

A prospective observational study on perioperative use of antibacterial agents in implant surgery

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Conflict of interest

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Abstract

Background. Dental implant surgery has become routine practice for replacing missing teeth. Little is known about the use of local antiseptics to control the development of bacterial plaque and to facilitate healing, as current practice guidelines do not address this issue.

Objectives. The objectives of this study were to describe antiseptic practices for implant surgery and to assess plaque control at the operative site as well as the investigator's satisfaction.

Material and methods. This prospective, observational study conducted in 4 European countries enrolled 911 adult patients receiving a single or multiple implant on the day of inclusion. Any medication prescribed during the pre- or postoperative periods was documented, particularly antibiotics, antiseptic mouthwashes and topical antiseptic gels. At a follow-up visit, the presence of plaque was documented on teeth adjacent to the implant and its extent determined using the Silness–Löe index.

Results. Oral antibiotics were prescribed prior to surgery in 53.8% of the patients. Antiseptic mouthwashes were prescribed to patients (49.6–65.7%) according to country. Following dental implant placement, 84.1–94.7% of patients were prescribed oral antibiotics, 45.6–86.5% of patients were prescribed antiseptic mouthwash and 72.8–100% of patients were prescribed an antiseptic gel. At the follow-up visit, plaque was observed in 45.4% of the patients. The mean Silness–Löe plaque index was 0.7 or 0.8, indicating a low level of plaque accumulation. The Löe and Silness gingival index was 0.6 or 0.7, which is consistent with a low level of gingival inflammation.

Conclusions. Use of antibiotics pre- and post-surgery is frequent in implant surgery, despite it being discouraged in practice guidelines. Use of antiseptic mouthwashes and topical antiseptic gels is widespread, although treatment paradigms vary widely. Practice guidelines covering antiseptics provision would be useful, since those products could be used as an alternative to antibiotics to facilitate wound healing.

Key words: dental implants, chlorhexidine, antibacterial agents, antiseptic gel, mouthwash

Introduction

Dental implant surgery has become routine practice for replacing missing teeth.^{1,2} In 1988, it was estimated that 100,000–300,000 dental implants were placed every year worldwide,³ whereas more recent data indicates that 3,000,000 people in the USA alone now have dental implants and that this number is growing by 500,000 per year.⁴

Over the last 30 years, considerable evidence has accumulated demonstrating the long-term stability of dental implants, with long-term success rates >95% after 5 years^{5,6} and >90% after 15 years.⁷ However, long-term survival of the implants may be compromised by inflammatory damage of the surrounding peri-implant tissues, leading to bone loss and subsequent implant loss.⁸ This is a consequence of peri-implant mucositis, characterized by inflammation of the mucosa surrounding the implant, or of peri-implantitis, where both the mucosa and the underlying bone are affected.⁸ Peri-implant mucositis may affect 80% of the subjects with dental implants and 50% of the implants, and peri-implantitis up to 56% of subjects and up to 40% of the implants.^{8,9}

Both abovementioned peri-implant diseases are caused by accumulation of bacteria from dental biofilms. As with natural teeth, there is a direct relationship between plaque accumulation and peri-implant disease. For this reason, good oral hygiene and maintenance strategies are critical for the long-term success of dental implant placement. Although international^{10–13} and national^{7,14–16} guidelines on different aspects of dental implant surgery have been published, none of these have specifically focused on peri- or postoperative local antiseptic management aimed at preventing plaque accumulation. In particular, there is no guidance for practitioners on the optimal timing and type of local antiseptic therapy to provide for their patients.

Local antiseptic therapy, using a mouthwash or a gel form containing an active antiseptic agent such as chlorhexidine, is widely accepted in oral surgery to prevent plaque formation and consequently to facilitate wound healing. The purpose of this local antiseptic is firstly to control the development of bacterial plaque in the direct environment of the operative wound, such as on the sutures in soft tissues, on healing screws (used in one-stage treatment procedures) and on adjacent teeth, and secondly to facilitate the physiological healing process by preventing potential delays due to localized inflammatory phenomena. Antiseptic gels may be of particular interest as they are applied directly in situ to the site of the operative wound, where they may provide a barrier effect, and present a longer-lasting antiseptic action compared to a mouthwash. This may provide a perceived benefit to patients who may be reluctant to interfere with the wound site during the postoperative period due to pain and fear of “weakening” the implant. In preclinical models, it has been demonstrated that application of a chlorhexidine-based gel

may speed up the rate of healing of an intrabuccal surgical wound in experimental animals.¹⁷

The lack of explicit consensus practice guidelines for perioperative (especially postoperative but also preoperative) antiseptic management in dental implant surgery has resulted in a range of individualized practices, whose use and outcomes are very insufficiently documented. In addition, disparities in national and even regional practice may exist, especially due to the workings of various health-care systems. It is thus important to collect information on the use of local antiseptic product in routine clinical practice.

The objectives of this study, conducted in 4 European countries, were to describe antiseptic practices for implant surgery and to assess plaque control at the operative site as well as the investigator’s satisfaction. Recommendations for dental care provided by the practitioner after surgery were also evaluated.

Material and methods

This prospective, longitudinal, observational study was conducted in 4 European countries; Poland, Bulgaria, Portugal, and Greece. The investigator sites were dental surgeons’ offices specialized or with a special interest in implantology and with regular implant activity of at least 1 implant per week. The study was performed between October 2015 and January 2016.

Participating centers

Dental surgeons were selected from the national register and stratified by region. Potential sites were randomly selected from each region based on the total number of surgeons in the region. To minimize selection bias, each dental practice was contacted sequentially in the order of the list and invited to participate in the study. Any reasons for refusal were recorded. This process continued until the required number of sites was obtained.

Patients

Adult patients (aged 18 years or older) for whom implant surgery had been indicated by the investigator and who received on the day of inclusion a single or multiple implant for which the surgical site was bordered by at least 1 tooth were eligible to be enrolled in the study. Patients were enrolled on the day they presented for the procedure. The dentist was free to decide if a one- or two-stage procedure and either a single or multiple implant therapy was appropriate and all surgical conditions were accepted. Participants were required to have healthy periodontal tissue or stabilized periodontal disease and patient management was expected to include at least 1 intra-oral antiseptic in the postoperative phase. Participants were excluded

if they were already enrolled in a clinical trial or were totally edentulous. All patients were required to provide informed consent.

Procedures and follow-up

In line with the observational nature of the study, no study-specific interventions were required. Patients were included in the study on the day on which dental implant placement was performed. Each investigator was encouraged to follow their normal routine. Participants received no additional incentives to adhere to the recommendations other than those which the investigator employed in their normal routine. The participant returned after a period of 7–21 days for a follow-up visit to assess the sutures and wound healing, according to routine practice. The time until the follow-up visit was decided by the investigator on a case-by-case basis. Participating sites were monitored throughout the study in order to optimize the quality of the data collected.

Data collection

Data was collected at the inclusion visit on the day of the procedure and on the day of the follow-up visit. At the inclusion visit, the dentist documented the patient's general health and periodontal disease, as well as the type of surgery performed. Any medication prescribed during the preoperative or postoperative periods was documented, and in particular, systemic and local antibacterial treatment – antibiotics and antiseptics (mouthwashes, gels). Other prescribed medications (non-steroidal anti-inflammatory drugs (NSAIDs), oral corticosteroids, oral analgesics, topical analgesics, and scar-healing products) have been also documented (data not shown). Any specific postoperative recommendations or counseling provided were also recorded.

At the follow-up visit, the presence of plaque was documented on teeth adjacent to the implant and its extent determined by the Silness–Loë plaque index.¹⁸ This index measures the accumulation of plaque on 4 surfaces of individual teeth on a four-point Likert scale ranging from 0 (no plaque) to 3 (abundance of soft matter within the gingival pocket and/or on the tooth and gingival margin). The tooth score is calculated as the mean of the individual scores for each of the 4 surfaces. A global score can be calculated as the mean values for several individual teeth. The state of the gums at the operative site (measured on the teeth adjacent to the implant site or on the provisional prosthesis) was scored using the Löe and Silness gingival index.¹⁹ This index measures gingival inflammation in proximity to individual teeth on a five-point Likert scale ranging from 0 (absence of inflammation) to 4 (severe inflammation defined by the presence of erythema, edema, marginal gingival hypertrophy of the unit or spontaneous bleeding, papillary, congestion, or ulceration). Individual tooth

scores or global scores are calculated as for the plaque index. The dentist's satisfaction with the oral antiseptic gel used during the postoperative period was evaluated with respect to 5 items, each rated on a ten-point numerical rating scale ranging from 1 (very unsatisfied) to 10 (very satisfied). Any adverse events reported during the study were to be documented on the case report form.

Sample size determination

The targeted sample size for the study was determined a priori in order to estimate the key variables at an assumed frequency of 50% with an accuracy of 5%. To achieve this, a total of 1,064 (266 per country) patients would be needed to be included. To achieve this, the target number of participating centers was 60 (15 per country), assuming that 70% of the centers would be active at the end of the inclusion period.

Statistical analysis

Analysis of the data was principally descriptive and no hypothesis was tested in the study. Categorical variables are reported as frequency counts and percentages, and continuous variables as mean values with standard deviation (SD) or median values with range. Missing data were not replaced. Data from each country were analyzed separately. The statistical analysis was carried out using SAS[®] v. 9.4 software (SAS Institute, Cary, USA).

Ethics

The study was conducted in accordance with the Guidelines of Good Practice in Epidemiology and pertinent international and national legislation. Approval was received from the national ethics committees in Greece, Poland and Portugal. In Bulgaria, ethics committee approval was waived since the study did not influence patient care. Written informed consent was obtained from all patients and no nominative information was recorded in the study database.

Results

Overall, 911 subjects receiving a dental implant were recruited into the study: 257 in Poland, 275 in Bulgaria, 207 in Greece, and 172 in Portugal. Two subjects in Portugal who were under 18 years of age were excluded from the analysis. The remaining 909 subjects were eligible for analysis. The demographic characteristics of these subjects are presented in Table 1. These were essentially similar between countries, with a mean age of around 50 years and a slight preponderance of women.

Clinical characteristics are presented in Table 2. Patients were comparable between countries, although Greek par-

Table 1. Socio-demographic characteristics of the subjects enrolled

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|---|----------------------------|----------------------------|----------------------------|----------------------------|
| Gender | | | | |
| men | n = 247 109 (44.1%) | n = 271 134 (49.4%) | n = 202 85 (42.1%) | n = 166 75 (45.2%) |
| women | 138 (55.9%) | 137 (50.6%) | 117 (57.9%) | 91 (54.8%) |
| Age, mean \pm SD [years] | n = 251 48.0 \pm 12.2 | n = 274 47.0 \pm 13.2 | n = 204 52.6 \pm 13.2 | n = 166 51.2 \pm 14.1 |
| BMI, mean \pm SD [kg/m ²] | n = 253 24.3 \pm 3.7 | n = 274 24.9 \pm 4.0 | n = 203 25.6 \pm 4.3 | n = 156 24.4 \pm 3.3 |

SD – standard deviation; BMI – body mass index.

Table 2. Clinical characteristics of the subjects enrolled

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|-------------------------------------|------------------------|------------------------|-----------------------|-----------------------|
| Periodontal disease history | n = 251 46 (18.3%) | n = 261 71 (27.2%) | n = 193 84 (43.5%) | n = 166 22 (13.3%) |
| Type of periodontal disease | | | | |
| chronic periodontitis | n = 42 34 (81.0%) | n = 70 65 (92.9%) | n = 78 65 (83.3%) | n = 21 16 (76.2%) |
| aggressive periodontitis | 1 (2.4%) | 4 (5.7%) | 9 (11.5%) | 1 (4.8%) |
| other type of periodontitis | 7 (16.7%) | 1 (1.4%) | 4 (5.1%) | 4 (19.0%) |
| Oral hygiene: presence of plaque | | | | |
| very good (no plaque) | n = 249 128 (51.4%) | n = 269 152 (56.5%) | n = 206 67 (32.5%) | n = 163 65 (39.9%) |
| average (<30% of teeth with plaque) | 119 (47.8%) | 113 (42.0%) | 125 (60.7%) | 92 (56.4%) |
| poor (>30% of teeth with plaque) | 2 (0.8%) | 4 (1.5%) | 14 (6.8%) | 6 (3.7%) |
| Comorbidities | | | | |
| diabetes mellitus | n = 257 8 (3.1%) | n = 275 4 (1.5%) | n = 207 8 (3.9%) | n = 170 4 (2.4%) |
| heart disease | 10 (3.9%) | 9 (3.3%) | 9 (4.3%) | 3 (1.8%) |
| other comorbidity | 25 (9.7%) | 30 (10.9%) | 3 (1.4%) | 3 (1.8%) |
| Tobacco use | | | | |
| current smoker | n = 252 36 (14.3%) | n = 271 65 (24.0%) | n = 206 54 (26.2%) | n = 162 19 (11.7%) |

Table 3. Characteristics of implant surgery performed

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|---|------------------------|------------------------|-----------------------|------------------------|
| Procedures | | | | |
| one-stage surgery | n = 257 58 (22.8%) | n = 275 104 (38.2%) | n = 207 49 (23.8%) | n = 167 102 (61.1%) |
| two-stage surgery | 195 (76.8%) | 168 (61.8%) | 155 (75.2%) | 63 (37.7%) |
| one-stage surgery and two-stage surgery | 1 (0.4%) | – | 2 (1.0%) | 2 (1.2%) |
| Immediate temporization (one-stage surgery) | n = 59 3 (5.1%) | n = 104 33 (31.7%) | n = 51 4 (7.8%) | n = 104 20 (19.2%) |
| Implant placement | | | | |
| single | n = 254 152 (59.8%) | n = 275 156 (56.7%) | n = 207 99 (47.8%) | n = 170 111 (65.3%) |
| multiple | 102 (40.2%) | 119 (43.3%) | 108 (52.2%) | 59 (34.7%) |

ticipants tended to have a higher frequency of periodontal disease and poorer dental hygiene. Comorbidities were documented in less than 10% of subjects and smoking rates were lower than national averages.

Implant surgery was performed in 2 stages for 64.1% of patients, with the exception of patients in Portugal, where one-stage surgery was more frequently performed (Table 3). In the case of one-stage surgery, immediate temporization was only performed in a minority of patients (<10% in Poland and Greece). Multiple sites were implanted in the same procedure for 42.8% of patients.

Preoperative prescription

Around 3/4 of patients (2/3 in Bulgaria) were prescribed an antibiotic or an antiseptic mouthwash, and most frequently both. Oral antibiotics were prescribed prior to surgery in 53.8% of patients, ranging from 48.0% in Poland to 58.6% in Bulgaria (Fig. 1). The most frequently prescribed class of antibiotics were beta-lactams (Table 4). Combinations of more than 1 antibiotic were prescribed to 38.8% of patients in Bulgaria, whereas this practice was uncommon (<5% of patients) in other countries (Table 4).

Table 4. Treatments used prior to dental implant placement

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|---|-------------------|---------------------|-------------------|---------------------|
| Treatment | n = 252 | n = 274 | n = 205 | n = 164 |
| neither antibiotic nor antiseptic mouthwash | 69 (27.4%) | 94 (34.3%) | 51 (24.9%) | 43 (25.9%) |
| antibiotic only | 22 (8.7%) | 46 (16.8%) | 46 (22.4%) | 42 (25.3%) |
| antiseptic mouthwash only | 65 (25.8%) | 20 (7.3%) | 43 (21.0%) | 34 (20.5%) |
| both antibiotic and antiseptic mouthwash | 96 (38.1%) | 114 (41.6%) | 65 (31.7%) | 47 (28.3%) |
| Oral antibiotic | n = 118 | n = 160 | n = 111 | n = 89 |
| beta-lactam | 60 (50.8%) | 57 (35.6%) | 94 (84.7%) | 76 (85.4%) |
| macrolide | 11 (9.3%) | 11 (6.9%) | 2 (1.8%) | 6 (6.7%) |
| combination therapy | 3 (2.5%) | 62 (38.8%) | 5 (4.5%) | 2 (2.2%) |
| Protocol | n = 97 | n = 153 | n = 104 | n = 81 |
| once only prior to procedure | 23 (23.7%) | 72 (47.1%) | 79 (76.0%) | 23 (28.3%) |
| other | 74 (76.3%) | 81 (52.9%) | 25 (24.0%) | 58 (71.7%) |
| Antiseptic mouthwash: treatment duration | n = 157 | n = 132 | n = 106 | n = 79 |
| starting 7 days prior to surgery | 29 (18.5%) | 103 (78.0%) | 21 (19.8%) | 4 (5.1%) |
| starting 24 h prior to surgery | 12 (7.6%) | 13 (9.9%) | 50 (47.2%) | 17 (21.5%) |
| starting on the day of the procedure | 112 (71.3%) | 14 (10.6%) | 35 (33.0%) | 55 (69.6%) |
| other treatment duration | 4 (2.6%) | 2 (1.5%) | 0 | 3 (3.8%) |
| Antiseptic mouthwash: treatment frequency | n = 32 | n = 107 | n = 36 | n = 19 |
| number of times per day (mean ±SD) | 2.6 ±0.5 | 2.2 ±0.8 | 2.6 ±0.5 | 2.5 ±0.5 |

SD – standard deviation.

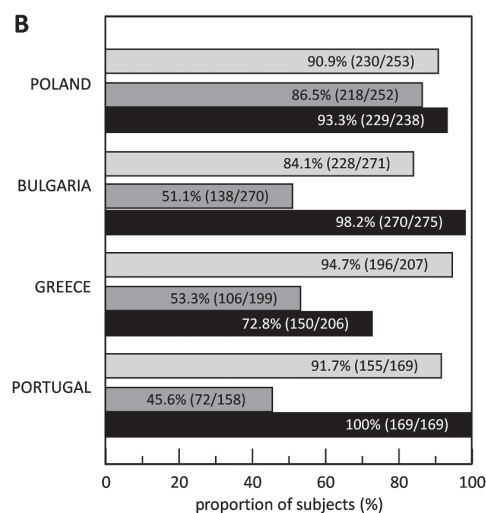
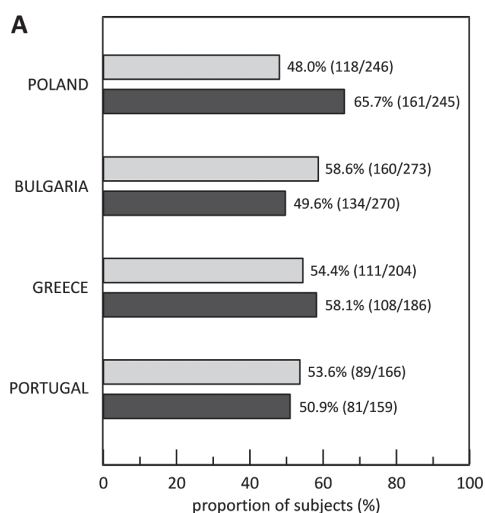


Fig. 1. Antibacterial agents in implant surgery

Greece was the only country where the majority of patients were instructed to take the antibiotic only once prior to the procedure (Table 4). Antiseptic mouthwashes were prescribed in all countries, the frequency of use ranging from 49.6% of patients in Bulgaria to 65.7% in Poland (Fig. 1). In Poland and Portugal, the mouthwash was most frequently started on the day of the procedure, whereas in Bulgaria the majority of patients were prescribed an antiseptic mouthwash to be used for 7 days prior to the procedure (Table 4).

Postoperative prescription

Over 90% of patients received either a systemic antibiotic or an antiseptic mouthwash or both (Table 5). Oral antibiotics were prescribed following dental implant placement to the majority of patients in all countries, ranging

from 84.1% in Bulgaria to 94.7% in Greece (Fig. 1). Again, beta-lactams were the most frequently prescribed class of antibiotic (Table 5). A relatively high proportion of patients in Bulgaria (30.7%) and, to a lesser extent, in Greece (20.4%) were prescribed more than 1 antibiotic (Table 5). An antiseptic mouthwash was prescribed to around half of the patients, except in Poland, where 86.5% received such a product (Fig. 1). For all but 18 patients who were prescribed a mouthwash, the active antiseptic ingredient was chlorhexidine. A topical antiseptic gel containing chlorhexidine was prescribed to nearly all patients, except in Greece, where this was the case for 72.8% of patients (Fig. 1). The gel was generally to be applied 2 or 3 times a day, and using a finger. In up to 40.4% of patients (in Portugal), a brush was used to apply the gel (Table 5). The duration of treatment was generally around 10 days. Use of an antiseptic gel did not differ according

Table 5. Treatments prescribed for the postoperative period

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|---|-------------------|---------------------|-------------------|---------------------|
| Treatment | n = 255 | n = 275 | n = 207 | n = 170 |
| neither antibiotic nor antiseptic mouthwash | 15 (5.8%) | 25 (9.1%) | 4 (1.9%) | 7 (4.1%) |
| antibiotic only | 22 (8.6%) | 112 (40.7%) | 97 (46.9%) | 91 (53.5%) |
| antiseptic mouthwash only | 10 (3.9%) | 22 (8.0%) | 7 (3.4%) | 8 (4.7%) |
| both antibiotic and antiseptic mouthwash | 208 (81.6%) | 116 (42.2%) | 99 (47.8%) | 64 (37.7%) |
| Oral antibiotic | n = 230 | n = 228 | n = 196 | n = 155 |
| beta-lactam | 120 (52.2%) | 72 (31.6%) | 144 (73.5%) | 121 (78.1%) |
| macrolide | 43 (18.7%) | 18 (7.9%) | 10 (5.1%) | 17 (11.0%) |
| combination therapy | 16 (7.0%) | 70 (30.7%) | 40 (20.4%) | 6 (3.9%) |
| other | 48 (20.9%) | 51 (22.4%) | 5 (2.6%) | 12 (7.7%) |
| Chlorhexidine-based antiseptic gel | n = 257 | n = 275 | n = 207 | n = 170 |
| | 238 (92.6%) | 270 (98.2%) | 150 (72.5%) | 169 (99.4%) |
| Time after procedure initiated, mean \pm SD [h] | n = 229 | n = 253 | n = 137 | n = 156 |
| | 11.4 \pm 13.2 | 8.8 \pm 10.5 | 12.1 \pm 7.3 | 4.6 \pm 6.0 |
| Number of applications per day | n = 233 | n = 266 | n = 143 | n = 164 |
| 1 | 13 (5.6%) | 4 (1.5%) | 0 | 1 (0.6%) |
| 2 | 106 (45.5%) | 88 (33.1%) | 69 (48.3%) | 56 (34.2%) |
| 3 | 105 (45.1%) | 56 (21.1%) | 54 (37.8%) | 51 (31.1%) |
| 4 or more | 9 (3.9%) | 118 (44.4%) | 20 (14.0%) | 56 (34.2%) |
| Duration of treatment, mean \pm SD [days] | n = 200 | n = 234 | n = 100 | n = 141 |
| | 10.1 \pm 4.0 | 10.5 \pm 4.5 | 11.5 \pm 4.6 | 12.3 \pm 5.7 |
| Method of application | n = 199 | n = 237 | n = 121 | n = 141 |
| brush | 36 (18.1%) | 1 (0.4%) | 30 (24.8%) | 31 (22.0%) |
| finger | 160 (80.4%) | 232 (97.9%) | 89 (73.6%) | 84 (59.6%) |
| tongue | 0 | 4 (1.7%) | 0 | 0 |
| brush and finger | 3 (1.5%) | 0 | 2 (1.7%) | 26 (18.4%) |

SD – standard deviation.

to the characteristics of the patient or of the surgery undergone (data not shown).

In addition, recommendations on appropriate hygiene techniques were given to 80.2% of the patients and recommendations on cleaning the remaining teeth given to 80.5%. Overall, 88.5% of patients were advised not to eat on the side of the operation and 87.8% to apply ice to relieve swelling. The pattern of these recommendations was similar between countries (Table 6), with the exception of Bulgaria, where patients were more frequently advised to refrain from

smoking (76.7% of patients) and less frequently advised to apply ice (63.1%) than in the other 3 countries (Table 6).

Clinical follow-up

The clinical follow-up visit was made on average 9.7 \pm 6.5 days after surgery, although this interval was highly variable (range: 0–97 days). The median interval was 8 days in all countries except Greece, where it was 7 days. At the follow-up visit, plaque was observed in 45.4% of patients, with

Table 6. Recommendations for postoperative care

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|---|------------------------|------------------------|------------------------|------------------------|
| Avoiding eating on the side of the wound | n = 254 223 (87.8%) | n = 275 245 (89.1%) | n = 207 174 (84.1%) | n = 169 159 (94.1%) |
| Avoiding sucking on the side of the wound | n = 254 151 (59.5%) | n = 275 219 (79.6%) | n = 207 108 (52.2%) | n = 169 108 (63.9%) |
| Recommendations on appropriate hygiene techniques | n = 254 196 (77.2%) | n = 275 238 (86.6%) | n = 206 151 (73.3%) | n = 168 139 (82.7%) |
| Brushing the operated area with an appropriate material | n = 255 71 (27.8%) | n = 275 164 (59.6%) | n = 206 67 (32.5%) | n = 168 112 (66.7%) |
| Recommendations for brushing the remaining teeth | n = 253 209 (82.6%) | n = 274 205 (74.8%) | n = 207 178 (86.0%) | n = 170 136 (80.0%) |
| Not smoking | n = 249 87 (34.9%) | n = 275 211 (76.7%) | n = 205 52 (25.4%) | n = 162 89 (54.9%) |
| Applying ice | n = 254 245 (96.5%) | n = 255 161 (63.1%) | n = 207 202 (97.6%) | n = 170 170 (100%) |

Table 7. Clinical follow-up

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|---|------------------------|-----------------------|------------------------|-----------------------|
| Presence of visible plaque | n = 234 101 (43.2%) | n = 253 97 (38.3%) | n = 182 101 (55.5%) | n = 151 73 (48.3%) |
| Mean plaque score on tooth/teeth adjacent to operating site | n = 231 0.7 ±0.7 | n = 251 0.8 ±0.7 | n = 192 0.8 ±0.7 | n = 136 0.8 ±0.7 |
| Löe and Silness gingival index | | | | |
| Mean score on tooth/teeth adjacent to operating site | n = 228 0.7 ±0.6 | n = 250 0.6 ±0.6 | n = 196 0.7 ±0.7 | n = 138 0.7 ±0.6 |
| Mean score on healing screws (for one-stage operations) | n = 82 0.6 ±0.6 | n = 90 0.7 ±0.7 | n = 54 0.8 ±0.6 | n = 85 0.4 ±0.6 |

no major differences being observed between countries (Table 7). The mean Silness–Löe plaque index on teeth adjacent to the operating site was 0.7 or 0.8 in all 4 countries, indicating a low level of plaque accumulation (Table 7). The Löe and Silness gingival index was 0.6 or 0.7 according to country, both for teeth adjacent to the operating site and on the healing screws in the operating site (Table 7). This is consistent with a low level of gingival inflammation.

Physician satisfaction

In all countries, physicians expressed high levels of satisfaction with oral antiseptic gels for use in the postoperative period (Table 8). On all 5 items, mean satisfaction scores were ≥ 7.8 on a scale ranging from 1 to 10. Satisfaction levels were generally lowest in Portugal (range: 7.8–8.5 according to item) and highest in Bulgaria (8.5–9.5). With regard to individual items, the lowest scores were observed for plaque control (range: 7.8–8.5 according to country) and highest for suitability for postoperative management after implant surgery (8.5–9.5).

Discussion

This observational study performed in 4 European countries indicates that antiseptic therapy using mouthwashes and, in the postoperative period, topical antiseptic gels

is a well-established part of the implant surgery protocol. Some differences were observed between countries in these practices, for example in the duration of treatment before surgery or in the extent of use in the postoperative period. Prior to surgery, around half of patients received oral antibiotics (53.8%) and a similar proportion received an antiseptic mouthwash (56.3%), although 28.7% received neither. These proportions were similar between countries. These 2 types of treatment were administered in the postoperative period. Around 90% of patients were prescribed an oral antibiotic in all countries, around 50% were prescribed an antiseptic mouthwash, except in Poland, where this was the case for 86.5% of patients. Topical antiseptic gels were prescribed to $>90\%$ of patients in all countries, except in Greece (72.8%). A likely explanation of this practice in Greece is that clinicians prescribe antibiotic treatment post-surgically to $\sim 95\%$ of patients (the highest percentage among the 4 countries) and, for this reason, local antiseptic gel is only prescribed adjunctively to the antibiotic. In Poland, due to the emphasis on reducing antibiotic therapy in generally healthy dental patients, local antiseptic with a mouthwash or gel is generally encouraged in pre-procedural and post-surgical protocols. In Portugal, clinicians are used to prescribe antibiotics in conjunction with implant surgery. Since bone grafts are very commonly used together with implant surgery, this could justify the need for antibiotics. The use of oral antiseptic rinses has been considered for many years to be

Table 8. Physician satisfaction with oral antiseptic gels for use in the postoperative period

| Variable | Poland n = 257 | Bulgaria n = 275 | Greece n = 207 | Portugal n = 170 |
|--|---------------------|---------------------|---------------------|---------------------|
| Plaque control at the operating site(s) | n = 256 8.2 ±1.7 | n = 268 8.5 ±1.4 | n = 202 8.1 ±1.5 | n = 164 7.8 ±1.9 |
| Inflammatory status at the operative site(s) | n = 255 8.1 ±1.6 | n = 268 8.9 ±1.5 | n = 202 8.2 ±1.5 | n = 164 8.2 ±2.8 |
| Quality of wound healing of surgical site | n = 255 8.6 ±5.2 | n = 268 9.1 ±1.5 | n = 202 8.4 ±1.4 | n = 163 8.3 ±1.8 |
| Effectiveness for postoperative management | n = 236 8.4 ±1.5 | n = 265 9.3 ±1.4 | n = 147 8.7 ±1.1 | n = 161 8.4 ±1.5 |
| Suitability for postoperative management | n = 235 8.6 ±1.5 | n = 263 9.5 ±1.3 | n = 144 8.7 ±1.1 | n = 161 8.5 ±1.5 |

good practice in most of the postoperative care protocols. In spite of certain practice differences between countries, due to diversity in education, healthcare system organization and economic level, practice was in general similar and the outcome in terms of absence of plaque around the implantation site was also similar.

No apparent differences were observed in the extent of antiseptic use according to the type of surgery performed. Practitioners in all countries encouraged appropriate hygiene techniques to ensure that plaque did not build up at the operative area. Ice was recommended to reduce pain and inflammation and refraining from smoking was advised to encourage healing.

Scientific evidence for the benefits of antibiotic prophylaxis during implant placement is limited.²⁰ In the early era of dental implant placement, implant surgery was seen as posing a high risk of infection and, for this reason, prophylactic antibiotic treatment before surgery was proffered systematically as a precautionary measure.²¹ However, the evidence accumulated from randomized clinical trials of perioperative antibiotic use in dental implant surgery suggests that the benefits are marginal.^{21–24} Current evidence is insufficient to recommend or discourage the use of prophylactic systemic antibiotics to prevent complications and failures of dental implants.²⁰ Nonetheless, given the problem of antibiotic resistance, it is now recommended that use of antibiotics prior to uncomplicated dental implant placement surgery be limited to patients who are at specific risk for infections, such as immunosuppressed patients, or possibly in patients at high risk of failure, such as those undergoing immediate post-extractive implant placement.^{21,23,25,26} The potential benefit needs to be assessed at the individual patient level and carefully weighed against the risk of adverse reactions, side effects and the emerging problems with antibiotic resistance.^{20,21} In the present study, around 50% of the patients received antibiotics prior to surgery and around 90% received them for the postoperative period. These proportions suggest that prescription of antibiotics in routine practice in all participating countries extended well beyond the population of patients expected to be at specific risk.

With respect to antiseptic use during the postoperative period, a topical gel was prescribed to virtually all patients and around half received an antiseptic mouthwash as well. All the gel products and most of the mouthwashes contained chlorhexidine. Considerable variation was observed within countries, and to a lesser extent between countries, in the recommendations given to patients on when to start using the antiseptic gel after surgery, on how many times a day the gel was to be applied and for how many days the treatment should be continued following surgery. It may be helpful for practitioners and for planning of health service provision to develop standard protocols for the use of topical antiseptic gels after dental implant surgery.

Whatever the antibacterial protocol used for this study, the outcome at the follow-up visit was satisfactory. Both

the Silness–Loë plaque index and the Löe and Silness gingival index on the teeth adjacent to the implantation site were <1, indicating good gingival status. Since the follow-up visit occurred at most 3 weeks after surgery, this is a good result. In addition, participating physicians reported being very satisfied with the suitability and effectiveness of topical antiseptic gels for postoperative management following dental implant surgery.

This study has several strengths and limitations. The strengths include the large number of patients included and the use of an identical protocol in 4 countries with very different healthcare systems. The limitations include the fact that, since dentist participation in the study was voluntary, it was not possible to ensure that their practice is representative of all implant surgery in the country. Given the design of the study, caution should therefore be exercised in interpreting the results. In addition, no long-term follow-up data was collected which could provide information on the benefits of antibiotic or antiseptic treatment in the postoperative period on periodontal health or on the need for supportive periodontal therapy a year following surgery.

Conclusions

The use of antiseptic mouthwashes prior to dental implant surgery and use of topical antiseptic gels after surgery is widespread in the countries participating in the study. However, treatment paradigms vary widely and it would be helpful to develop practice guidelines covering antiseptic provision in this field. Use of antibiotics is still widespread, in spite of this being discouraged in current practice guidelines, and may not have been justified in certain patients. Where antibiotics are not justified, antiseptics could be used as an alternative to ensure satisfactory wound healing. Nevertheless, interventional studies should be conducted to support this hypothesis and to identify the most appropriate protocol of administration. Education programs for dental surgeons on the issue of antibiotic use in implant surgery would be useful.

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