Original Article

A systematic review and meta-analysis on influencing factors of failure of oral implant restoration treatment

Bo Lu, Xu Zhang, Binghao Liu

Department of Stomatology 2, The Fourth Clinical College of Xinxiang Medical University, Xinxiang, China

Contributions: (I) Conception and design: B Lu, B Liu; (II) Administrative support: B Lu; (III) Provision of study materials or patients: B Lu, X Zhang; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: All authors; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Binghao Liu. Department of Stomatology 2, The Fourth Clinical College of Xinxiang Medical University, 56 Jinsui Avenue, Xinxiang 453003, China. Email: lbh_doctor@163.com.

Background: With the continuous improvement of human living standards, more and more dental patients are requiring oral implant restoration treatment. However, there is still controversy regarding the influence of risk factors such as osteoporosis, radiotherapy, diabetes, and smoking on the failure of oral implants. This study aimed to explore the correlation between risk factors and failure of oral implant restoration treatment.

Methods: The databases of China National Knowledge Infrastructure (CNKI), Baidu Academic, Weipu, Wanfang, PubMed, EBSCO, Medline, Web of knowledge, Ovid, and the Cochrane Library were searched. The search strategies included: subject terms related to research results such as survival, osseointegration, failure, removal, replacement, and loss; related to risk factors: osteoporosis, head and neck cancer, diabetes, and smoking; and oral implantology as a keyword.

Results: Thirty-two articles were included in meta-analysis, there was a high heterogeneity between radiotherapy and dental implant failure (I^2=71.6%, P=0.000), and there was an obvious correlation between radiotherapy and dental implant failure [relative risk (RR) =2.09, 95% confidential interval (CI): 1.68–2.61]. There was heterogeneity between diabetes and oral implant failure in the included articles (I^2=59.6%, P=0.084). There was no remarkable correlation between osteoporosis and dental implant failure (RR =1.19, 95% CI: 0.81–1.74). There was a high heterogeneity between smoking and dental implant failure in the included articles (I^2=33.8%, P=0.092), showing obvious correlation (RR =1.80, 95% CI: 1.53–2.11).

Discussion: The results of meta-analysis confirmed that radiotherapy and smoking were greatly associated with oral implant failure.

Keywords: Failure of oral implants; influencing factors; meta-analysis

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Introduction

In the past 10 years, with the improvement of medical standards, dental implants have been increasingly clinically used to repair missing teeth (1). Compared with traditional restoration techniques, implant restoration has the advantages of no damage to adjacent teeth, strong chewing load function, and high comfort, which has led to increased patient acceptance (2). According to research reports, the 5-year survival rate and ten-year survival rate of oral implants are 97% and 90%, respectively. However, implantation failures due to implant shedding still exist (3).

With the continuous development of implant materials and implant surgery technology, the current dental implants can obtain good osseointegration, and the bone supports the implant crown to bear occlusal pressure. However, it is worth paying attention to how the implant can function in the oral cavity for a long time, and the occurrence of peri-

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implant diseases is an important factor affecting the long-term effect of implant dentures. The failure of implant restoration is divided into early failure and late failure according to whether it is connected to the abutment. The former has no occlusal force load, and the latter has occlusal force load (4). The causes of the two failure types are also different: early failure is due to the formation of obstacles to the osseointegration between bone and implant, and late failure is mostly caused by peri-implant inflammation or excessive load. Generally, the early planting failure rate is higher than the late planting failure rate (5). Early failure generally refers to the loss of the implant that occurs 3–6 months after implantation and before restoration. The incidence of early implant failure is 0.7–4%.

Dental implants are loose. On the one hand, it is necessary to consider the loosening of the restored crown due to poor osseointegration. In this case, it is necessary to take out the implant in time, and then implant the tooth again after the bone healing. There is another case to consider whether it is caused by local loosening of the tissue, which can be fixed by repeatedly screwing and applying force, or fixed by re-bonding, so as to reduce the loosening phenomenon. If there is a problem in the early stage of implant placement, osseointegration cannot be achieved, let alone important indicators such as later restoration and aesthetics. If we can foresee and address these early problems or take corresponding remedial measures, we can increase the success rate of planting, save time, reduce cost, and improve efficiency, and learn lessons such cases, so as to implement necessary preventive measures to reduce the occurrence of early failures (6).

Meta-analysis is conducted when a certain scientific problem needs to be solved, by formulating inclusion criteria and exclusion criteria to systematically collect related literature published globally, and screen out high-quality literature that meets the requirements. Statistical methods are adopted to synthesize the research results of multiple documents, calculate the corresponding total effect, and finally yield a quantitative result (7). Compared with traditional narrative reviews, meta-analysis is more scientific and repeatable.

At present, it is recognized that the factors that may cause early implant failure include host factors, iatrogenic factors, implantation sites, and implant factors. In recent years, with the rapid advancement of materials science and surgical technology, implant failures caused by dental implants and implant surgical factors have gradually decreased. A large number of studies have focused on the effect of host factors, especially osteoporosis, radiotherapy, diabetes, and smoking among populations with the highest incidence. Smoking directly and indirectly affects oral bacteria, which may lead to changes in the functional pathways of microbial groups by changing saliva microbial groups, and then lead to diseases related to smoking. Oral microorganisms are an important part of changing the balance between oral and even systemic health and diseases. Based on modern gene high-throughput sequencing technology, more than 600 different microbial species such as bacteria, viruses, fungi, mycoplasma and chlamydia have been found on the surfaces of soft and hard tissues such as teeth, gingival sulcus, buccal tongue, soft and hard palate, which are collectively referred to as oral microbiota. The ecological imbalance of oral microflora can not only induce a variety of oral diseases, such as dental caries, periapical diseases and periodontal diseases, but also closely related to systemic diseases such as cardiovascular diseases, respiratory diseases, tumors, diabetes, rheumatoid arthritis, premature delivery and nervous system diseases. Modern studies believe that inflammation is the core mechanism of pathophysiology of many chronic systemic diseases. Oral microorganisms can spread to different parts of the body through oral mucosa and periodontal pockets through direct dissemination, blood circulation, immunization and other ways, causing systemic or local infection. Oral microbiome plays an important role in the pathogenesis of cardiovascular diseases. However, there is still very little literature on the impact of these risk factors on the treatment of dental implants, and dentists call for the use of more high-level evidence-based data to analyze it.

Therefore, this study took osteoporosis, radiotherapy, diabetes, and smoking as risk factors to systematically evaluate and meta-analyze the related research on failure of oral implant restoration treatment, and the final quantitative results provided scientific evidence-based reference for clinical oral implant restoration treatment. We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/apm-21-3449).

Methods

Literature retrieval

Before the search, the authors read a large number of documents related to the subject of this article, conducted a preliminary search in electronic databases, and determined

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Table 1 Risk quality assessment form

No.	Item	Yes	No
1	The definition of implant treatment is standardized or precise enough?	1	0
2	Is failure of oral implants precisely defined?	1	0
3	Is the lack of dental implants precisely defined?	1	0
4	Does the study detail the training or background of dental implant therapists?	1	0
5	Does the study specify the time and frequency of collecting hazards?	1	0
6	Are risk factors collected using standard scales or checklists?	1	0
7	Is the number of participants who withdrew or lost follow-up in each study group determined?	1	0
8	Have you determined the total number of implant failure cases designated by each study group?	1	0
9	Have you determined the type of implant failure in each study group?	1	0
10	Is the analysis type of implant failure data determined?	1	0

the search strategy and search terms. Searches were performed in the China National Knowledge Infrastructure (CNKI) database, Baidu Academic, Weipu, Wanfang, PubMed, EBSCO, Medline, Web of knowledge, Ovid, and the Cochrane Library. The searched articles were randomized controlled trials (RCTs) taking osteoporosis, radiotherapy, diabetes, and smoking as risk factors to explore the failure of oral implant restoration treatments published from the establishment of the database to 25 June 2021. The subject words were combined freely for multiple searches to obtain all references that could be included. The search strategies included: subject terms related to research results such as survival, osseointegration, failure, removal, replacement, and loss; related to risk factors: osteoporosis, head and neck cancer, diabetes, and smoking; and oral implantology as a keyword. Then, each article was tracked with a search engine. Finally, the relevant experts and researchers who published the articles were contacted by e-mail to obtain the latest research progress.

Inclusion and exclusion criteria of the articles

Articles meeting the following conditions were included: using case-based RCTs design method, and the subject of patients with failure of oral implants.

Articles which met the following conditions were excluded: individual cases, reviews, and non-research literature; non-RTCs; articles which were published repeatedly; without available data and information; articles animal subjects and *in vitro* experimental research; and no mention of the data regarding relevant risk factors.

Data extraction

Uniform standards were applied whereby two evaluators extracted the authors, institutions, journals, and funding projects of the included articles, and then independently extracted the article data. The main data extracted include basic research information: title, country, name of the first author, journal of publication, and publication period; characteristics of the participants: gender, age, and number of cases; and information related to risk factors: the number and location of oral implants, and data related to implant failure.

Bias risk assessment

The risk of bias for the included RCTs was simultaneously evaluated by two reviewers, and if they encountered differences, they were resolved through discussion. This study used the internationally recognized *McMaster Quality Assessment Scale of Harms* (McHarm) by Holahan *et al.* [2008] (8) as a reference, extracted important evaluation information, developed a risk quality evaluation table that conformed to this article, and evaluated the quality of the included literature according to a score of 0–10 points (*Table 1*).

Statistical analysis

The software Stata SE 12.0 (Stata Corp., College Station, TX, USA) was used for statistical analysis. This article took failure of oral implants as the final statistical research result,

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and relative risk (RR) as an evaluation indicator. The risk of bias assessment chart under RevMan 5.3 software (Cochrane Collaboration, Copenhagen, Denmark) was adopted to assess the risk bias of the included references, after sorting and filtering the data, inputting it into Rev Man 5.3 software to draw the chart. Each effect was represented by a 95% confidence interval (CI). When P>0.01 and I^2<50%, the fixed effects model (FEM) was used for meta-analysis. When P<0.01 and I^2>50%, the random effects model (REM) was used for meta-analysis.

Sensitivity analysis

The REM and the FEM were used to compare the results. According to the consistency of the results, the reliability of the combined results was analyzed and the funnel chart was drawn to determine whether there was publication bias.

Results

Results of articles retrieval and the basic characteristics of included articles

A total of 1,522 articles were retrieved from the database and 1,041 articles were obtained from the registry. After reading research titles and abstracts, 816 duplicate articles were eliminated, 425 unqualified articles were eliminated, and 87 were excluded for other reasons, leaving 1,235 articles. After full text reading screening, 526 articles were eliminated, leaving 709 articles. Among the subjects, 548 were repeatedly excluded, leaving 161. Then, 129 further articles were removed, including 76 reviews, and 53 with incomplete data indicators. Finally, 32 articles were obtained for meta-analysis. Among them, 3 articles discussed the factors of osteoporosis, 10 articles discussed the factors of radiotherapy, 3 articles discussed the factors of diabetes, and 16 articles discussed the factors of smoking. A flowchart of the literature search and screening is show in *Figure 1*.

There were 13 articles with a score of 8–10 (40.62%), 15 articles with a score of 4–7 (46.88%), and 4 article with a score of 0–3 (12.5%). *Tables 2-5* display the basic information of literature discussing osteoporosis factors, radiotherapy factors, diabetes factors, and smoking factors, in sequence. According to the national statistics of the first author, 5 articles were from the United States; 7 articles were from Belgium; 2 articles were from the United Kingdom; 1 articles were from Australia; 5 articles were from Germany; and 1 article was from New Zealand.

Risk bias assessment of the included articles

Among the 32 RCTs in this study, only 3 articles (13-15) described the correct random allocation method, accounting for 9.37%; only 1 article (19) described in detail the concealment of the allocation plan, accounting for 3.12%; and no blind method was used in the remaining articles, accounting for 87.5%. The reference risk bias evaluation chart and summary chart, are shown in *Figures 2*,*3*, respectively, which were drawn using Rev Man 5.3 software.

Meta-analysis results of smoking as a risk factor

There were 16 articles (9-24) on failure of oral implants with smoking as a risk factor, with a total of 2,481 cases; there were 518 cases in the smoking group with 4,816 oral implants and there were 1,963 cases in the non-smoking group with 8,847 oral implants. The results of the meta-analysis showed that there was a high degree of heterogeneity between smoking and failure of oral implants in the included literature (I^2=33.8%, P=0.092), showing observable correlation (RR =1.80, 95% CI: 1.53–2.11). A forest diagram of failure of oral implants in the smoking group and the non-smoking group is displayed in *Figure 4*.

Meta-analysis results of radiotherapy as a risk factor

There were 14 articles (9,25-37) on the influence of radiotherapy as a risk factor on failure of oral implants, with a total of 965 cases, including 310 cases in the radiotherapy group with 1,514 oral implants and 655 cases in the non-radiotherapy group with 3,266 oral implants. The results of the meta-analysis showed that there was high heterogeneity between radiotherapy and failure of oral implants in the included articles (I^2=71.6%, P=0.000), showing visible correlation (RR =2.09, 95% CI: 1.68–2.61). A forest diagram of failure of oral implants in the radiotherapy group and the non-radiotherapy group is shown in *Figure 5*. The funnel diagram of failure of oral implants in the radiotherapy group and the non- radiotherapy group is displayed in *Figure 6*.

Meta-analysis results of diabetes as a risk factor

There were 3 included articles (9,10,38) on failure of oral implants with diabetes as a risk factor, with a total of

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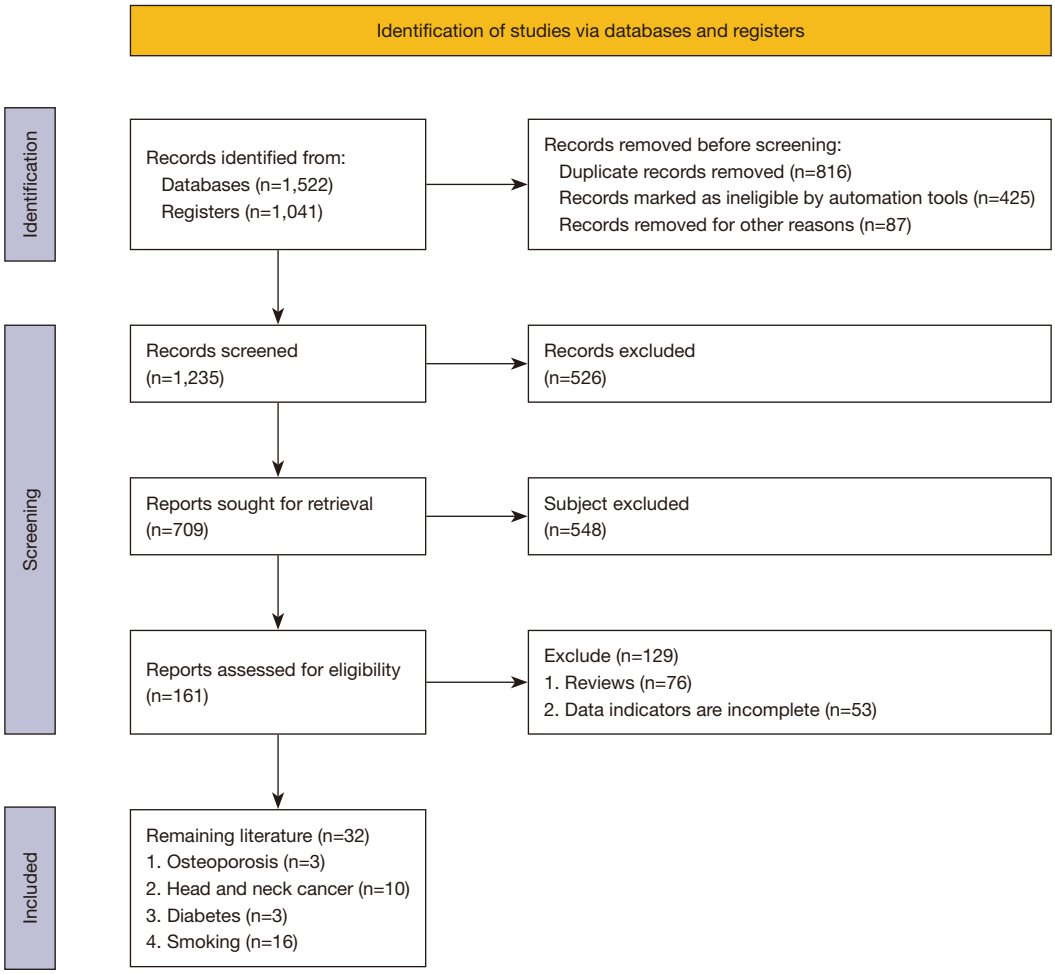

Figure 1 The entire retrieval process.

1,550 cases, including 379 cases in the diabetes group with 704 oral implants and 1,171 cases in the non-diabetic group with 2,954 oral implants. The results of the meta-analysis showed that there was heterogeneity between diabetes and failure of oral implants in the included articles (I^2=59.6%, P=0.084), showing no visible correlation (RR =0.95, 95% CI: 0.64–1.41). A forest diagram of failure of oral implants in the diabetes group and the non-diabetics group is shown in *Figure* 7.

Meta-analysis results of osteoporosis as a risk factor

There were 3 articles (9,39,40) on the influence of osteoporosis as a risk factor on failure of oral implants, with a total of 628 cases (142 cases in the osteoporosis group with 520 oral implants and 486 cases in the non-osteoporosis group with 1,877 oral implants). The meta-analysis results showed that there was a high heterogeneity between osteoporosis and failure of oral implants in the included articles (I^2=63.1%, P=0.067), showing no remarkable correlation (RR =1.19, 95% CI: 0.81–1.74). A forest diagram of failure of oral implants in the osteoporosis group and the non-osteoporosis group is displayed in *Figure 8*. The funnel diagram of failure of oral implants in the osteoporosis group and the non-osteoporosis group is shown in *Figure 9*.

Analysis on publication bias

A funnel chart of the included articles is shown in *Figure 10*. It can be seen that the circle and the midline of the articles were basically symmetrical, indicating that the research

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Table 2 The basic information of articles discussing smoking

The first author	Year of publication	State	Characteristics of patients			Characteristics of patients			Duration of follow-up
			Average age (years old)	Smoking group (n)	Control group (n)	Smoking group (n)	Control group (n)	Location (upper jaw/lower jaw)	
Alsaadi (9)	2008	Belgium	NA	61	351	223	1,291	698/816	2 years
Anner (10)	2010	Israel	52±12	63	412	226	1,400	NA	31±28 months
De Bruyn (11)	1994	Belgium	21–80	26	91	114	338	244/208	NA
De Bruyn (12)	1999	Belgium	NA	10	13	30	32	Maxilla	7 years
Gorman (13)	1994	USA	NA	82	228	1420	646	NA	NA
Jones (14)	1999	USA	50	19	44	126	217	204/147	58 months
Karoussis (15)	2003	Switzerland	NA	12	41	28	84	NA	10 years
Lambert (16)	2000	USA	NA	NA	NA	959	1,928	1,271/1,616	3 years
Levin (17)	2008	Israel	45	10	54	10	54	NA	6.14 years
Lindquist (18)	1997	Sweden	33–64	21	24	125	139	Mandible	10 years
Olson (19)	2000	USA	56±12	NA	NA	51	65	Grafted maxillary sinus	38±15 months
Rodriguez-Argueta (20)	2011	Spain	53.1±12.5	113	182	389	644	NA	≥6 months
Schwartz-Arad (21)	2000	Israel	47	NA	NA	6	50	39/17	5 years
van Steenberghe (22)	2002	Belgium	50±14	NA	NA	156	1,107	NA	NA
Vandeweghe (23)	2011	Belgium	54±13.4	41	288	104	608	NA	22 months
Vervaeke (24)	2012	Belgium	56±12	60	235	849	244	458/648	31±7.2 months

accuracy was high, there was no bias in publication, and the final conclusions obtained were more credible.

Discussion

The meta-analysis results of this study showed that there was a clear correlation between radiotherapy smoking as a risk factor and failure of oral implants. Compared with patients in the non-radiotherapy group, patients who received radiotherapy before or after oral implant surgery have a 75% probability of failure of oral implants (41-43). Studies have pointed out that the failure rate of implants implanted in bone tissues that receive radiotherapy is about 2.5 times that of ordinary bone tissues, which is similar to the results of this study (44). In addition, studies have reported that the failure rate of oral implants in the maxilla after radiotherapy is higher than that in the mandible (45). The cause may be that after the bone tissue receives radiotherapy, the cells or blood vessels located in the bone tissue receiving the radiotherapy react with the cells or blood vessels in the surrounding tissues, and the tissue metabolism changes. At present, some potential mechanisms can explain this change, including changes in the repair function of bone tissues and osteoclasts. The formation and destruction of hypoxic cell tissue and ischemic donor tissue are related to tissue perfusion capacity and tissue fibrosis. The radiotherapy dose may have a great correlation with tissue changes. Therefore, a small dose and multiple frequency method should be used in radiotherapy to reduce the damage to the human body. Auxiliary hyperoxia therapy can promote the tissue repair ability of radiotherapy, but there is no relevant research confirming that it can reduce the probability of failure of oral implants in patients.

Peri-implant inflammation is one of the important factors affecting the long-term success of implants. The diagnosis of peri-implant inflammation is the condition of the mucosa in the patient's oral cavity, and there may be redness, bleeding or slight pus overflow of the mucosa around the

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Table 3 The basic information of articles discussing radiotherapy

The first author	Year of publication	State	Characteristics of patients			Radiotherapy		Characteristics of patients			Duration of follow-up
			Average age (years)	Radiotherapy group (n)	Control group (n)	Time	Dose (Gy)	Radiotherapy group (n)	Control group (n)	Location (upper jaw/lower jaw)	
Alsaadi (9)	2008	Belgium	56.2	2	410	NA	NA	15	1,499	698/816	2 years
Cuesta-Gil (25)	2009	Spain	52	79	32	Mixed	50–60	395	311	Local: 454/ grafted: 252	NA
Fenlon (26)	2012	UK	NA	12	29	After placement	66	35	110	Grafted bone	NA
Jacobsen (27)	2014	Switzerland	52.4	NA	NA	After placement	NA	47	93	Local: 41/ grafted: 99	67 months
Klein (28)	2009	Germany	58.4	27	16	Before placement	<50 or >50	116	74	Local: 62/ grafted: 128	5 years
Landes (29)	2006	Germany	63	19	11	Before placement	57	72	42	NA	36 months
Linsen (30)	2012	Germany	56±16	34	32	Before placement	36 or 60	127	135	213/49	48±34.3 months
Nelson (31)	2007	Germany	59	29	NA	Before placement	Up to 72 Gy	124	311	NA	10.3 years
Salinas (32)	2010	USA	NA	22	22	Mixed	>60	90	116	Local: 105/ grafted: 114	41.1 months
Schepers (33)	2006	Netherlands	66.11	21	27	After placement	60–68	61	78	NA	23 months
Schoen (34)	2008	Netherlands	62±11	19	16	After placement	60.1±7.7	76	64	NA	12 months
Shaw (35)	2005	UK	58	34	43	Before placement	40–66	172	192	Local: 238/ grafted: 126	3.5 years
Werkmeister (36)	1999	Germany	55	12	17	Before placement	54	30	79	Local: 64/ grafted: 45	3 years
Yerit (37)	2006	Austria	58±14	NA	NA	Before placement	50	154	162	Local: 238/ grafted: 78	5.4±3.2 years

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Table 4 The basic information of articles discussing diabetes

The first author	Year of publication	State	Characteristics of patients			Characteristics of patients			Duration of follow-up
			Average age (years old)	Diabetes group (n)	Control group (n)	Osteoporosis group (n)	Diabetes group (n)	location (upper jaw/lower jaw)	
Alsaadi (9)	2008	Belgium	NA	61	351	223	1,291	698/816	2 years
Anner (10)	2010	Israel	52±12	63	412	226	1,400	NA	31±28 months
Morris (38)	2000	New Zealand	NA	255	408	255	263	Mixed	36 months

Table 5 The basic information of articles discussing osteoporosis

The first author	Year of publication	State	Characteristics of patients			Characteristics of patients			Duration of follow-up
			Average age (years old)	Osteoporosis group (n)	Control group (n)	Osteoporosis group (n)	Control group (n)	Location (upper jaw/lower jaw)	
Alsaadi (9)	2008	Belgium	NA	61	351	223	1,291	698/816	2 years
Amorim (39)	2007	Israel	58.2	19	20	39	43	Mandible	9 months
Dvorak (40)	2011	New Zealand	≥45	62	115	258	543	396/432	6±4 years

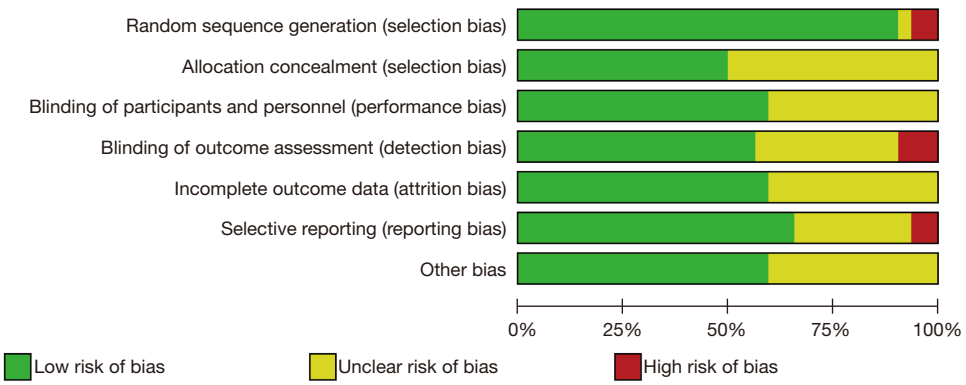

Figure 2 Assessment of risk bias of the included articles.

implant. Secondly, probe with periodontal probe to check whether the probe depth around the implant exceeds the normal limit, generally more than 4 mm, and judge whether there is bleeding, pus overflow and fistula during probe, which is preliminarily identified as peri-implant inflammation. Then, auxiliary examination is carried out by means of radiographic film. Through radiographic examination, we can see the degree of combination between implant and alveolar bone and the degree of alveolar bone absorption. In the systematic treatment of periodontal disease, periodontal support therapy is an essential link to prevent the recurrence of periodontal disease. Similarly, it should also carry out daily maintenance for the implant week. As a periodontal support therapy, peri-implant maintenance must be made and adjusted according to the risk assessment of patients. Most of the patients undergoing implant restoration have missing teeth due to periodontitis, and their oral hygiene is usually poor. Therefore, before implant surgery, patients must be informed of the importance of self-maintenance of oral health. The speed of tissue destruction and bone resorption around implants is obviously higher than that of natural teeth. Doctors should advise patients to improve oral hygiene, maintain implants and restorations continuously and effectively, and timely report problems to doctors.

Compared with non-smoking patients, there is about

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Figure 3 Multiple risk bias evaluation results of included articles. "+", low risk; "−", high risk; "?", unclear.

40% probability for smoking patients to suffer from failure of oral implants. The meta-analysis results of this study confirm that smoking populations are more likely to have failure of oral implants than non-smoking populations, which is similar to the results of Esser *et al.* [1997] (46). At present, there is no related article to explain the internal mechanism of the effects of smoking and failure of oral implants, but many studies have pointed out that the nicotine in tobacco can reduce the healing and repair function of oral tissues. Some researchers have suggested a ban on smoking for patients 1 week before the oral implant restoration treatment to promote the healing of oral implants, but the results show that short-term smoking ban has no effect on the probability of failure of oral implants.

This study also found no significant correlation between osteoporosis and diabetes and failure of oral implants, and osteoporosis and diabetes have a high incidence in elderly patients. Studies have reported that osteoporosis and diabetes affect the repair ability of oral tissues to a certain extent. Generally, clinical medications are used for diabetes patients, but dentists do not perform oral implant surgery on diabetes patients who are not well-controlled. The most commonly used drugs for osteoporosis are bisphosphonates, but long-term use of these drugs may cause osteonecrosis of the jaw. As osteoporosis and diabetes can be controlled by drug intervention, in the current meta-analysis, there were few studies on the correlation between the severity of osteoporosis and diabetes and failure of oral implants, which would have exerted a certain impact on the evaluation of osteoporosis and diabetes as risk factors in this study.

Conclusions

This study screened the related articles with osteoporosis, radiotherapy, diabetes, and smoking as risk factors, and compared the risk factor group and the non-risk factor group to perform a meta-analysis, aiming to explore the relevance of each risk factor to the failure of oral implant restoration treatment. The results of meta-analysis confirmed that radiotherapy and smoking was obviously correlated with failure of oral implants. However, there were some shortcomings in this study. The judgment of the confounding factors included in the study was subjective, and the interference of other risk factors could not be completely ruled out. More articles have to be included in the later period to continue to explore the combined effect of multiple factors on the failure of oral implants. In

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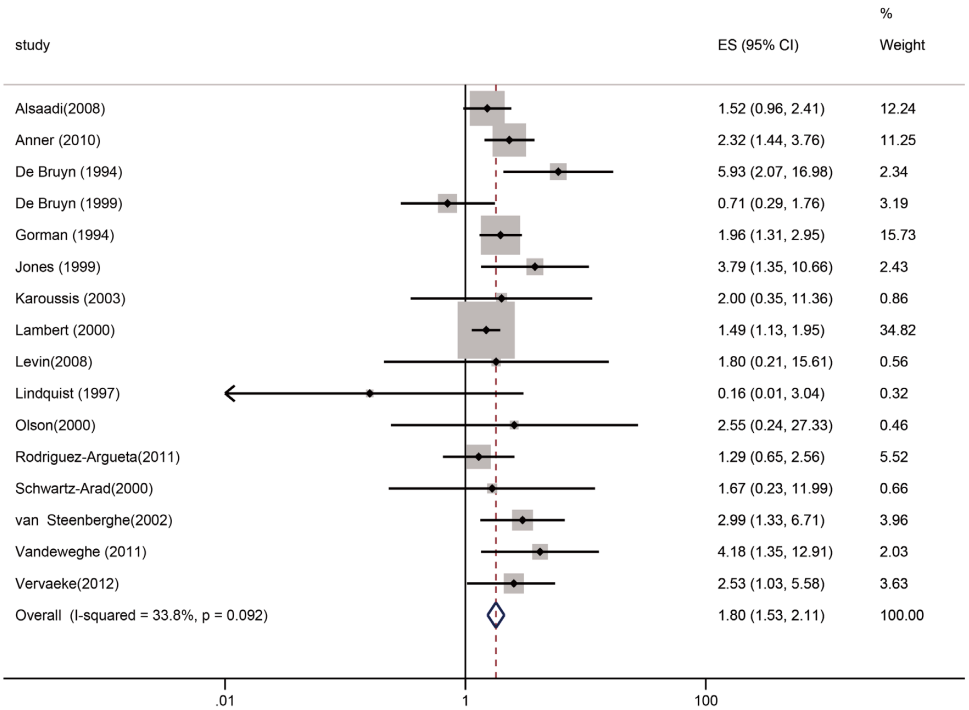

Figure 4 Forest diagram of failure of oral implants in the smoking group and the non-smoking group. ES, effect size; CI, confidence interval.

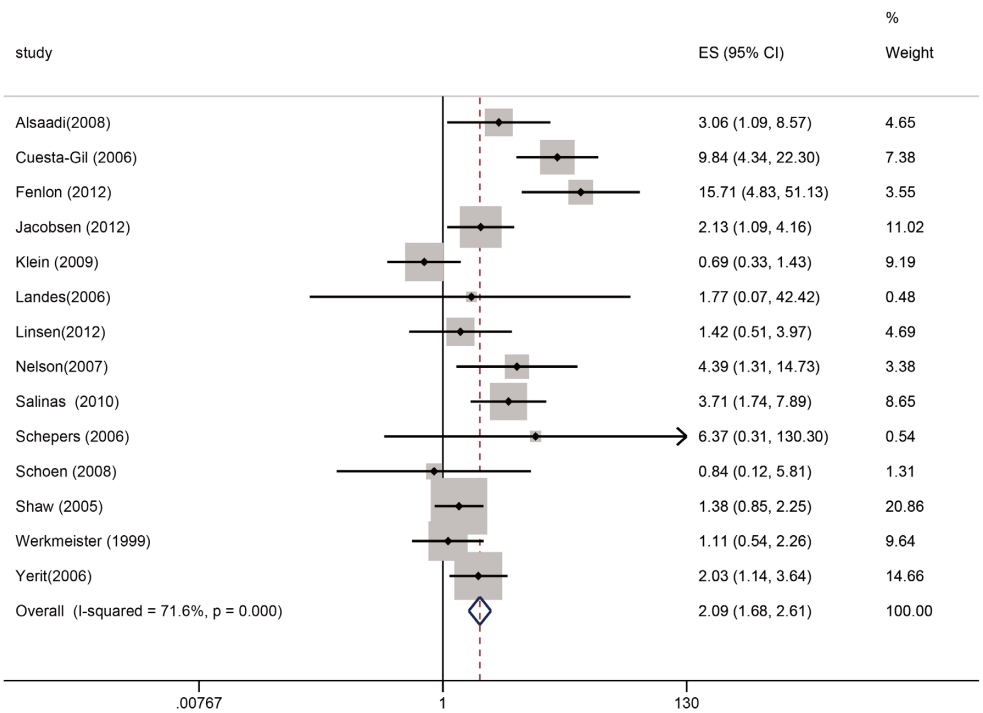

Figure 5 The forest diagram of failure of oral implants in the radiotherapy group and the non-radiotherapy group. ES, effect size; CI, confidence interval.

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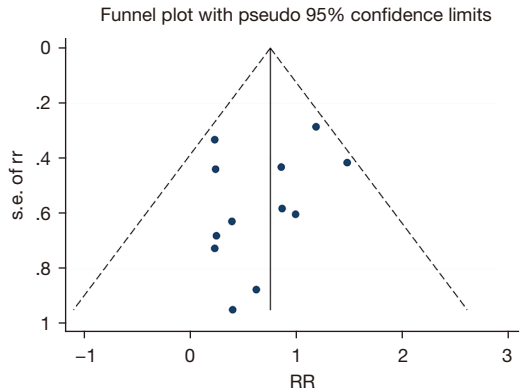

Figure 6 The funnel diagram of failure of oral implants in the radiotherapy group and the non-radiotherapy group. RR, relative risk.

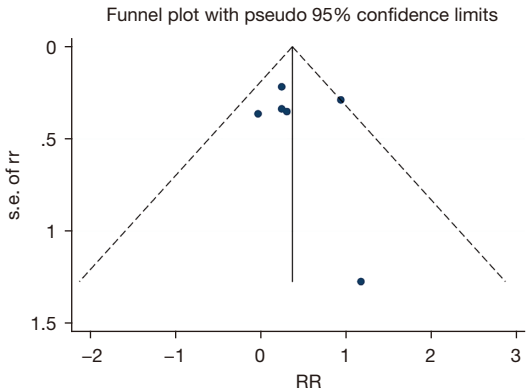

Figure 9 The funnel diagram of failure of oral implants in the osteoporosis group and the non-osteoporosis group. RR, relative risk.

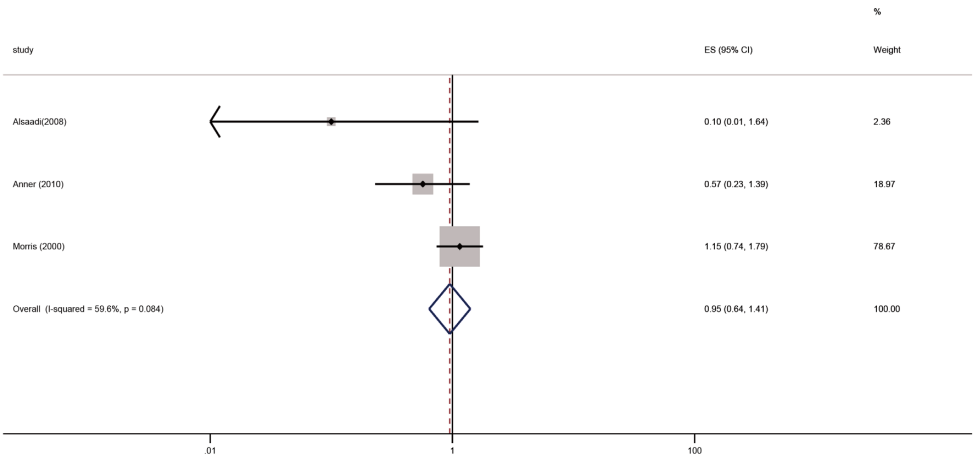

Figure 7 The forest diagram of failure of oral implants in the diabetes group and the non-diabetics group. ES, effect size; CI, confidence interval.

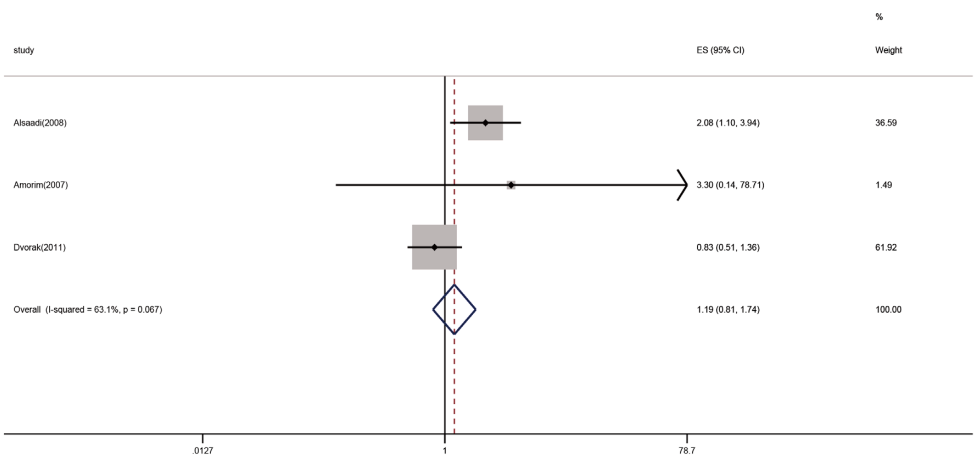

Figure 8 The forest diagram of failure of oral implants in the osteoporosis group and the non-osteoporosis group. ES, effect size; CI, confidence interval.

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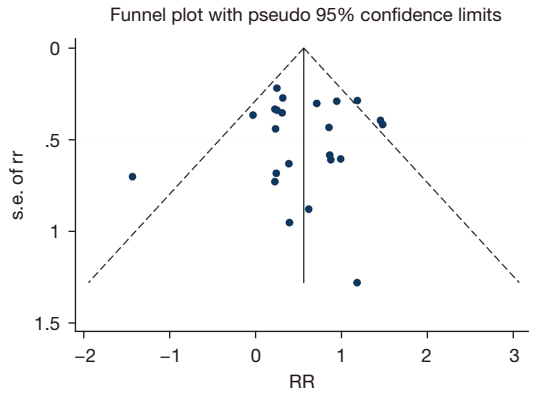

Figure 10 Funnel chart of included articles. RR, relative risk.

summary, this study provides a more reliable evidence-based basis for dental clinicians, and provides a reference for the design of later treatment plans.

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Footnote

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