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Evaluating the efficacy of pulsed electromagnetic field stimulation in spinal fusion and tibial fracture healing
A meta-analysis

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Αξιολόγηση της αποτελεσματικότητας της διέγερσης παλμικού ηλεκτρομαγνητικού πεδίου στη σπονδυλοδεσία και στην επούλωση κατάγματος κνήμης: Μια μετα-ανάλυση

Περίληψη στο τέλος του άρθρου

OBJECTIVE **To assess the role of pulsed electromagnetic field stimulation on spinal fusion and tibial fracture using meta-analysis approach.** METHOD **A meta-analysis study during July and August 2024 was performed. The study search strategy was performed in Embase, PubMed, and Scopus. To assess the quality of the articles, the Newcastle-Ottawa Scale and the Modified Jadad Scale were used. Data from the study were presented as counts and percentages (n [%]). We evaluated publication bias using Egger's test and a funnel plot. Heterogeneity of the data was assessed using the I^2 statistic. The primary results of the study were analyzed using the Mantel-Haenszel test, presented with odds ratio (OR) and a 95% confidence interval (CI).** RESULTS **Nineteen articles were included in this study, consisting of 13 articles on the impact of pulsed electromagnetic field stimulation on spinal fusion and 6 articles on the impact of pulsed electromagnetic field stimulation on tibial fractures. Our results revealed that the use of pulsed electromagnetic field stimulation significantly enhanced spinal fusion healing. In contrast, no significant improvement was observed regarding the use of pulsed electromagnetic field stimulation in tibial fracture healing. In the subgroup analysis by article quality, our study found that moderate-quality articles showed an impact of pulsed electromagnetic field stimulation on spinal fusion and tibial fracture healing, while high-quality articles did not.** CONCLUSIONS **This study confirms that the use of pulsed electromagnetic field stimulation has a crucial impact on spinal fusion and tibial fracture healing.**

Key words

Bone
Pulsed electromagnetic field stimulation
Spinal fusion
Tibial fracture

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Bone healing involves intricate physiological mechanisms and is the main goal of treating fractures, surgical osteotomies, and spinal fusion procedures.[1] This complex bone-healing process is usually associated with imperfect healing or even failure. Failed bone healing usually requires further interventions to be carried out.[2] These secondary interventions may impose increased pain and functional limitations on patients. Besides being invasive and costly for patients, these secondary procedures have also been reported to cause severe morbidity in many cases. In contrast, the socioeconomic burden of complications arising from failed bone healing is enormous and includes not only the costs of the treatment itself but also lost wages, lowered productivity, and delay of getting back to work.[3]

Pulsed electromagnetic field stimulation has emerged as a popular adjunct therapy for promoting bone healing across various conditions.[4] Basic science study showed that pulsed electromagnetic field stimulation can enhance bone healing by activating the calcium-calmodulin system. Several impacts have been associated with this procedure, including the upregulation of transforming growth factor-β, bone morphogenetic proteins, and other cytokines.[5] However, clinical evidence supporting the use of pulsed electromagnetic field stimulation for bone healing remains inconclusive.[6] Different supplementary therapies, including biological agents and electrical stimulation, have been recommended to promote spinal fusion.[7] Pulsed electromagnetic field stimulation is believed to increase fusion rates both directly and indirectly by enhancing bone morphogenetic proteins. As a result, it can stimulate the formation of new bone and its remodeling.[8] Furthermore, the use of pulsed electromagnetic field stimulation has been approved by the Food and Drug Administration (FDA).[9]

Following Dwyer's early report in 1974 from his clinical trial concerning the use of pulsed electromagnetic field stimulation for spinal fusion and long bone fracture healing,[10] several studies have examined this modality on clinical and or radiologic outcomes.[8,11–28] However, these trials have produced inconclusive results. To assist clinicians in assessing the best effectiveness, there is a need for an evaluation of pulsed electromagnetic field stimulation on spinal fusion and tibial fracture healing. Therefore, the aim of this study was to assess the efficacy of pulsed electromagnetic field stimulation in spinal fusion and tibial fracture healing using a meta-analysis approach.

MATERIAL AND METHOD

Design

This meta-analysis study was conducted between July and August 2024. The meta-analysis was performed by collecting data from databases to determine the effect estimate of the role of pulsed electromagnetic field stimulation in spinal fusion and tibial fracture healing. The protocol used in this meta-analysis study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist,[29] and the study protocol has also been registered at Prospero under number 576234.

Eligibility criteria

The inclusion criteria for this study encompassed articles with randomized controlled trial (RCT) designs and observational studies that specifically assessed the impact of pulsed electromagnetic field stimulation on spinal fusion and tibial fracture healing. Additionally, articles had to have complete data necessary for calculating cumulative effect estimates. Conversely, the exclusion criteria for this meta-analysis study included articles that were irrelevant based on their title and or abstract, as well as articles categorized as reviews or commentaries. Furthermore, articles of poor quality were also excluded from this study. In our present study, we assessed the quality of the articles using the Newcastle-Ottawa Scale for non-RCT articles or the Modified Jadad Scale for RCT articles.

Quality assessment

The tools used to assess the quality of articles in this meta-analysis study were the Newcastle-Ottawa Scale for non-RCT articles,[30] and the Modified Jadad Scale for RCT articles.[31] The Newcastle-Ottawa Scale evaluates several components such as selection, comparability, and exposure.[30] Meanwhile, the Modified Jadad Scale assesses aspects such as randomization, blinding, withdrawals/dropouts, eligibility criteria, adverse events, and statistical analysis.[31] The Newcastle-Ottawa Scale has a scoring range from 0 to 9. The interpretation of the Newcastle-Ottawa Scale is as follows: Scores ranging from 0 to 3 represent low quality, scores from 4 to 6 signify moderate quality, and scores between 7 and 9 indicate high quality.[30] Additionally, the Modified Jadad Scale has a scoring range from 0 to 8. The interpretation of the Modified Jadad Scale is as follows: Scores of 0–3 indicate low quality, 4–6 indicate moderate quality, and 7–8 indicate high quality.[31] The quality assessment of the articles in this meta-analysis study was conducted by FF.

Search strategy

The source databases for the search strategy in this meta-analysis study included PubMed, Embase, and Scopus. The article search was conducted up to July 25, 2024. Only articles published in English were deemed eligible for inclusion in this meta-analysis study. The key words used in our article search were "pulsed electromagnetic field stimulation" and "spinal fusion" and "tibial fracture". These key words are consistent with medical subject headings. In addition to database searches, we also conducted article searches from the references of related articles.

Data extraction

To conduct a comprehensive evaluation of the role of pulsed electromagnetic field stimulation in spinal fusion and tibial fracture healing, we extracted data from each article, including the primary author, year of publishing, country in which the study was carried out, study design, age of participants, and sample size of cases and controls. The data extraction procedure was carried out by FF.

Covariates

The predictor variable in this study was the use of pulsed electromagnetic field stimulation. Meanwhile, we defined spinal fusion and tibial fracture healing as the outcome variables. Tibial fracture healing was defined as the union of the fracture evaluated clinically and radiologically. On the other hand, we defined fusion success as the presence of bridging trabeculae, no pseudoarthrosis line, absence of correlatable pain, consolidation of the bone graft, and no failure of instrumentation. In addition, we also performed a subgroup analysis based on the quality of the articles, which were categorized into high-quality and moderate-quality articles.

Statistical analysis

In this meta-analysis study, we presented data on the union rate of tibial fracture patients and the fusion success rate in spinal fusion patients as percentages n (%). To determine whether our data had potential publication bias, we conducted data analysis using Egger's test and Funnel Plot. We determined that an Egger's p-value less than 0.05 and or an asymmetric Funnel Plot indicated potential publication bias. Furthermore, if publication bias was detected, the effect estimate calculation was adjusted using the Trim and Fill method.[32] Moreover, we evaluated data heterogeneity in this study using I squared and p-heterogeneity statistics. If heterogeneity was present, data were analyzed with a random effects model; if no heterogeneity was observed, a fixed effects model was applied.[33] The impact of the role of pulsed electromagnetic field stimulation in spinal fusion and tibial fracture healing in this study was evaluated using the Mantel-Haenszel test. A p-value lower than 0.05 signified a significant effect. The effect estimate was presented as an odds ratio (OR) with a 95% confidence interval (CI) in a Forest Plot.[34] All analyses in this study were conducted using Review Manager version 5.4 (RevMan; Cochrane; UK).

RESULTS

Article selection

In the initial article search process for this study, we identified 23,404 articles from the database and 28 articles from the references list of related articles. From this number, we excluded 23,357 articles due to irrelevant titles and or abstracts. Additionally, we excluded 16 articles because of duplication. Subsequently, we included 59 articles for full-text evaluation. Of these, 18 articles were omitted due to missing data and 22 articles were excluded because they were reviews. Finally, we determined that 19 articles were eligible to be included in our study.[8,11–28] Table 1 provides a summary of the baseline characteristics of the articles included in our study, and figure 1 illustrates the article selection process in our study.

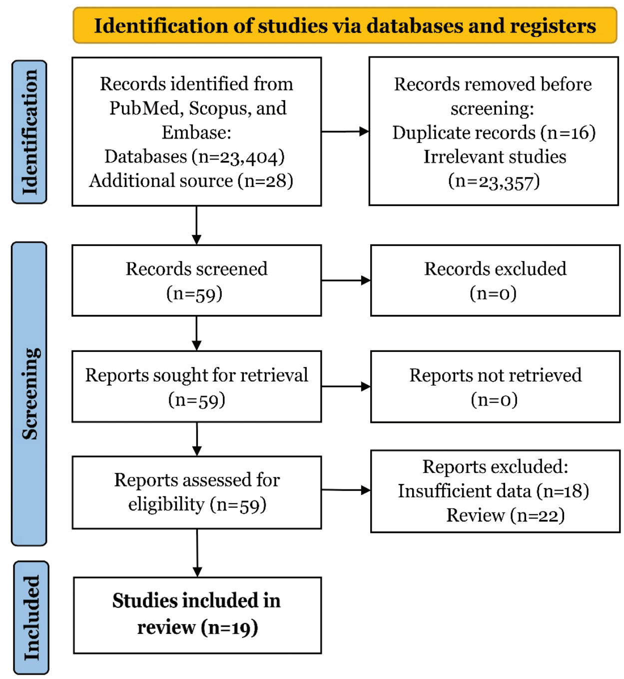

Figure 1. A flowchart of article selection in our study.

Table 1. Baseline characteristics of studies included in our analysis.

Study	Country	Design	Age (years)	Sample size	Case	Outcomes	Quality assessment
Sharrad[26]	UK	RCT	34.7±18	45	Tibial fracture	Union incidence	Moderate
Marks[19]	US	RCT	40.6±8.3	61	Spinal fusion	Fusion success	Moderate
Barker[24]	UK	RCT	≥18	16	Tibial fracture	Union incidence	Moderate
Coric[8]	US	Retrospective	54.9±12.9	309	Spinal fusion	Fusion success	Moderate
Simonis[28]	UK	RCT	32.0±16.0	34	Tibial fracture	Union incidence	Moderate
Cheaney[12]	US	Retrospective	57.5±13.9	36	Spinal fusion	Union incidence	High
Andersen[11]	Denmark	RCT	68.9 (59–80)	95	Spinal fusion	Fusion success	High
Foley[13]	US	RCT	18–75	240	Spinal fusion	Fusion success	High
Shi[27]	China	RCT	41.1±14.5	58	Tibial fracture	Union rate	High
Adie[23]	Australia	RCT	38.5±12.3	204	Tibial fracture	Union rate	High
Goodwin[14]	US	RCT	45.0±15.3	179	Spinal fusion	Fusion success	Moderate
Mooney[21]	Canada	RCT	37.9±14.2	117	Spinal fusion	Fusion success	High
Kane[16]	US	RCT	NA	59	Spinal fusion	Fusion success	Moderate
Kucharzyk[17]	US	RCT	54.1±12.8	130	Spinal fusion	Fusion success	Moderate
Meril[20]	US	RCT	39.3±15.1	225	Spinal fusion	Fusion success	Moderate
Scott[25]	UK	RCT	NA	21	Tibial fracture	Union rate	Moderate
Jenis[15]	US	RCT	NA	61	Spinal fusion	Fusion success	Moderate
Linovitz[18]	US	RCT	57.2±17.6	201	Spinal fusion	Fusion success	Moderate
Rogozinski[22]	US	RCT	41.5±14.7	94	Spinal fusion	Fusion success	Moderate

RCT: Randomized controlled trial, UK: United Kingdom, US: United States, NA: Not available

The impact of pulsed electromagnetic field stimulation in spinal fusion

We collected data from 13 articles to assess the effect of pulsed electromagnetic field stimulation on spinal fusion.[8,11–22] Our data showed that the use of pulsed electromagnetic field stimulation had a positive impact on fusion success, with an OR of 2.63 compared to patients not receiving pulsed electromagnetic field stimulation (OR: 2.63; 95% CI: 2.06, 3.36; Egger's p-value: 0.1501; I^2: 44%; $p<0.0001$) (fig. 2A). In the subgroup analysis, data from high-quality articles indicated that the use of pulsed electromagnetic field stimulation had no significant impact on spinal fusion (OR: 1.63; 95% CI: 0.58–4.60; Egger's p-value: 0.4887; I^2: 75%; $p=0.3600$) (fig. 2B). In contrast, data from moderate-quality articles showed that pulsed electromagnetic field stimulation was associated with a 3.23-fold increase in the likelihood of fusion success compared to the control (OR: 3.23; 95% CI: 2.38–4.38; Egger's p-value: 0.1117; I^2: 0%; $p<0.0001$) (fig. 2C).

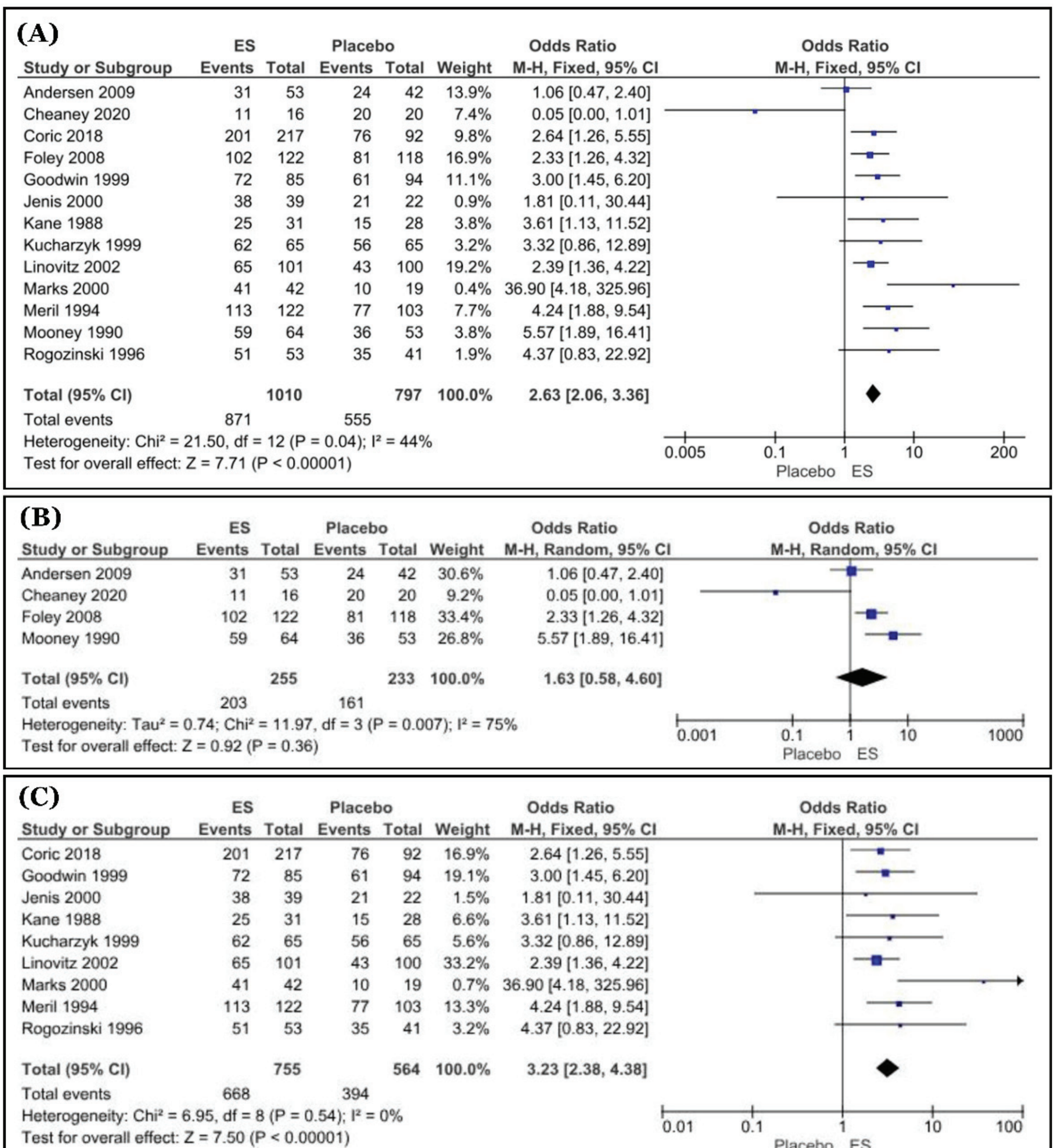

Figure 2. Forest plot of the impact of pulsed electromagnetic field stimulation on spinal fusion outcomes. **(A)** All studies (OR: 2.63; 95% CI: 2.06–3.36; Egger's p: 0.1501; I^2: 44%; $p<0.0001$). **(B)** High-quality studies (OR: 1.63; 95% CI: 0.58–4.60; Egger's p: 0.4887; I^2: 75%; $p=0.3600$). **(C)** Moderate-quality studies (OR: 3.23; 95% CI: 2.38–4.38; Egger's p: 0.1117; I^2: 0%; $p<0.0001$). OD: Odds ratio, 95% CI: 95% confidence interval.

The impact of pulsed electromagnetic field stimulation in tibial fracture

To assess the impact of pulsed electromagnetic field stimulation on tibial fractures, we analyzed data obtained from 6 articles.[23–28] Our study found that the use of pulsed electromagnetic field stimulation had no significant impact on tibial fracture healing (OR: 2.69; 95% CI: 0.96, 7.54; Egger's p-value: 0.0850; I^2: 58%; p=0.0600) (fig. 3A). In the subgroup analysis, findings from high-quality studies revealed that pulsed electromagnetic field stimulation had no notable impact on tibial fracture healing (OR: 1.17; 95% CI: 0.71–1.92; Egger's p-value: Not available [NA]; I^2: 31%; p=0.5400) (fig. 3B). Conversely, results from moderate-quality studies indicated that pulsed electromagnetic field stimulation was linked to a 6.22-fold increase in fracture healing likelihood compared to the control (OR: 6.22; 95% CI: 2.12–18.23; Egger's p-value: 0.9595; I^2: 32%; p=0.0009) (fig. 3C).

Heterogeneity among studies and potential publication bias

Our evaluation using I^2 statistics found that the spinal fusion variable had an I^2 of 44%. Therefore, the impact of pulsed electromagnetic field stimulation on spinal fusion was assessed using a fixed effects model. In the subgroup analysis, data from high-quality articles showed the presence of heterogeneity (I^2: 75%), and therefore, the data were analyzed using a random-effects model. In contrast, data from moderate-quality articles indicated no heterogeneity (I^2: 0%), and thus, the data were analyzed using a fixed-effects model. Meanwhile, we found that the I^2 for the tibial fracture variable was 58%. Thus, a random effects model was used to evaluate the impact of pulsed electromagnetic field stimulation on tibial fractures. In the subgroup analysis, data from both high-quality articles (I^2: 31%) and moderate-quality articles (I^2: 32%) indicated no

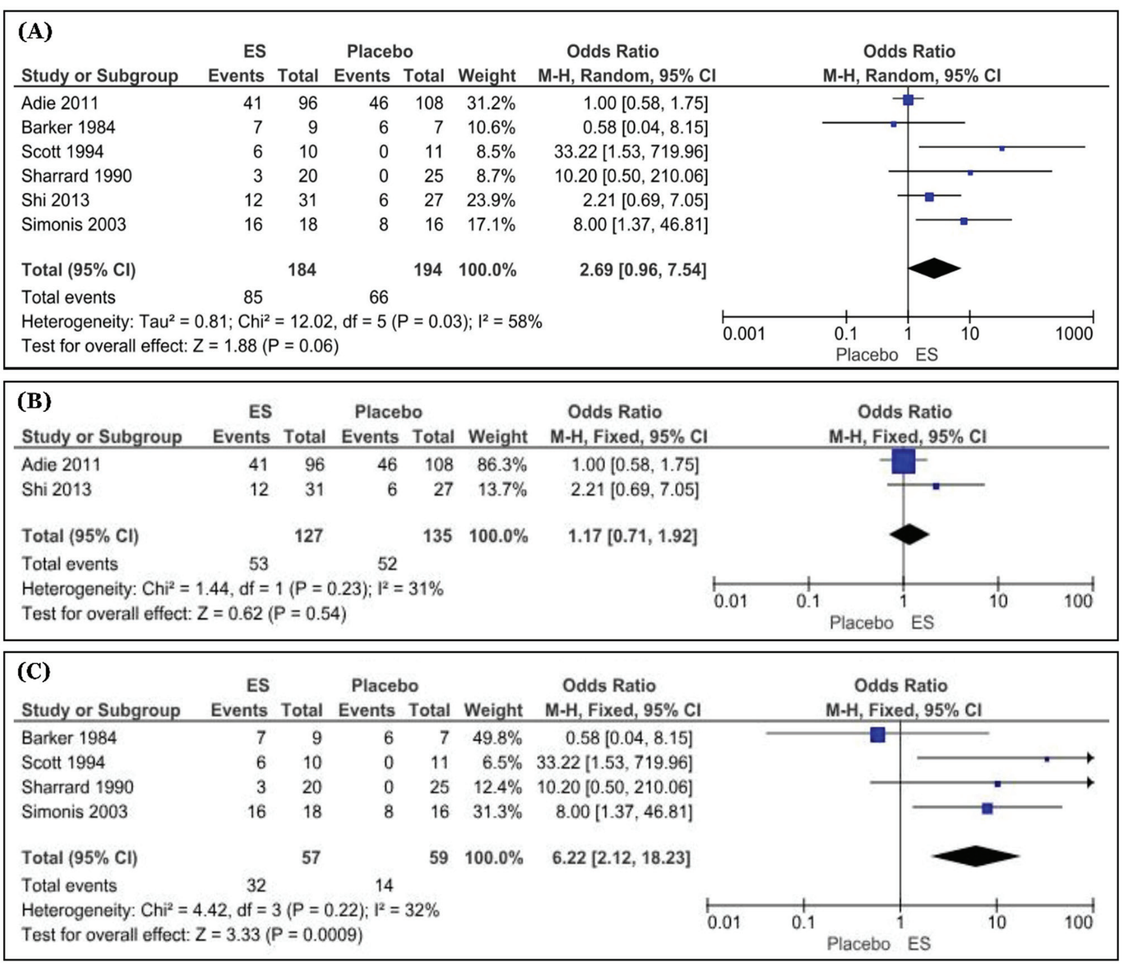

Figure 3. Forest plot illustrating the effects of pulsed electromagnetic field stimulation on tibial fracture healing. **(A)** All studies (OR: 2.69; 95% CI: 0.96–7.54; Egger's p: 0.0850; I^2: 58%; p=0.0600). **(B)** High-quality studies (OR: 1.17; 95% CI: 0.71–1.92; Egger's p: NA; I^2: 31%; p=0.5400). **(C)** Moderate-quality studies (OR: 6.22; 95% CI: 2.12–18.23; Egger's p: 0.9595; I^2: 32%; p=0.0009). OD: Odds ratio, 95% CI: 95% confidence interval, NA: Not available.

significant heterogeneity, and therefore, the data were analyzed using a fixed-effects model. Additionally, regarding potential publication bias, our analysis using the Egger test found that neither variable, spinal fusion nor tibial fracture, exhibited potential publication bias (p>0.05) (tab. 2).

DISCUSSION

Our study found that spinal fusion patients who received pulsed electromagnetic field stimulation had an impact on achieving fusion success with an OR of 2.63 compared to patients who did not receive pulsed electromagnetic field stimulation. However, conversely, we could not demonstrate the role of pulsed electromagnetic field stimulation in tibial fracture healing. Furthermore, in the subgroup analysis based on article quality, our study revealed consistent results. Data from moderate-quality articles indicated an impact of pulsed electromagnetic field stimulation on the healing of spinal fusion and tibial fractures. In contrast, data from high-quality articles did not demonstrate a significant impact of pulsed electromagnetic field stimulation. This difference in results indicated a varied impact of this pulsed electromagnetic field stimulation modality depending on the type of bone injury. To the best of our knowledge, no meta-analysis had simultaneously evaluated the role of pulsed electromagnetic field stimulation in both spinal fusion and tibial fractures. Therefore, we could not make a direct head-to-head comparison. Nevertheless, the role of pulsed electromagnetic field stimulation in various types of fractures had been reported in previous meta-analyses. Prior meta-analyses reported on the role of pulsed electromagnetic field stimulation in long bone fractures.[5,35] Their studies combined all data from long bone fractures to assess the effectiveness of pulsed electromagnetic field stimulation.[5,35] This approach introduced a high potential for bias, as we reported that the effectiveness of pulsed electromagnetic field stimulation varied by fracture type. Therefore, our results, which evaluated specific types of fractures, provided new insights into the role of pulsed electromagnetic field stimulation in fracture management. Furthermore, although previous meta-analysis had reported on the impact of pulsed electromagnetic field stimulation on spinal fusion, they had combined data from humans and animal subjects.[36] This could have introduced potential bias due to differences between animal models and humans. Our study involved only human samples, and therefore, provided more precise results compared to previous studies.

The theoretical basis explaining the results of this study is not yet fully known. However, some literature may serve as a reference for why pulsed electromagnetic field stimulation impacts spinal fusion healing. It is well-known that bone growth and remodeling occur in response to mechanical stress. On the other hand, electrical stimulation can mimic or enhance these stress signals.[37] This will facilitate bone formation and healing during spinal fusion.[38] Additionally, the piezoelectric effect shows that bone can generate electrical charges in response to mechanical stress. Therefore, electrical stimulation might enhance this natural process. As a result, it will promote osteoblast activity and accelerate spinal fusion.[39] Moreover, other theories suggest that electrical stimulation may modulate the inflammatory response and reduce inflammation. Consequently, this will create a more supportive environment for bone healing during spinal fusion.[40]

Several theories may explain the impact of pulsed electromagnetic field stimulation on tibial fracture healing, as observed in our study. First, the modulation of membrane receptors might play a role, as pulsed electromagnetic field stimulation exposure increases the presence of A2A and A3 receptors on synoviocytes, chondrocytes, and osteoblasts, which elevates intracellular cAMP levels and reduces NF-kβ activation, thereby decreasing inflammation and promoting bone and cartilage regeneration.[41] Second, pulsed electromagnetic field stimulation likely activates osteoinductive and angiogenesis pathways, stimulating the production of growth factors like bone morphogenetic

Table 2. A summary of analysis regarding the role of pulsed electromagnetic field stimulation on tibial fracture and spinal fusion.

Covariates	Case/total	NS	Model	OR	95% CI	p Egger	I-squared (%)	p
Spinal fusion	1,426/1,807	13	Fixed	2.63	2.06; 3.36	0.1501	44	<0.0001
High-quality study	364/488	4	Random	1.63	0.58; 4.60	0.4887	75	0.3600
Moderate-quality study	1,062/1,319	9	Fixed	3.23	2.38; 4.38	0.1117	0	<0.0001
Tibial fracture	151/378	6	Random	2.69	0.96; 7.54	0.0850	58	0.0600
High-quality study	105/262	2	Fixed	1.17	0.71; 1.92	NA	31	0.5400
Moderate-quality study	46/116	4	Fixed	6.22	2.12; 18.23	0.9595	32	0.0009

NS: Number of studies, OR: Odds ratio, 95% CI: 95% confidence interval, NA: Not available proteins (BMPs) and transforming growth factor beta 1 (TGF-β1), which are essential for osteoprogenitor cell recruitment and bone healing.[41] Third, the alteration of the extracellular matrix could contribute to the study results, as pulsed electromagnetic field stimulation influences the synthesis of cell matrix proteins, crucial for bone tissue repair and mineralization.[41] Fourth, pulsed electromagnetic field stimulation may affect ion channels and intracellular signaling, enhancing the production of growth factors and cell matrix proteins, thereby supporting the healing process.[41] Lastly, pulsed electromagnetic field stimulation has been shown to enhance callus formation, an early stage of bone healing, with experimental studies in rats demonstrating significant increases in callus formation after two and five weeks of pulsed electromagnetic field stimulation compared to controls.[42]

Several clinical implications arose from this study. First, the study supported the benefit of using pulsed electromagnetic field stimulation postoperatively as an adjunctive therapy to enhance radiographically defined fusion success rates and tibial fracture healing. Given the challenges associated with spinal fusion healing,[2] this study offered hope for improved spinal fusion outcomes. Second, the study was conducted with the aim of benefiting the medical field, particularly in orthopedic surgery. Therefore, the results of this study helped ensure the positive impact of pulsed electromagnetic field stimulation in the future. The use of pulsed electromagnetic field stimulation was expected to become one of the modalities in orthopedic surgery to achieve better spinal fusion success and tibial fracture healing. Third, although many factors contributed to the success of bone fusion and tibial fracture healing, the study hoped that in the future, the use of pulsed electromagnetic field stimulation would have a significant impact. Fourth, while this study had important implications for clinical practice concerning fusion success outcomes and tibial fracture healing, further research considering various confounding factors was needed to establish the effectiveness of pulsed electromagnetic field stimulation on pain, functional outcomes, and quality of life.

However, there were several limitations in this study. First, the success of fusion and fracture healing were the only focuses of our study. We did not include other data such as functional status, complications, and patient satisfaction because these data were not always reported by the individual articles. Second, although the fusion and union rate were consistently used to measure the effectiveness of pulsed electromagnetic field stimulation, the assessment of fusion and union was performed using different imaging modalities in each article. This factor likely introduced potential bias. Third, another limitation reported in this study was the inclusion of several articles with observational designs. Thus, the incorporation of different study designs also implied a risk of bias. Fourth, most of the studies included in this meta-analysis were conducted in the United States (US) and United Kingdom (UK). Therefore, special attention was needed when generalizing the findings of our study. Fifth, the included articles had populations with varying ages. This also introduced potential confounding factors, considering that age is one of the factors contributing to fracture healing.[43]

In conclusion, this study found evidence supporting the use of pulsed electromagnetic field stimulation postoperatively as an adjunctive therapy for spinal fusion and tibial fracture. Compared to placebo controls or no stimulation, patients who received pulsed electromagnetic field stimulation postoperatively exhibited significantly higher rates of fusion and union success. Nevertheless, comprehensive evidence requires further studies that consider functional status, pain scales, quality of life, and potential side effects.

ΠΕΡΙΛΗΨΗ

Αξιολόγηση της αποτελεσματικότητας της διέγερσης παλμικού ηλεκτρομαγνητικού πεδίου στη σπονδυλοδεσία και στην επούλωση κατάγματος κνήμης: Μια μετα-ανάλυση

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Αρχεία Ελληνικής Ιατρικής 2025, 42(6):771–779

ΣΚΟΠΟΣ Εκτίμηση του ρόλου της διέγερσης του παλμικού ηλεκτρομαγνητικού πεδίου στη σπονδυλοδεσία και στο κάταγμα της κνήμης, χρησιμοποιώντας προσέγγιση μετα-ανάλυσης. **ΥΛΙΚΟ-ΜΕΘΟΔΟΣ** Εκπονήθηκε μια μελέτη μετα-ανάλυσης τον Ιούλιο και τον Αύγουστο του 2024. Η στρατηγική αναζήτησης της μελέτης διενεργήθηκε στα Embase, PubMed και Scopus. Για την αξιολόγηση της ποιότητας των άρθρων χρησιμοποιήθηκε η κλίμακα Newcastle-Ottawa και η Modified Jadad Scale. Τα δεδομένα από τη μελέτη παρουσιάστηκαν ως μετρήσεις και ποσοστά (n [%]). Αξιολογήσαμε την προκατάληψη δημοσίευσης χρησιμοποιώντας τη δοκιμή Egger και μια γραφική παράσταση διοχέτευσης. Η ετερογένεια των δεδομένων αξιολογήθηκε χρησιμοποιώντας τη στατιστική I^2. Τα πρωτεύοντα αποτελέσματα της μελέτης αναλύθηκαν χρησιμοποιώντας τη δοκιμασία Mantel-Haenszel, που παρουσιάστηκε με odds ratio (OR) και διάστημα εμπιστοσύνης 95% (CI). **ΑΠΟΤΕΛΕΣΜΑΤΑ** Συμπεριλήφθηκαν 19 άρθρα σε αυτή τη μελέτη, αποτελούμενα από 13 άρθρα σχετικά με την επίδραση της διέγερσης παλμικού ηλεκτρομαγνητικού πεδίου στη σπονδυλική σύντηξη και 6 άρθρα αναφορικά με την επίδραση της διέγερσης παλμικού ηλεκτρομαγνητικού πεδίου στα κατάγματα της κνήμης. Τα αποτελέσματα αποκάλυψαν ότι η χρήση διέγερσης παλμικού ηλεκτρομαγνητικού πεδίου ενίσχυσε σημαντικά την επούλωση της σπονδυλοδεσίας. Αντίθετα, δεν παρατηρήθηκε σημαντική βελτίωση όσον αφορά στη χρήση παλμικής διέγερσης ηλεκτρομαγνητικού πεδίου στην επούλωση των καταγμάτων της κνήμης. Στην ανάλυση υποομάδας ανά ποιότητα αντικειμένου διαπιστώθηκε ότι τα άρθρα μέτριας ποιότητας έδειξαν επίδραση της διέγερσης του παλμικού ηλεκτρομαγνητικού πεδίου στη σπονδυλοδεσία και στην επούλωση του κατάγματος της κνήμης, ενώ τα άρθρα υψηλής ποιότητας όχι. **ΣΥΜΠΕΡΑΣΜΑΤΑ** Επιβεβαιώνεται ότι η χρήση παλμικής διέγερσης ηλεκτρομαγνητικού πεδίου έχει κρίσιμο αντίκτυπο στη σπονδυλοδεσία και στην επούλωση των καταγμάτων της κνήμης.

Λέξεις ευρετηρίου: Διέγερση παλμικού ηλεκτρομαγνητικού πεδίου, Κάταγμα κνήμης, Οστό, Σπονδυλοδεσία

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