Antibiotic prophylaxis during oral implant surgery in Northwest China

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Research Article

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Abstract

Background

There is still no consensus on prophylactic antibiotics in dental implants in China. This study aims to further understand the current status of prophylactic antibiotics in dental implants in China and to provide evidence-based data for the guidelines of prophylactic antibiotic use in dental implants.

Methods

This study is based on a cross-sectional study of a National dental implant specialist member. The questionnaire survey was conducted from April to December of 2021. It consisted of three parts: the basic information of respondents, the cognitive environment of using prophylactic antibiotics in dental implants in Northwest China, and the use of antibacterial in dental implants. The conclusion was drawn by statistical analysis of the questionnaire survey.

Results

A total of 318 dentists were surveyed. Approximately 65.41% of respondents generally prescribed antibiotics during dental implant surgery, 33.65% just prescribed antibiotics under certain circumstances, and 0.94% never prescribed antibiotics. The most frequently-used antibiotic classes were penicillin (such as amoxicillin), cephalosporin (such as cefazolin), and nitroimidazole (such as metronidazole). It is common to treat patients with a combination of antibiotics. Furthermore, 55.87% of respondents used antibiotics for more than 24 hours in common dental implants, and 85.08% used antibiotics in dental implants with bone grafts.

Conclusions

Since there are no standards for regulations about the choice of varieties, dosage, and course of prescribing antibiotics during dental implants, the use of prophylactic antibiotics is largely based on the experience of dentists. Therefore, it’s necessary to formulate guidelines for using antibiotics in dental implants, improve the standardization of antibiotics, and prevent overuse and bacterial resistance.

Introduction

Nowadays, dental implants are the most predictable treatment for restoring missing teeth due to their positive long-term clinical results. However, implant failures caused by post-operative infection, smoking, surgical operation, etc., indeed occur[1, 2]. Given that more than 500–700 bacterial species live in the oral cavity, the prescription of antibiotic prophylaxis has been incorporated into implant surgery to prevent surgical site infection.
Epidemiological studies have shown that antibiotic use is directly related to the emergence of resistant bacterial strains[3]. Therefore, antibiotic use must align with verified scientific evidence so that bacteria resistance against antibiotics will develop slowly. However, no worldwide consensus about antibiotic prophylaxis during dental implants has been established. A Cochrane systematic review of randomized controlled trials (RCTs) in 2013 has shown that antibiotic prophylaxis effectively reduces early dental implant failures [4, 5]. However, given the possible risks of antibiotic resistance and threat to public health, some evidence further suggests that antibiotic prophylaxis should not be recommended in “straightforward” implant surgery in systemically healthy patients [6, 7].

A high prevalence of antibiotic prescription has been reported in many countries[8–10], with approximately 10% of all commonly used antibiotics being prescribed by dentists [11]. Some studies have surveyed the prescribing habits of clinicians dealing with dental implant surgery in different countries, including Turkey, Spain, Italy, and the Netherlands[12–15]. Even within the same country, clinicians differ significantly on the use of antibiotics in routine dental implants.

China is one of the largest manufacturers and consumers of antibiotics in the world [16], but the resistance rates for multiple pathogens have reached alarming levels [17]. A nationwide study based on 48 healthcare facilities in six provinces in China found that 52.9% of outpatient visits in primary care settings involved antibiotics [18]. Therefore, it is crucial for China to take action to promote the rational use of antibiotics. However, how dentists use antibiotics in dental implant surgery in China remains unclear.

The primary aim of this study is to investigate the current situation of antibiotic prescription habits and the cognitive environment of antibiotics in dental implants in China. The secondary aim is to assess the type and amount of antibiotics prescribed to evaluate whether any consensus has been reached. This study will provide data from China to guide prophylactic antibiotics in dental implant surgery.

Infection is the leading cause of early implant failure [6, 13, 19, 20]. Using antibiotics for dental implants can prevent and reduce the risk of infection [7, 21–25] and produce a local sterile environment that benefits wound healing and bone integration [4, 5, 26, 27]. Pathogenic bacteria can directly or indirectly cause peri-implant infection and damage the osseointegration of implants by generating destructive inflammatory mediators.

Antibiotics have been widely used in the prevention and treatment of oral diseases. Meanwhile, their side effects have attracted widespread attention [28]. Several aspects, such as bacterial resistance, adverse reactions to antibiotics, and the pressure of medical insurance payment, are related to the rational use of antibiotics [11, 29]. About 10% of commonly used antibiotics are prescribed by dentists [11]. According to the Center for Disease Control, about one-third of outpatient antibiotic prescriptions are unnecessary [30]. However, dentists worldwide routinely use antibiotics to prevent infection when performing invasive dental procedures [31].
Methods

This observational cross-sectional study is reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines[32], all methods were performed in accordance with the relevant guidelines and regulations.

Participants

In China, most oral implantologists are members of the Chinese Stomatological Association Oral Implantology Committee. As of April 2021, 6351 members registered in the Chinese Stomatological Association Oral Implantology Committee member network(http://www.cn/dent.com/), and the email address or contact information of 2099 members was obtained in Northwest China. Questionnaires were then sent to them via email or WeChat, and the finished questionnaires were collected until December 2021.

Study design

According to the circumstances in China, the questionnaire was designed to collect data concerning the prescription habits of preventive antibiotics during oral implant therapy. An experienced oral implantologist then reviewed the questionnaire for comprehensibility and logical order. How the questions were formulated was found appropriate for assessing the intended objectives. The questionnaire mainly consists of three parts: the basic information of respondents (Table 1), the cognitive situation of prophylactic antibiotics in dental implants (Table 2), and the use of antibacterial in dental implants (Table 3).

Table 1  The basic information
| 1. Your professional title | Primary title  
|                           | Middle title  
|                           | Senior title  |
| 2. Your educational background | Bellow Bachelor  
|                                | Bachelor  
|                                | Master  
|                                | Doctor  |
| 3. Your profession | General stomatology  
|                    | Oral and maxillofacial surgery  
|                    | Oral implantology  
|                    | Prosthodontics  |
| 4. Type of your current organization | Stomatological hospital  
|                                   | Department of stomatology, general hospital  
|                                   | Dental clinic  |
| 5. Number of implants placed per year? | $\geq 100$  
|                                        | 51-100  
|                                        | $\leq 50$  |

Table 2 Cognitive situation of prophylactic antibiotics in dental implants.
<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
</table>
| 6. Do you use antibiotics during the perioperative period of dental implants? | Never  
Sometimes  
Always |
| 7. During the perioperative period of dental implants, do you think which problems need to be further clarified? | Indications for antibiotic use  
Antibiotic types  
Course of using antibiotics  
Starting time  
Others |
| 8. The reason and necessity of establishing the guideline for prophylactic antibiotics in dental implant | Reduce the overuse of antibiotics  
Standardize the use of antibiotics  
Protect professional rights and interests in a lawsuit  
Others |

Table 3 Questions about antibiotic prescription habits of the clinicians.
9. When do you use antibiotics in dental implant surgery

- Only pre-operative
- Pre- and post-operative
- Only post-operative
- Only in special cases

10. If you suggest pre-operative administration, then the specific time of administration is

- More than 1 day prior
- 1 day prior
- 1h prior
- Immediately

11. Antibiotic types. Which antibiotic do you prefer? Please assume that the patients had no antibiotic allergies.

- Penicillins (e.g., amoxicillin)
- Cephalosporins (e.g., cefazolin)
- Macrolides (e.g., roxithromycin)
- Lincomycin (e.g., clindamycin)
- Nitroimidazoles (e.g., metronidazole)
- Others

12. Course of antibiotics for common dental implants

- ≤24h
- 24h
- ≤24h
- 24h

13. Course of antibiotics for dental implants which use bone grafts

- ≤24h
- 24h
- ≤24h
- 24h

Statistical Methods

SPSS 22.0 software was used for data analysis. Measurement data were expressed in (x ± s), and the t-test or ANOVA were used for comparison. Counting data were expressed in examples (percentages), and the comparison was carried out by the χ² test. P<0.05 indicates a statistically significant difference.

Results
Participants

A total of 318 participants returned the survey with a response rate of 15.15%.

Demographic data

The 318 participants are from Northwest China, and the effective recovery is 100% for the questionnaire. Among all participants, 27.99% of respondents have senior professional qualifications; 50.94% have intermediate professional qualifications; 11.32% have doctorate degrees; 27.04% have master’s degrees; 48.43% have bachelor’s degrees; 49.69% performed more than 50 dental implant operations per year (Table 4).

Table 4 Basic information of the respondents (n=318).
The status quo of prophylactic antibiotics

The survey results showed that over half of dentists (65.41%, n=318) routinely prescribed antibiotic prescriptions, but 0.94% (n=318) stated never using antibiotics, and 33.65% (n=318) respondents sometimes prescribed antibiotics but not routinely when the patients had an underlying disease (Table 4).
Cognitive situation of using prophylactic antibiotics

Regarding the use of antibiotics in dental implant surgery, which needs further clarification, 44.40% of the respondents were more concerned about the indications for antibiotic use. Fewer respondents focused on the types and the course of using antibiotics (Figure 1).

Most respondents with different professional qualifications believed that the significance of the guidelines for prophylactic antibiotics in dental implants is mainly to reduce the overuse of antibiotics and standardize the use of antibiotics in dental implants. Furthermore, 59.55% of respondents with senior professional qualifications thought that the development of guidelines may protect professional rights and interests in a lawsuit (Figure 2).

Current status of prophylactic antibiotic use in dental implant surgery

Time to use antibiotics

In addition to three respondents reporting never using antibiotics, 315 respondents routinely used antibiotics during dental implants. Regarding when to use antibiotics in the perioperative period, most respondents said they would choose a pre- and post-operative protocol (74.60%), while only 4.13% chose a pre-operative and 15.87% chose a post-operative protocol. Most respondents used prophylactic antibiotics 1 hour before the surgery. Table 5

Table 5  Timing of prophylactic antibiotic use (n=315).
Antibiotic types

The questionnaire survey showed that nitroimidazoles, penicillins, and cephalosporins were the most commonly chosen types of prophylactic antibiotics in dental implants (Figure 3). Considering the advantages of anaerobes in oral infection, respondents usually used a combination of nitroimidazoles. The survey also showed that 37.14% of respondents used nitroimidazoles in combination with penicillin, and 31.11% used nitroimidazoles in combination with cephalosporins (Figure 3), so nitroimidazoles accounted for the highest proportion.

Course of using antibiotics

According to the guideline for the Clinical Application of Antibiotics in China (2015), most maxillofacial surgeries are clean-contaminated surgery, and the course of prophylactic antibiotic is less than 24 hours. The survey results show that 44.13% of respondents used antibiotics for less than 24 hours, while 55.87% used antibiotics for more than 24 hours in common dental implant surgeries. As shown in Table 6, for this 55.87%, the primary, middle, and senior degrees account for 50%, 53.13%, and 65.17%, respectively, and the respondents from the stomatological hospital, department of stomatology general hospital, and dental clinic account for 48.31%, 56.26%, and 61.21%, respectively. Table 6.

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only pre-operative</td>
<td>13</td>
<td>4.13%</td>
<td>4</td>
<td>15.38%</td>
</tr>
<tr>
<td>-more than 1 day prior</td>
<td>1</td>
<td>7.69%</td>
<td>1</td>
<td>7.69%</td>
</tr>
<tr>
<td>-1 day prior</td>
<td>1</td>
<td>7.69%</td>
<td>9</td>
<td>69.23%</td>
</tr>
<tr>
<td>-1h prior</td>
<td>2</td>
<td>15.38%</td>
<td>2</td>
<td>15.38%</td>
</tr>
<tr>
<td>-immediately</td>
<td>2</td>
<td>15.38%</td>
<td>2</td>
<td>15.38%</td>
</tr>
<tr>
<td>Pre- and post-operative</td>
<td>235</td>
<td>74.60%</td>
<td>235</td>
<td>74.60%</td>
</tr>
<tr>
<td>-more than 1 day prior</td>
<td>39</td>
<td>16.60%</td>
<td>39</td>
<td>16.60%</td>
</tr>
<tr>
<td>-1 day prior</td>
<td>58</td>
<td>24.68%</td>
<td>58</td>
<td>24.68%</td>
</tr>
<tr>
<td>-1h prior</td>
<td>125</td>
<td>53.19%</td>
<td>125</td>
<td>53.19%</td>
</tr>
<tr>
<td>-immediately</td>
<td>13</td>
<td>5.53%</td>
<td>13</td>
<td>5.53%</td>
</tr>
<tr>
<td>Only post-operative</td>
<td>50</td>
<td>15.87%</td>
<td>50</td>
<td>15.87%</td>
</tr>
<tr>
<td>Only in special cases</td>
<td>17</td>
<td>5.40%</td>
<td>17</td>
<td>5.40%</td>
</tr>
<tr>
<td>Total</td>
<td>315</td>
<td>100.00%</td>
<td>315</td>
<td>100.00%</td>
</tr>
</tbody>
</table>
In dental implants with bone grafts, antibiotics were used for less than 24 hours by 14.92% of respondents and for more than 24 hours by 85.08% of respondents. For the 85.08% of respondents, primary, middle, and senior degrees account for 81.82%, 83.75%, and 89.89%, respectively. Regarding organization, among the 85.08% of respondents, respondents from the stomatological hospital, department of stomatology general hospital, and dental clinics account for 83.15%, 83.64%, and 87.93%, respectively (Table 7). The prophylactic course of antibiotics for bone grafting is significantly longer than common dental implants.

Table 7 Course of antibiotics for dental implants with bone grafts (n=315)

<table>
<thead>
<tr>
<th>Category</th>
<th>n/%</th>
<th>≤24h /%</th>
<th>n</th>
<th>&gt;24h /%</th>
<th>n</th>
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<tr>
<td>Professional qualifications</td>
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<td></td>
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<tr>
<td>Primary</td>
<td>33</td>
<td>50.00</td>
<td>33</td>
<td>50.00</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>75</td>
<td>46.87</td>
<td>85</td>
<td>53.13</td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>31</td>
<td>34.83</td>
<td>58</td>
<td>65.17</td>
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<tr>
<td>Organization</td>
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</tr>
<tr>
<td>Stomatological hospital</td>
<td>46</td>
<td>51.69</td>
<td>43</td>
<td>48.31</td>
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<td>Department of stomatology</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>general hospital</td>
<td>48</td>
<td>43.64</td>
<td>62</td>
<td>56.26</td>
<td></td>
</tr>
<tr>
<td>Dental clinic</td>
<td>45</td>
<td>38.79</td>
<td>71</td>
<td>61.21</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>139</td>
<td>44.13</td>
<td>176</td>
<td>55.87</td>
<td></td>
</tr>
</tbody>
</table>

In dental implants with bone grafts, antibiotics were used for less than 24 hours by 14.92% of respondents and for more than 24 hours by 85.08% of respondents. For the 85.08% of respondents, primary, middle, and senior degrees account for 81.82%, 83.75%, and 89.89%, respectively. Regarding organization, among the 85.08% of respondents, respondents from the stomatological hospital, department of stomatology general hospital, and dental clinics account for 83.15%, 83.64%, and 87.93%, respectively (Table 7). The prophylactic course of antibiotics for bone grafting is significantly longer than common dental implants.

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<table>
<thead>
<tr>
<th>Category</th>
<th>n/%</th>
<th>≤24h /%</th>
<th>n</th>
<th>&gt;24h /%</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional qualifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>12</td>
<td>18.18</td>
<td>54</td>
<td>81.82</td>
<td></td>
</tr>
<tr>
<td>Middle-level</td>
<td>26</td>
<td>16.25</td>
<td>134</td>
<td>83.75</td>
<td></td>
</tr>
<tr>
<td>Senior</td>
<td>9</td>
<td>10.11</td>
<td>80</td>
<td>89.89</td>
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<tr>
<td>Organization</td>
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<tr>
<td>Stomatological hospital</td>
<td>15</td>
<td>16.85</td>
<td>74</td>
<td>83.15</td>
<td></td>
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<tr>
<td>Department of stomatology</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>general hospital</td>
<td>18</td>
<td>16.36</td>
<td>92</td>
<td>83.64</td>
<td></td>
</tr>
<tr>
<td>Dental clinic</td>
<td>14</td>
<td>12.07</td>
<td>102</td>
<td>87.93</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>14.92</td>
<td>268</td>
<td>85.08</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

The respondents of this survey are from Northwest China, and the organizations involved are the stomatological hospital, the department of stomatology general hospital, and dental clinics. There are no guidelines for prophylactic antibiotic use in dental implants in China. The results of this questionnaire have important implications for the selection, medication time, combination, and course of antibiotics. The results are consistent with the survey results of the United Kingdom [31], India [33], Spain [13], Italy [34], the Netherlands [35], the United States [36], Sweden [37], Santo Domingo, Dominican Republic [38], etc. To a certain extent, the results of this questionnaire are representative.
55.5% of respondents in this questionnaire routinely prescribe antibiotics to prevent infection in dental implant surgery, consistent with the survey results in Britain[31]. In Italy[34], 84% of dentists routinely use antibiotics to prevent infection; in the Netherlands[35], 43.7% of dentists routinely use antibiotics. The data on never using antibiotics in dental implant surgery varies greatly in different countries. In China, only 0.94% never use antibiotics to prevent infection, while in Italy, only 1 of 160 dentists perform implant surgery without using antibiotics[34], 3.3% in the Netherlands[35], 13% in the UK[31], and 25.9% in Santo Domingo, Dominican Republic[38].

For the selection of prophylactic antibiotics in dental implant surgery, the preferred types of prophylactics in China are penicillins, cephalosporins, and nitroimidazoles. The dosage of antibiotics is given according to the commonly used dosage in the manual or drug instructions. Amoxicillin, amoxicillin-clavulanate, and metronidazole are the main types used in other countries [33-36]. Clindamycin is usually used in patients with penicillin allergy. The routine pre-operative amoxicillin dose is 1g to 3g, and the best solution is a single dose of 3g given 1h before surgery[26, 29]. The dose of antibiotics in China varies greatly.

The guidelines for the Clinical Application of Antibiotics (2015) show that oral surgery through oropharyngeal mucosa is a clean-contamination surgery with a course of prophylaxis antibiotics of less than 24 hours. However, this questionnaire showed that only 44.13% of respondents followed this standard in dental implant surgery, and 55.87% used antibiotics for more than 24 hours, especially among the respondents with a senior high degree. Respondents with senior degrees usually treat more patients with complicated underlying diseases, so their surgery is also complicated.

There is no clear classification standard for the difficulty level of dental implant surgery, and there are no references for the relation between the difficulty of dental implant surgery and the infection. It is not clear whether the treatment course of antibiotics needs to be differentiated according to difficulty levels. Therefore, the standards need to be established as soon as possible.

**Limitations**

This questionnaire is a multi-province cross-sectional survey conducted by the Committee of Oral Implantology. There are some methodological flaws. First, the number of institutions that can perform dental implant surgery in China cannot be accurately counted. The committee members are mainly from the stomatological hospital and department of stomatology general hospital, and fewer from dental clinics. Therefore, the survey objects cannot be selected by random sampling method.

Second, causal-effect judgments cannot be obtained from cross-sectional studies. Prospective and systematic clinical studies are needed to determine the timing and course of prophylaxis antibiotics in dental implant surgery. Furthermore, due to the limited number of respondents, the final conclusion still needs to be further verified by a larger randomized investigation. Currently, most dental implantologists have study experience in stomatological hospitals. The respondents in this survey come from various
institutions in Northwest China, which can reflect the current antibiotic use in dental implant surgery to a certain degree. It can be inferred that the participants in this study properly represent the target population.

**Conclusion**

Since the launch of special antibiotic management in 2012, China has promulgated various regulations to promote the rational use of antibiotics. In recent years, the rationality and standardization of antibiotics have been greatly improved in China. However, due to the particularity of dental implant surgery, wound infection, and peri-implantitis, the standard for the selection, medication time, combination, and course of antibiotics in dental implant surgery has not been established. This study provides evidence-based data for antibiotic use in dental implant surgery in China and shows some differences between China and foreign countries. It can be seen from this questionnaire that the doctors engaged in dental implants attach high importance to the standardization of antibiotic use and have high expectations for the development of related guidelines. Therefore, it is urgent to issue relevant guidelines or consensus to standardize the use of antibiotics in dental implants to reduce the unreasonable use of antibiotics and curb bacterial resistance.

**Declarations**

**Ethics approval and consent to participate**

Because this study did not perform any intervention in humans and it did not use any personal data or biological samples of human origin, ethical approval for the study was waived by IRB of School of Stomatology, the Fourth Military Medical University (NO KQ-YJ-2023-077). All collected data were completely anonymized. Informed consent was obtained for each questionnaire. All methods were carried out in accordance with relevant guidelines and regulations.

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**Authors’ contributions**


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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author interests
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References


Figures
Figure 1

Questions that need further clarification of antibiotic use in dental implants

Figure 2

The significance of developing guidelines
Figure 3

Proportion of antibiotics