

Postoperative Complications in Smoking Patients Treated With Implants: A Retrospective Study

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Purpose: To identify the risk of complications (eg, implant loss, infection, peri-implantitis, and mucositis) in a group of patients treated with osseointegrated implants and to assess the effect of smoking on this risk.

Materials and Methods: A retrospective cohort study of patients treated in the Unit of Implantology, University of Barcelona Faculty of Dentistry was performed. All patients had already undergone prosthetic treatment, and the minimal follow-up time after implant surgery was 6 months.

Results: A total of 295 patients fulfilled the inclusion criteria; 56.9% were women and 43.1% were men. They received a total of 1,033 implants. There were 209 complications (32 cases of implant loss, 2 cases of infection, 70 cases of peri-implantitis, and 105 cases of mucositis). The smoking habit was associated with an increased risk of complications ($P = .008$).

Conclusion: Smokers had an increased risk of complications, including infection, implant loss, mucositis, and peri-implantitis, compared with nonsmoking patients.

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Smoking has been associated with a greater risk of postoperative complications in many surgical fields. Reports have shown the negative effects of this habit in areas well beyond dentistry, including abdominal, orthopedic, and oncologic surgery.¹⁻⁷

As a general rule, surgeons ask their patients to stop smoking before any surgical procedure. Nevertheless, short-term smoking cessation does not seem to decrease

the rate of complications in colorectal surgery,⁸ because it seems to reduce the altered chemotaxis of macrophages and neutrophils only marginally.⁹ However, a recent systematic review of randomized controlled trials on smoking cessation showed that intensive programs performed at least 4 weeks before surgery seemed to improve the results and increase the cessation rates.¹⁰

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Smoking is also associated with healing complications in oral surgery and periodontology, such as dry socket,¹¹ slow epithelization in free gingival graft donor sites,¹² and a poor prognosis for periodontal treatment.^{13,14}

The use of osseointegrated implants for tooth replacement has become a highly predictable treatment, with success rates usually greater than 90% for different implants systems,¹⁵ although these data depend much on the criteria used by researchers to assess implant success.¹⁶⁻¹⁸

Implant loss, infection, and inflammation of the peri-implant mucosa, with or without bone loss, are among the most common complications of implant treatment. These complications are associated with different risk factors, both implant related (eg, surgical procedure, implant surface, number and position of the implants, and loading protocol, among others) and patient related (eg, hygiene, uncontrolled diabetes, alcohol abuse, and smoking).^{19,20}

These complications (ie, implant loss, infection, mucositis, and peri-implantitis) can be divided into immediate, early, and late and, in turn, can be reversible or irreversible, depending on the type and extent of the complication.²¹ Although tobacco has been reported as a risk factor for implant failure and bone loss around implants,²²⁻²⁴ few reports have addressed the risk of complications in smoking patients. Therefore, the purpose of the present study was to identify the risk factors of several complications (ie, implant loss, infection, peri-implantitis, and mucositis) in a group of patients treated with osseointegrated implants and to assess the effect of smoking on this risk.

Materials and Methods

A retrospective cohort of patients, who were treated at the Unit of Implantology, University of Barcelona Faculty of Dentistry, was selected. The data were retrospectively recovered from the medical and dental records, including the clinical and radiographic examinations. All patients treated from January 2002 to January 2009 were eligible. The institutional review board (Ethical Committee of Clinical Investigation, University of Barcelona Dental School) reviewed and approved the study protocol.

All implants had been placed according to the manufacturer's instructions under sterile conditions by fellows of the Master Degree Program in Oral Surgery and Orofacial Implantology under direct supervision of clinical assistant professors. After the operation, an antibiotic (usually amoxicillin 750 mg every 8 hours for 4 to 7 days [Clamoxyl 750; GlaxoSmithKline, Madrid, Spain]), a nonsteroidal anti-inflammatory drug (usually ibuprofen 600 mg every 8 hours for 4 to 5 days [Alginasdin 600; Esteve, Barcelona, Spain]), and a

mouthrinse (0.12% chlorhexidine digluconate every 12 hours for 15 days [Clorhexidina Lacer; Lacer, Barcelona, Spain]) were prescribed. The inclusion criteria were patients with clinical and radiographic follow-up at least 6 months after implant placement and having already undergone prosthetic rehabilitation. Patients who did not attend the scheduled follow-up visits and could not be contacted were excluded.

The following variables were collected: age, gender, number and position of the implants, implant manufacturer and system, length and diameter of each implant, and follow-up time. The smoking habit was recorded as smoker or nonsmoker. The postoperative complications were classified per implant as follows: failure to achieve osseointegration, when the implant was lost before loading; mucositis, when the mucosa surrounding the implant had inflammatory signs (ie, redness, swelling, or bleeding) but no objective bone loss had occurred; peri-implantitis, when the mucosa surrounding the implant had inflammatory signs and bone loss of more than 1 thread had occurred compared with the initial situation; and postoperative infection, when swelling and suppuration followed the insertion of the osseointegrated implants.

For analysis purposes, the complications were grouped as loss of osseointegration or infectious complications, which included the 3 last aforementioned complications.

To evaluate the association of smoking habit and other categorical variables and the occurrence of complications, χ^2 tests were used. The data were processed using the Statistical Package for Social Sciences, version 15.0, for Windows (SPSS, Chicago, IL). The association of scale variables with the complications was explored using 1-way analysis of variance tests and *t* tests.

Results

A total of 43 patients were excluded because they did not attend the follow-up visits and could not be contacted. Thus, 295 patients fulfilled the inclusion criteria. They had received a total of 1,033 implants. Of the 295 patients, 127 were men (43.1%) and 168 were women (56.9%). The mean age was 53.1 ± 12.5 years (range 21 to 68), and 113 patients (38.3%) were smokers. The smokers were significantly younger (mean age 43.4 ± 10.9 yrs) than the nonsmokers (53.1 ± 12.5 yrs; $t = 6.477$; $df = 233$; $P = 5.5 \cdot 10^{-10}$).

There were 209 complications, which are listed in Table 1 stratified by smoking status. The smoking habit was associated with an increased risk of complications ($\chi^2 = 9.672$; $df = 2$; $P = .008$). Men had a greater risk of complications, but this association could have been because smoking was significantly

Table 1. COMPLICATIONS IN SMOKING AND NONSMOKING PATIENTS

Variable	No Complications	Implant Loss	Peri-Implantitis	Mucositis	Postoperative Infection	Total
Smoking	291 (74.8)	14 (3.6)	36 (9.3)	46 (11.8)	2 (0.5)	389 (100)
Nonsmoking	533 (82.8)	18 (2.8)	34 (5.3)	59 (9.2)	0 (0)	644 (100)
Total	824 (79.8)	32 (3.1)	70 (6.8)	105 (10.2)	2 (0.2)	1,033 (100)

Data presented as numbers, with percentages in parentheses.

Rodriguez-Argueta et al. *Smoking and Dental Implants. J Oral Maxillofac Surg* 2011.

more prevalent in men ($\chi^2 = 110.115$; $df = 1$; $P = 9.25 \cdot 10^{-26}$).

Implants with complications were found more often in older patients ($t = -3.547$; $df = 383.82$; $P = .0001$).

The distribution of complications related to implant manufacturer and system are listed in Table 2. An association was detected between the implant diameter and complications ($F = 5.478$; $df = 2$; $P = .004$). Wider implants were more prone to loss of osseointegration and thinner implants to infectious complications. Patients receiving more than 1 implant had a greater risk of presenting with implant loss or infectious complications (eg, mucositis, peri-implantitis, or postoperative infection; $F = 36.35$, $df = 2$; $P = 5.57 \cdot 10^{-16}$). The implant length was also associated with a loss of implants or infectious complications ($F = 8.026$; $df = 2$; $P = .0003$). Longer implants were more prone to loss of osseointegration and shorter implants to infectious complications.

Six implant brands were used. Three (Zimmer, Straumann, Biomet 3i-3i) (Zimmer Dental Ibérica S.L.U., Cardedeu, Spain; Straumann S.A., Madrid, Spain; Biomet 3i Ibérica, Cornellà de Llobregat, Spain) accounted for a total of 19 implants and were excluded from the analysis because of the small number of cases. These implants had no complications. Most implants placed were Nobel Biocare (Brånemark and Replace systems; Nobel Biocare

Ibérica, Cornellà de Llobregat, Spain), Impladent SL (Defcon Tissue care system; Impladent S.L., Sentmenat, Spain), and AstraTech (Astra Tech S.A., L'Hospitalet de Llobregat, Spain), all with rough surfaces. In the maxilla, more complications occurred, both infectious and loss of osseointegration ($\chi^2 = 6.27$; $df = 2$; $P = .043$). In the mandible, 82.9% of the implants did not present with any complications, and only 12 fixtures were lost. In contrast, in the maxilla, this rate was clearly greater, with 20 implants failing to osseointegrate and only 76.8% free of complications. The distribution of complications according to implant position (ie, incisor, canine, bicuspid, or molar) is listed in Table 3. No significant differences were found in the complication rates for the different locations (ie, incisor, cuspid, bicuspid, molar), although the location associated with fewer complications was the incisor area ($\chi^2 = 5.577$; $df = 6$; $P = .472$).

Discussion

The pathogenic mechanisms of smoking on wound healing seem to be quite complex. Cigarette smoke contains more than 4,000 toxins, including nicotine, carbon monoxide, nitrosamines, benzenes, aldehydes, and hydrogen cyanide.

Nicotine is a potent vasoconstrictor that reduces blood flow and nutrient delivery to healing sites, caus-

Table 2. OCCURRENCE OF COMPLICATIONS ACCORDING TO IMPLANT MANUFACTURER

Manufacturer	No Complications	Implant Loss	Peri-Implantitis	Mucositis	Postoperative Infection	Total
AstraTech						
Smoking	21 (95.5)	1 (4.5)	0 (0)	0 (0)	0 (0)	22
Nonsmoking	24 (100)	0 (0)	0 (0)	0 (0)	0 (0)	24
Nobel Biocare						
Smoking	174 (80.6)	9 (4.2)	23 (10.6)	9 (4.2)	1 (0.5)	216
Nonsmoking	378 (84.0)	10 (2.2)	17 (3.8)	45 (10.0)	0 (0)	450
Impladent Defcon						
Smoking	90 (62.1)	4 (2.8)	13 (9.1)	37 (25.5)	1 (0.7)	145
Nonsmoking	115 (74.7)	8 (5.2)	17 (11.0)	14 (9.1)	0 (0)	154

Data presented as numbers, with percentages in parentheses.

Straumann, Zimmer, and Biology of Metals 3i not listed because of low number of cases in our sample.

Rodriguez-Argueta et al. *Smoking and Dental Implants. J Oral Maxillofac Surg* 2011.

Table 3. COMPLICATIONS AND IMPLANT LOCATION

Location	No Complications	Implant Loss	Peri-Implantitis	Mucositis	Postoperative Infection	Total
Incisors	255 (83.6)	10 (3.3)	16 (5.2)	23 (7.5)	1 (0.3)	305 (100)
Canine	9 (75)	0 (0)	0 (0)	3 (25)	0 (0)	12 (100)
Premolar	334 (78.2)	13 (3)	32 (7.5)	48 (11.2)	0 (0)	427 (100)
Molar	226 (78.2)	9 (3.1)	22 (7.6)	31 (10.7)	1 (0.3)	289 (100)
Total	824 (79.8)	32 (3.1)	70 (6.8)	105 (10.2)	2 (0.2)	1,033 (100)

Data presented as numbers, with percentages in parentheses.

Rodriguez-Argueta et al. *Smoking and Dental Implants. J Oral Maxillofac Surg* 2011.

ing tissue glucose reduction and acidosis. However, nicotine does not seem to be the only factor responsible for the dramatic decrease in blood flow and oxygen tension in the skin and mucosa observed in smokers.²⁵ Carbon monoxide also reduces the oxygen-carrying capacity of erythrocytes, and hydrogen cyanide causes tissue hypoxia. An experimental work with rats has shown that nicotine does not seem to affect bone development, but it might inhibit the bone matrix-related gene expressions required for wound healing and thereby diminish implant osseointegration at a late stage.²⁶

In contrast, smokers' fibroblast activity and collagen metabolism is affected by a lack of vitamin C and by a change in the inflammatory cell response.^{27,28} Smokers have a vitamin C deficiency, probably owing to the greater turnover caused by the smoke-derived oxidant products and because of a dietary deficit of fruit and vegetables.²⁹

Moreover, some compounds of tobacco also act as chemotactic substances, which enhance tissue destruction by enzymes released by neutrophils and macrophages, such as matrix metalloproteinases.³⁰

Bain and Moy²¹ in 1993, were the first to find a statistical association between tobacco and implant failure. Subsequent studies by De Bruyn and Collaert,³¹ Lambert et al,³² Bain,³³ Moy et al,³⁴ and Klokkevold and Han¹⁵ reported an increased risk of implant failure in smokers. However, implant failure has been associated with many other factors, including bone type and the presence of systemic pathologic disorders, among others.

Studies by Esposito et al^{35,36} in 1998 and Quirynen et al³⁷ in 2001 found no relationship between tobacco use and implant survival. However, Hinode et al³⁸ in a meta-analysis that included 19 studies revealed a high risk of implant failure in smokers compared with nonsmokers (odds ratio 2.17). Most studies referred to the risk of implant failure but did not include other complications such as peri-implantitis or mucositis. In the present study, smokers had a greater risk of osseointegration impairment. The total failure rate in nonsmokers was 17.2% compared with 25.2% in

smokers, in agreement with most of the published data. Bain and Moy²¹ reported an 89% success rate in smokers compared with 95% in nonsmokers. Schwartz-Arad et al¹⁷ reported a failure rate of 4% for smokers and 2% for nonsmokers. Sanchez-Perez et al³⁹ reported a failure rate of 15.8% at 5 years for smokers and 1.4% for nonsmokers. Therefore, smoking is a risk factor for implant survival.^{40,41}

In partially edentulous patients, an implant location in the maxilla has been identified as a risk factor for peri-implant disease.⁴² Some studies have failed to find a relationship between smoking and peri-implant disease,⁴³ and others have found such an association.⁴⁴ Also, a connection exists between smoking and bone loss around the implants, with vasoconstriction of the peri-implant tissues as the etiologic mechanism.⁴⁵

A meta-analysis showed that smoking was a risk factor for implant failure and peri-implant inflammation and also for implant failure in procedures with bone augmentation.⁴⁶ In this meta-analysis, the implant-related odds ratio for smokers was 2.6 for implant failure in nonaugmentation sites and 3.6 when bone augmentation techniques were used.

A recent review reported that smoking was the most commonly identified risk factor for early failure of dental implants.⁴⁷ Smoking seems to have a detrimental effect on the bone integration of implant oxidized surfaces.⁴⁸ Bone regeneration techniques have had poorer results in smokers, and not only because of membrane exposure, but also because of a greater rate of inflammation.⁴⁹ Also, flapless implant insertion might be jeopardized in smokers compared with nonsmokers.⁵⁰

The most common complication encountered in our series was mucositis (11.8% for smokers vs 9.2 for nonsmokers). Peri-implantitis was also more common in smokers (9.2% vs 5.3%). The reason for this could be multifactorial, because the tobacco toxic effects are multiple, including blood flow, chemotactic activity of leukocytes or collagen synthesis, among others.

Defcon Tissue Care implants had significantly more complications than Nobel Biocare implants. AstraTech

was the implant system that had fewer complications. Because the selection of a particular implant system was not randomized and the number of implants from each manufacturer differed, it seems hazardous to draw conclusions.

The implant size was related to complications. A possible explanation is that long implants could heat the bone, making the loss of osseointegration more likely, and short implants are usually placed in sites with considerable resorption, which could interfere with oral hygiene. This last consideration could also explain why thinner implants were more prone to infectious complications.

An association was recorded between the risk of complications and older patients, although this relation might have been from other age-related factors such as systemic diseases (eg, diabetes), bone type, and difficulty in oral hygiene. The number of implants placed is also greater in older patients, and we found an association between this variable and the occurrence of complications.

Smokers had an increased risk of complications (ie, infection, implant loss, mucositis, and peri-implantitis) compared with nonsmoking patients. Although implant therapy can be applied to smokers, these patients should be encouraged to cease this habit or decrease its intensity, otherwise complications could occur.

References

- Lindström D, Sadr-Azodi O, Wladis A, et al: Effect of perioperative smoking cessation intervention on postoperative complications: A randomized trial. *Ann Surg* 248:739, 2008
- Møller AM, Villebro N, Pedersen T, et al: Effect of preoperative smoking intervention on postoperative complications: A randomized clinical trial. *Lancet* 12:114, 2002
- Møller AM, Pedersen T, Villebro N, et al: Effect of smoking on early complications after elective orthopaedic surgery. *J Bone Joint Surg Br* 85:178, 2003
- Sørensen LT, Hørby J, Friis E, et al: Smoking as a risk factor for wound healing and infection in breast cancer surgery. *Eur J Surg Oncol* 28:815, 2002; Erratum in *Eur J Surg Oncol* 29:482, 2003
- Sørensen LT, Hemmingsen UB, Kirkeby LT, et al: Smoking is a risk factor for incisional hernia. *Arch Surg* 140:119, 2005
- Sørensen LT, Hemmingsen U, Kallehave F, et al: Risk factors for tissue and wound complications in gastrointestinal surgery. *Ann Surg* 241:654, 2005
- Sørensen LT, Malaki A, Wille-Jørgensen P, et al: Risk factors for mortality and postoperative complications after gastrointestinal surgery. *J Gastrointest Surg* 11:903, 2007
- Sørensen LT, Jørgensen T: Short-term pre-operative smoking cessation intervention does affect postoperative complications in colorectal surgery: A randomised clinical trial. *Colorectal Dis* 5:347, 2003
- Sørensen LT, Nielsen HB, Kharazmi A, et al: Effect of smoking and abstinence on oxidative burst and reactivity of neutrophils and monocytes. *Surgery* 136:1047, 2004
- Thomsen T, Tønnesen H, Møller AM: Effect of preoperative smoking cessation interventions on postoperative complications and smoking cessation. *Br J Surg* 96:451, 2009
- Noroozi AR, Philbert RF: Modern concepts in understanding and management of the "dry socket" syndrome: Comprehensive review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 107:30, 2009
- Silva CO, Ribeiro-Edel P, Sallum AW, et al: Free gingival grafts: Graft shrinkage and donor-site healing in smokers and non-smokers. *J Periodontol* 81:692, 2010
- Kinane DF, Radvar M: The effect of smoking on mechanical and antimicrobial periodontal therapy. *J Periodontol* 68:467, 1997
- Wan CP, Leung WK, Wong MC, et al: Effects of smoking on healing response to non-surgical periodontal therapy: A multi-level modeling analysis. *J Clin Periodontol* 36:229, 2009
- Klokkevold PR, Han TJ: How do smoking, diabetes, and periodontitis affect outcomes of implant treatment. *Int J Oral Maxillofac Implants* 22:173, 2007; Erratum in *Int J Oral Maxillofac Implants* 23:56, 2008
- Baig MR, Rajan M: Effects of smoking on the outcome of implant: A literature review. *Indian J Dent Res* 18:190, 2007
- Schwartz-Arad D, Samet N, Samet N, et al: Smoking and complications of endosseous dental implants. *J Periodontol* 73:153, 2002
- Sverzut AT, Stabile GA, de Moraes M, et al: The influence of tobacco on early dental implant failure. *J Oral Maxillofac Surg* 66:1004, 2008
- Smith RA, Berger R, Dodson TB: Risk factors associated with dental implants in healthy and medically compromised patients. *Int J Oral Maxillofac Implants* 7:367, 1992
- Weyant RJ: Characteristics associated with the loss and peri-implant tissue health of endosseous dental implants. *Int J Oral Maxillofac Implants* 9:95, 1994
- Bain CA, Moy PK: The association between the failure of dental implants and cigarette smoking. *Int J Oral Maxillofac Implants* 8:609, 1993
- Heitz-Mayfield LJ, Huynh-Ba G: History of treated periodontitis and smoking as risk for implant therapy. *Int J Oral Maxillofac Implants* 24:39, 2009
- Levin L, Schwartz-Arad D: The effect of cigarette smoking on dental implants and related surgery. *Implant Dent* 14:357, 2005
- Park SH, Wang HL: Implant reversible complications: Classification and treatments. *Implant Dent* 14:211, 2005
- Sørensen LT, Jørgensen S, Petersen LJ, et al: Acute effects of nicotine and smoking on blood flow, oxygen, and aerobic metabolism of the skin and subcutis. *J Surg Res* 152:224, 2009
- Yamano S, Berley JA, Kuo WP, et al: Effects of nicotine on gene expression and osseointegration in rats. *Clin Oral Implants Res* 21:1353, 2010
- Palmer RM, Wilson RF, Hasan AS, et al: Mechanisms of action of environmental factors—Tobacco smoking. *J Clin Periodontol* 32:180, 2005
- Sørensen LT, Toft BG, Rygaard J, et al: Effect of smoking, smoking cessation, and nicotine patch on wound dimension, vitamin C, and systemic markers of collagen metabolism. *Surgery* 148:982, 2010
- Hampel JS, Taylor CA, Johnston CS: Vitamin C deficiency and depletion in the United States: The Third National Health and Nutrition Examination Survey, 1988–1994. *Am J Public Health* 94:870, 2004
- Perlstein TS, Lee RT: Smoking, metalloproteinases, and vascular disease. *Arterioscler Thromb Vasc Biol* 26:250, 2006
- De Bruyn H, Collaert B: The effect of smoking on early implant failure. *Clin Oral Implants Res* 5:260, 1994
- Lambert PM, Morris HF, Ochi S: The influence of smoking on 3-year clinical success of osseointegrated dental implants. *Ann Periodontol* 5:79, 2000
- Bain CA: Implant installation in the smoking patient. *Periodontol* 2000 33:185, 2003
- Moy PK, Medina D, Shetty V, et al: Dental implant failure rates and associated risk factors. *Int J Oral Maxillofac Implants* 20:569, 2005
- Esposito M, Hirsh JM, Lekholm U, et al: Biological factors contributing to failures of osseointegrated oral implants. (I). Success criteria and epidemiology. *Eur J Oral Sci* 106:527, 1998
- Esposito M, Hirsh JM, Lekholm U, et al: Biological factors contributing to failures of osseointegrated oral implants. (II). Etiopathogenesis. *Eur J Oral Sci* 106:721, 1998
- Quirynen M, De Soete M, Van Steenberghe D: Infectious risks for oral implants: A review of the literature. *Clin Oral Implants Res* 13:1, 2002

38. Hinode D, Tanabe SI, Yokohama M, et al: The influence of smoking on osseointegrated implant failure: A meta-analysis. *Clin Oral Implants Res* 17:473, 2006
39. Sanchez-Perez A, Moya-Villaescusa MJ, Caffesse RG: Tobacco as a risk factor for survival of dental implants. *J Periodontol* 7:351, 2007
40. Vercruyssen M, Marcelis K, Coucke W, et al: Long-term, retrospective evaluation (implant and patient-centred outcome) of the two-implants-supported overdenture in the mandible. Part 1: Survival rate. *Clin Oral Implants Res* 21:357, 2010
41. Anner R, Grossmann Y, Anner Y, et al: Smoking, diabetes mellitus, periodontitis, and supportive periodontal treatment as factors associated with dental implant survival: A long-term retrospective evaluation of patients followed for up to 10 years. *Implant Dent* 19:57, 2010
42. Koldslund OC, Scheie AA, Aass AM: Prevalence of implant loss and the influence of associated factors. *J Periodontol* 80:1069, 2009
43. Koldslund OC, Scheie AA, Aass AM: The association between selected risk indicators and severity of peri-implantitis using mixed model analyses. *J Clin Periodontol* 38:285, 2011
44. Alissa R, Oliver R: Influence of prognostic risk indicators on osseointegrated dental implant failure: A matched case-control analysis. *J Oral Implantol Epub* 2010 Oct 8
45. Souza JG, Bianchini M, Ferreira C: Relationship between smoking and bleeding on probing. *J Oral Implantol Epub* 2010 Aug 6
46. Strietzel FP, Reichart PA, Kale A, et al: Smoking interferes with the prognosis of dental implant treatment: A systematic review and meta-analysis. *J Clin Periodontol* 34:523, 2007
47. Palma-Carrió C, Maestre-Ferrín L, Peñarrocha-Oltra D, et al: Risk factors associated with early failure of dental implants: A literature review. *Med Oral Patol Oral Cir Bucal Epub* 2011 Jan 3
48. Shibli JA, Piattelli A, Iezzi G, et al: Effect of smoking on early bone healing around oxidized surfaces: A prospective, controlled study in human jaws. *J Periodontol* 81:575, 2010
49. Lindfors LT, Tervonen EA, Sándor GK, et al: Guided bone regeneration using a titanium-reinforced ePTFE membrane and particulate autogenous bone: The effect of smoking and membrane exposure. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 109:825, 2010
50. Nickenig HJ, Wichmann M, Schlegel KA, et al: Radiographic evaluation of marginal bone levels during healing period, adjacent to parallel-screw cylinder implants inserted in the posterior zone of the jaws, placed with flapless surgery. *Clin Oral Implants Res* 21:1386, 2010