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Effect of Omega-3 On Orthodontic Tooth Movement: A Systematic Review

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ABSTRACT
Orthodontic movement is a continuous and balanced process characterized by resorption and apposition of bone in areas of pressure and tension after mechanical strength forces are applied. The purpose of this systematic review was to determine the effect of omega-3 administration on orthodontic tooth movement from various studies that have been carried out previously. Search articles online using PubMed, ProQuest, Scopus, Ebscohost, and Google Scholar between 1995-2021. The keywords used were (Orthodontic tooth movement OR Orthodontic movement AND bone remodelling OR Alveolar bone remodelling OR Alveolar remodelling AND Omega 3 OR Fatty acids OR EPA DHA). A total of 530 articles were obtained and then screened using titles, abstracts, and can access full text there are 44 articles. Then by using inclusion and exclusion criteria, three full-text journals were obtained and compiled using PRISMA. These studies show that omega-3 administration affects orthodontic tooth movement. Omega 3 can slow down the movement of orthodontic teeth so that it can consider as a method of preventing relapse by giving omega-3 at the end of orthodontic treatment.

Keywords: orthodontics tooth movement; omega 3; bone remodeling; EPA DHA; arachidonic acid

INTRODUCTION
Orthodontic movement is a continuous and balanced process characterized by resorption and apposition of bone in areas of pressure and tension after mechanical strength forces are applied [1]. Alveolar bone remodelling is a key component of orthodontic tooth movement [2] consisting of two phases, the process of bone formation by osteoblast cells and bone resorption by osteoclastic cells [3]. The rate of bone resorption controls the rates of movement of the teeth, while the rate of bone formation determines the success of treatment [4]. The results of orthodontic treatment have the potential for instability that tends to return to its original position, this event is called relapse [5]. Relapsing after orthodontic treatment has the same process as orthodontic tooth movement [6].

Orthodontic relapsing is caused [7] by a long and unstable remodelling process [8]. The main regulators of the bone remodelling process during orthodontic tooth movement are three cytokines, IL-1β, IL-6, and TNF-α [9]. Cytokines are extracellular signalling proteins that are directly involved in bone remodelling in inflammatory processes [10].

Omega 3 exhibits anti-inflammatory effects by lowering levels of pro-inflammatory cytokines and pro-inflammatory mediators. Omega-3 is a polyunsaturated fatty acid consisting of eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA) [11]. Essential fatty acids especially EPA and DHA have an influence on the bone remodelling process [12].

Therefore, the purpose of this study is to summarize from existing research journals the effects of omega-3 administration on orthodontic tooth movement can be considered as one of the alternatives to prevent relapsing.

MATERIALS AND METHODS
Search Strategy and Data Extraction
The strategy used to search for journals is to use four databases (PubMed, ProQuest, Scopus, Ebscohost) and one search engine (Google Scholar). Search journals using keywords typed using free text searching and Boolean logic "(orthodontic tooth movement AND bone remodelling AND omega 3 OR fatty acids OR EPA DHA)". The PICOS (Population, Intervention, Comparison, Outcome, and Study) framework to analyze problems in the selected journals [13] then PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) was used as a reference for implementing the research protocol [14, 15]. Besides the criteria (Table 1), the selected journal can be opened full-text and has no conflict of interest.

Study Selection
Articles have obtained based on keywords were screened again based on the content of the abstract then analyzed using the inclusion and exclusion criteria contained in PICOS [16].

TABLE 1: Inclusion and exclusion criteria

PICOST *framework*	Inclusion	Exclusion
Population	Research on rodents	Research on primates and dogs
Intervetion	- Orthodontic appliances - Omega 3	- Tooth extraction, orthodontic surgery - non-omega 3
Comparison	- Control group - Treatment group (treatment 3 to 14 days)	- There is no control group - Treatment duration is less than 3 days or more than 14 days
Outcome	Orthodontic tooth movement	Other data
Study design & publicaton type	Randomied Controlled Trials (RCT), Quasi experimental	Systematic review/literature review article review/book/thesis/case report
Publishing year	1995 – 2021	before 1995
Language	English	Other language

Quality Assessment

The JBI Critical Appraisal Tool is used to assess articles quality. Articles that use RCTs design for quality assessment will use a checklist from The JBI critical appraisal tool for RCTs while using quasi-experimental will use The JBI Critical Appraisal tool for quasi-experimental studies [17].

The assessment criteria that given a score of 'yes' or 'no' or 'unclear' or 'not applicable' and each criterion with a score of 'yes' will be a value of one point and the other scores were zero, each study score calculated and added up. The assessment score obtained is at least 50% for articles included in this systematic review [16]. In the last screening, the articles used in this study were just three because the score achieved was more than 50% (Table 2).

TABLE 2: The JBI Critical Appraisal tool for RCTs and quasi-experimental studies

	Criteria (RCTs)													**Results**
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Ogrenim, et al [11]	√	√	√	√	√	√	√	√	√	√	√	√	√	13/13 (100%)
	Criteria (Quasi experimental)													
	1	2	3	4	5	6	7	8	9					
Karunia,et al [18]	√	√	√	√	√	√	√	√	√					9/9 (100%)
Iwami-Morimoto, et al [19]	√	√	√	√	√	√	√	√	√					9/9 (100%)

Data Analysis

Data analysis was done qualitatively.

RESULTS

The total data obtained based on keywords searched through databases and search engines was 530 articles from Google scholar, PubMed, ProQuest, Scopus, Ebscohost. Just three articles were selected for qualitative synthesis (systematic review).

PRISMA flow diagram shows in Figure 1. The articles were compared with each other shown in Table 3. The three articles concluded that omega 3 slowed orthodontic tooth movement. Furthermore, the full texts of these articles were analyzed resulted in 3 journals that could be used in this systematic review (Figure 1)

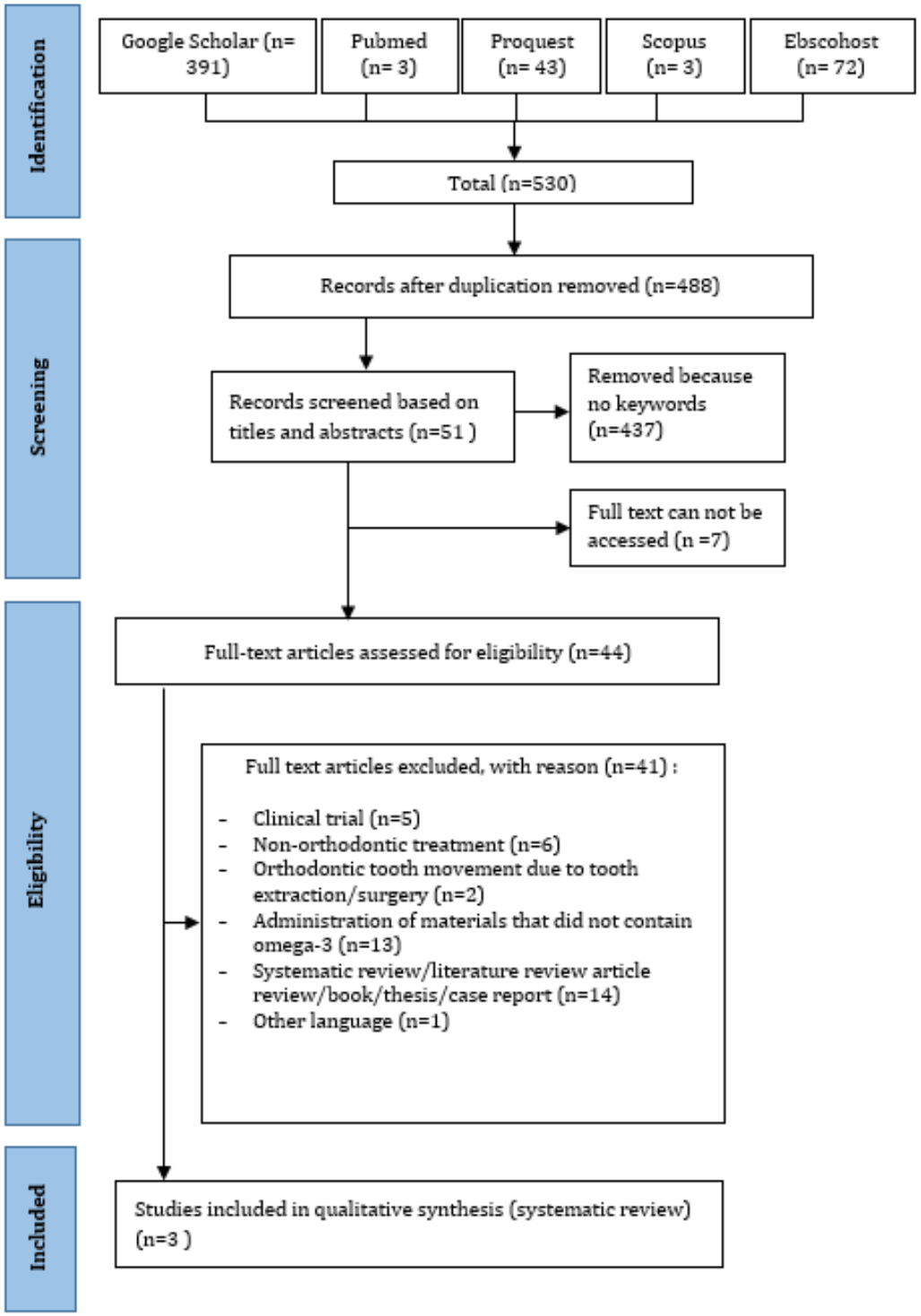

FIGURE 1: PRISMA flow diagram for this systematic review

TABLE 3: Article comparison

Author & Year	Animal	Age	N	Follow-up (days)	Group	Orthodontic appliance	Omega 3 Dose	Orthodontic tooth movement (OTM)	Conclusion
(Karunia et al, 2019) [11]	Males of New Zealand rabbits	6-8 week old	15	3,7,14	3 groups (n = 5): 1. Control group (OTM) 2. DHA- 750 mg group 3. DHA- 1500 mg group	Open coil spring	DHA (750 mg and 1500 mg)	Controls group (5.50 ± 0.21 mm) DHA- 750 mg group (4.80 ± 0.14mm) DHA-1500 mg group (4.63 ± 0.37 mm)	Dietary DHA microalgae inhibiting orthodontic tooth movement
(Ogrenim et al, 2018) [18]	Adult male Wistar albino rats	12 week old	56	3,7,14	7 groups (n=8): 1. Control group (without any treatment) Tooth movement groups 2. tooth movement group for 3 days 3. tooth movement group for 7 days 4. tooth movement group for 14 days Omega groups 5. tooth movement and omega-3 administration group for 3 days 6. tooth movement and omega-3 administration group for 7 days 7. tooth movement and omega-3 administration group for 14 days	Closed-coil springs	400mg/kg	Tooth movement group - 3 days (0.369 ±0.072) - 7 days (0.323 ±0.109) - 14 days (0.501 ±0.099) Omega group - 3 days (0.358 ±0.038) - 7 days (0.253 ±0.069) - 14 days (0.394 ±0.079)	Omega 3 fatty acids could decelerate orthodontic tooth movement by decreasing the number of osteoclasts
(Iwami-Morimoto et al, 1999) [19]	Male Wistar Strai rats	4 week old	60	0,3,7,14	8 groups: Control group (diet containing 10% corn oil) (n=30): 1. 0 day (n=6) 2. 3 days (n=8) 3. 7 days (n=8) 4. 14 days (n=8) Experimental group (diet containing 10% refined fish oil) (n=30): 5. 0 day (n=6) 6. 3 days (n=8) 7. 7 days (n=8) 8. 14 days (n=8)	Lateral expansion spring	Purified diet containing 10% refined fish oil	Day 3 - Control group (0.542±0.083 mm) - The amount of tooth movement was slightly less in fish oil group Day 7 Tooth movement in booth groups progressed relatively slowly up to 7 days Day 14 - Control group (1.082±0.170 mm) - Experimental group The amount of tooth movement in the fish oil group was significantly less than in the controls (82% and 80% at 7 and 14 days, respectively)	The amount of tooth movement in the fish oil group was 80% of that seen than in controls

DISCUSSION

This systematic review aims to identify articles that conduct research on the effects of omega 3 on orthodontic tooth movement. Following a PRISMA assessment, the total number of articles obtained are three. Two articles are quasi experimental and one RCTs design studies, it was discovered after making a selection that omega 3 research in dentistry that met the inclusion criteria was very limited.

Table 3 shows the experiments were carried out in different periods. The difference in days is due to differences in the phases of tooth movement, consisting of the initial phase, lag phase, and post lag phase [20]. The initial phase usually occurs between 24 hours to 2 days [21]. The highest increase in tooth movement occurred between the 7th and 14th days which indicated the initial phase, then decreased between the 14th and 28th days which showed the lag phase [22]. The Post lag phase is a phase where tooth movement occurs gradually or suddenly increases [23]. The tooth that has just been moved is surrounded by the newly formed osteoid bone. This uncalcified bone does not provide adequate stabilization of the teeth so contributes to relapse [24].

The use of different orthodontic appliances was also found in the articles studied, namely, in the research of Ogrenim et al [11] using closed-coil springs, in the study of Karunia et al [18] using open coil springs, while Iwami-Morimoto [19] lateral expansion springs, each device has a different function. Closed coil springs have a function as a space closure while opening coil springs are intended for opening space [25] while lateral expansion springs affect increasing the width of the dental arch and tooth spacing [26] research by Ogrenim et al [11] uses closed-coil springs, in Karunia et al [18] research uses open coil springs, while Iwami-Morimoto [19] lateral expansion springs, each device has different functions. Closed coil springs have a function as a space closure while opening coil springs are intended for opening space [25] while lateral expansion springs affect increasing the width of the dental arch and tooth spacing [26].

The doses of omega-3 from the journals used as data in this study were different, Ogrenim et al [11] used omega 3 with the same dose for the treatment group (400 mg/kg), in the study Karunia et al [18] used different doses for the treatment group. DHA (750 mg and 1500 mg), while Iwami-Morimoto et al [19] used pure fish oil. In a recent study conducted by Abou-Saleh et al [27], it was found that low doses of concentrated fish oil (CFO) with high EPA and DHA content can protect against bone loss compared to the use of high doses of regular fish oil. Fish oil-mediated beneficial effects on bone health are related to the concentration of EPA + DHA supplements.

Table 3 also shows different orthodontic tooth movements between the control group compared to the group given omega 3. The key to tooth movement is changes in arachidonic acid levels that affect bone resorption [11]. Arachidonic acid produces eicosanoids that have a role in the inflammatory process. Eicosanoids are involved in modulating the intensity and duration of the inflammatory response [28]. Omega-3 enriched diet had an inhibitory effect on OTM. Omega-3 induced changes in arachidonic acid level in alveolar bone with accompanying changes in PG levels [29]. EPA contained in omega-3 also produces eicosanoids but has different properties from eicosanoids derived from arachidonic acid [28]. EPA can also act as a substrate for both cyclooxygenase (COX) and 5-lipooxygenase (5-LOX), giving rise to eicosanoids with a slightly different structure from those formed from arachidonic acid (Figure 2) [30]. EPA and DHA also stimulate the formation of resolvin which has anti-

inflammatory properties. Resolvin D1 inhibits IL-1β production, and protectin D1 inhibits TNF and IL-1β production. The role of resolvin and related compounds is very important because it can stop the ongoing inflammatory process and limit tissue damage [28].

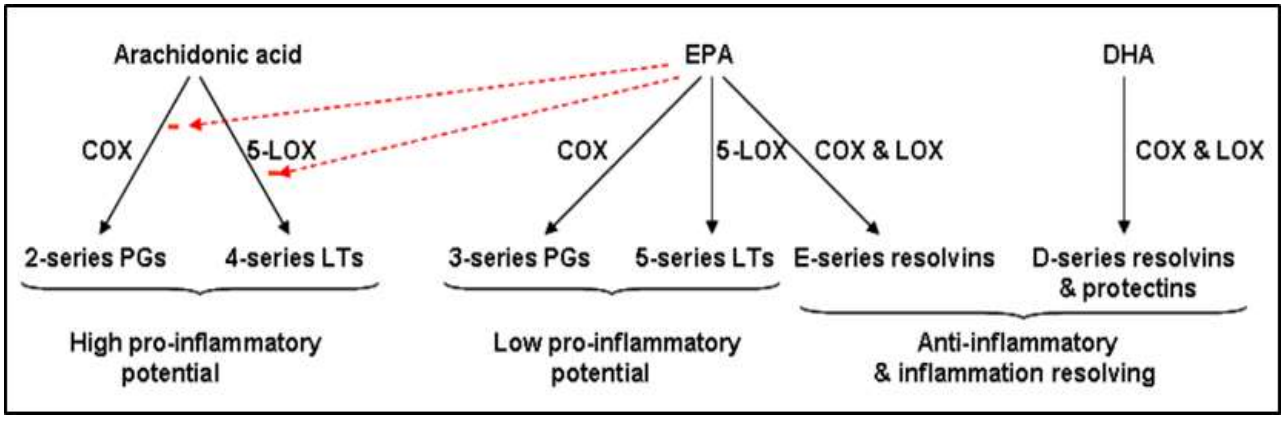

FIGURE 2: Overview of the synthesis and action of lipid mediators produced from arachidonic acid, EPA and DHA. COX, cyclooxygenase; LOX, lipoxygenase; LT, leukotrienes; PGs, prostaglandins [28].

CONCLUSION

The effect of giving omega-3 on orthodontic tooth movement showed that there was a slowing of tooth movement in the group that was given omega-3. In orthodontic treatment, giving omega-3 should be done at the end of orthodontic treatment.

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