanium
Kim et al., 2018 (5)	Retrospective	28	13	15
Leno et al., 2017 (11)	Prospective	44	23	21
Filinte et al., 2015 (15)	Retrospective	31	12	19
Bhatt et al., 2015 (16)	Retrospective	60	24	36
Xun-ding et al., 2015 (17)	Prospective	90	45	45
Ahmed et al.,2013 (18)	RCT	69	34	35
Buijs et al., 2012 (16)	RCT	17	8	9
Park et al., 2011 (19)	Retrospective	82	56	26

Primary endpoints

Risk ratio of Primary endpoints between biodegradable and titanium group was -0.23 (RR, -0.23 95% CI -1.30, 0.84) with low heterogeneity (I^2=0.00%; P =80); there was no statistically significant difference between two groups (Figure 2).

Subgroup meta-analysis

Risk ratio of malunion (6-12 weeks follow-up) between biodegradable and titanium group was -0.67 (RR, -0.67 95% CI -3.79, 2.46); there was no statistically significant difference between two groups (Figure 2).

Risk ratio of mobility of bone segments (6-12 weeks follow-up) between biodegradable and titanium group was 0.72 (RR, 0.72 95% CI -1.63, 3.08); there was no statistically significant difference between two groups (Figure 2).

Risk ratio of malocclusion (<4 weeks follow-up) between biodegradable and titanium group was -0.69 (RR, -0.69 95% CI -2.91, 1.53) with low heterogeneity (I^2=0.00%; P =0.99); there was no statistically significant difference between two groups (Figure 2).

Risk ratio of malocclusion (6-12 weeks follow-up) between biodegradable and titanium group was -0.33 (RR, -0.33 95% CI -2.09, 1.42) with low heterogeneity (I^2=0.00%; P =23); there was no statistically significant difference between two groups (Figure 2).

Secondary endpoints

Risk ratio of Secondary endpoints between biodegradable and titanium group was -0.36 (RR, -0.36 95% CI -1.19, 0.46) with low heterogeneity (I^2=0.00%; P =0.92); there was no statistically significant difference between two groups (Figure 3).

Risk ratio of infection (12 weeks follow-up) between biodegradable and titanium group was -0.53 (RR, -0.53 95% CI -1.68, 0.61) with low heterogeneity (I^2=0.00%; P =0.76); there was no statistically significant difference between two groups (Figure 3).

Risk ratio of Abscess (>12 weeks follow-up) between biodegradable and titanium group was 0.24 (RR, 0.24 95% CI -1.81, 2.28) with low heterogeneity (I^2=0.00%; P =0.92); there was no statistically significant difference between two groups (Figure 3).

Risk ratio of swelling (>12 weeks follow-up) between biodegradable and titanium group was 1.23 (RR, 1.23 95% CI -1.89, 4.35). There was no statistically significant difference between two groups (Figure 3).

Risk ratio of palpability of plates/screws (>12 weeks follow-up) between biodegradable and titanium group was -1.13 (RR, -1.13 95% CI -3.24, 0.98) with low heterogeneity (I^2=0.00%; P =0.71); there was no statistically significant difference between two groups (Figure 3).

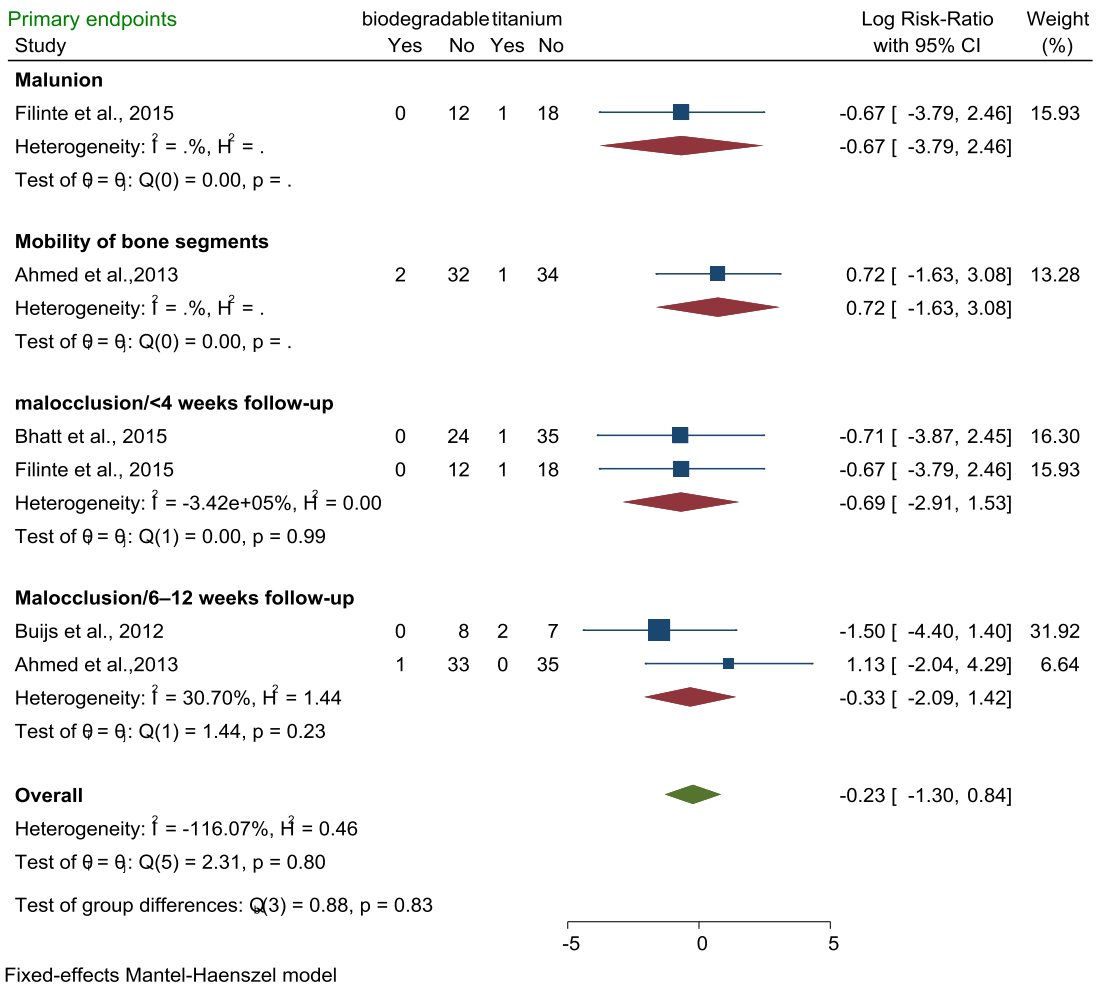

Figure2. Forest plot showed Primary endpoints between biodegradable and titanium group

Discussion

Based on the meta-analysis findings in the present study, it was found that the performance of biodegradable osteosynthesis and titanium osteosynthesis are similar in terms of malunion, malocclusion and mobility of bone segments and no statistically significant difference was observed between the two groups; The heterogeneity between the studies was so small that the results of these studies can be cited and provide sufficient evidence. The meta-analysis findings in the present study also showed that biodegradable osteosynthesis and titanium osteosynthesis are similar in terms of infection, swelling, palpability of plates and / or screws and abscess formation and no statistically

significant difference was observed between the two groups; The heterogeneity between the studies was so small that the results of these studies can be cited and provide sufficient evidence.Studies have shown that perioperative screw breakage is greater in the biodegradable osteosynthesis group than in titanium osteosynthesis; it is recommended that more studies be done in this area to provide sufficient evidence.The present study focused on objective malocclusion.

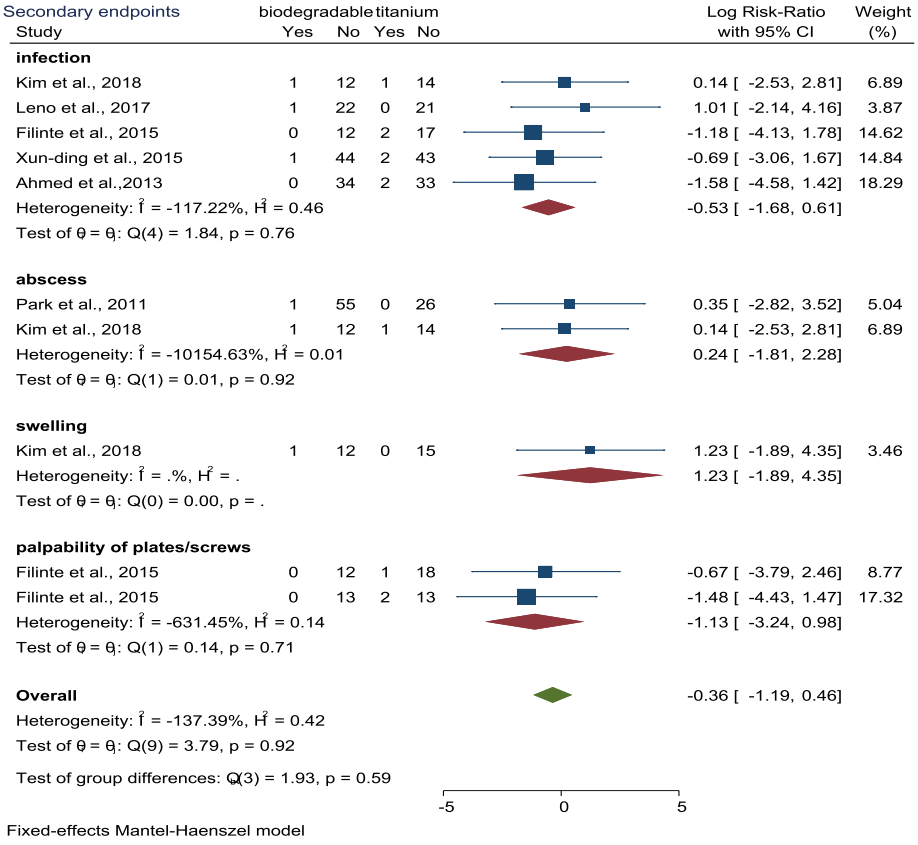

Figure3. Forest plot showed Secondary endpoints between biodegradable and titanium group

One of the key aspects of biodegradable osteosynthesis is its ability to break down and be absorbed by the human body, which may eliminate the need to remove implants in a second operation.According to studies, biodegradable osteosynthesis material is removed much less than titanium osteosynthesis material(8).Based on the findings, there was no difference between the two groups in children in terms of symptomatic plate removal; Further studies are needed to provide sufficient evidence.Thus, titanium osteosynthesis eventually leads to more reoperations compared to biodegradable osteosynthesis in children.Studies have shown that the morphology and arteries of the mandible can negatively affect the stabilization and degradation of biodegradable osteosynthesis(18, 20).Further studies should investigate the symptomatic plate removal rates in mandibular fractures compared to other facial fractures in comparison with the two groups studied(21).The follow-up period of most studies was between 6 and 24 months, a longer follow-up period is needed to provide stronger evidence.Gareb et al., 2022 (22) compared the physico-chemical properties, histological response and radiographs of four copolymeric biodegradable osteosynthesis systems in a goat model with 48-months follow-up; the result showed Nanoscale residual polymeric fragments could still be observed after 4 years. Nikparto et al., 2020 in A systematic review and meta-analysis showed

biodegradable osteosynthesis can be considered a suitable alternative to titanium osteosynthesis if used in the treatment of maxillofacial trauma(23). Gareb et al., 2020 (24) in a systematic review with meta-analysis and trial sequential analysis showed biodegradable osteosynthesis is a viable alternative to titanium osteosynthesis when applied in the treatment of maxillofacial trauma. Given the similar findings with the results of the present study, it is suggested that more RCT studies be performed in this regard.

Conclusion

Based on the findings of the present meta-analysis, no significant differences were observed in the efficacy and morbidity of biodegradable versus titanium osteosynthesis after maxillofacial trauma in children; both groups present the same findings. Further studies are needed to confirm the evidence; the quality of the studies was considered moderate to high; there was also little heterogeneity between the method and the findings.

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