Jpn. J. Infect. Dis., 74, 392-398, 2021

Original Article

Risk Factors for Post-Tooth Extraction Complications in HIV-Infected Patients: a Retrospective Study

Yumiko Nakagawa[1, 2]*, Yasuyuki Shimada[3], Yohei Kawasaki[4], Haruhito Honda[2], Takahiro Aoki[2], Yusuke Takanabe[3], Ritsuo Takagi[5], Yutaka Maruoka[3], and Shinichi Oka[2]

[1]*Department of Oral health Sciences, Otemae Junior College, Hyogo;* [2]*AIDS Clinical Center, and* [3]*Department of Oral and Maxillofacial Surgery, National Center for Global Health and Medicine, Tokyo;* [4]*Faculty of Nursing, Japanese Red Cross College of Nursing, Tokyo; and* [5]*Division of Oral and Maxillofacial Surgery, Faculty of Dentistry & Graduate School of Medical and Dental Sciences, Niigata University, Niigata, Japan*

SUMMARY: We aimed to assess the rate and risk factors of postoperative complications following tooth extraction in HIV-infected patients by CD4 count. The study participants were 231 HIV-infected patients who underwent tooth extraction at our institution between January 2007 and December 2011. Blood test results, underlying diseases, surgical site, extraction method, and postoperative complication data were obtained from medical records. Potential risk factors of postoperative complications were analyzed using multivariate logistic regression. Patients were divided into two groups: 61 (26%) patients with a CD4 count < 200/μL, and 170 (74%) with a CD4 count ≥ 200/μL. Of the 231 patients, 12 (5.2%) developed postoperative complications (alveolar osteitis, n = 10; surgical site infection, n = 2). The rate of complications did not differ between the CD4 < 200/μL group (1.6%) and the CD4 ≥ 200/μL group (6.5%) (adjusted odds ratio [aOR]: 9.328, 95% confidence interval [CI]: 0.470, 185.229; P = 0.1431). Surgical extraction with bone excavation, but without CD4 count, was identified as a risk factor for post-extraction complications (aOR: 22.037, 95% CI: 1.519, 319.617; P = 0.0234). A low CD4 count is not a risk factor for post-extraction complications in patients with HIV infection. We conclude that tooth extraction should be performed based on dental/oral conditions, and not delayed until CD4 count improvement.

INTRODUCTION

Human immunodeficiency virus (HIV) infection is a progressive and transmissible disease wherein HIV infects CD4-positive T lymphocytes (CD4 cells), leading to a gradual destruction of the immune system (1). Because CD4 count reflects the host's residual immune response capacity, it reflects the pathological level at a particular point of HIV infection (2). A CD4 count less than 200/μL in patients with HIV infection is a risk factor for the development of various opportunistic diseases (3–5). Moreover, if the CD4 count is less than 200/μL, it is classified as AIDS due to immunodeficiency according to the US guidelines (6).

Although surgical procedures, such as tooth extraction in immunocompromised patients (e.g., those with HIV infection) are associated with potential postoperative infections and incomplete wound healing (7), there are no safety guidelines for dental treatment in such patients. Ikeda et al. (8) concluded that, as long as the CD4 count is above 200/μL, there are almost no dental treatments that would pose a risk to patients. Although there are reports of postoperative complications in cases of abdominal surgery (9–11) with a CD4 count below 200/μL, there are few (12) reports produced outside of Japan concerning the safety of dental treatment as it relates to CD4 count; in Japan, the only available material is the Ikeda manual. While being the sole report available for clinical reference as a specialist opinion, the aforementioned manual is not backed by clinical data. Nonetheless, considering the current situation in which there are no clinical reports regarding this important subject matter, this manual represents the commonly accepted theory in Japan.

Given this situation, in order to determine if risks exist with dental treatment in the case of a CD4 count below 200/μL, we divided the HIV-infected patients who underwent tooth extraction at our Department of Oral and Maxillofacial Surgery into two groups—CD4 < 200/μL and CD4 ≥ 200/μL—and compared their clinical data. We then analyzed risk factors

Received July 28, 2019. Accepted December 17, 2020.
J-STAGE Advance Publication January 29, 2021.
DOI: 10.7883/yoken.JJID.2019.273
*Corresponding author: Mailing address: Department of Oral health Sciences, Otemae Junior College, 6-42 Ochayashocho, Nishinomiya, Hyogo 662-8552, Japan. Tel: +81-798-34-6331, Fax: +81-798-32-5040, E-mail: yunakaga@otemae.ac.jp

for postoperative complications with HIV, and also studied the relationship between CD4 count and the postoperative complications rate.

MATERIALS AND METHODS

Study design and population: We conducted a retrospective cohort study using medical records from our institution. During the study period Between January 2007 and December 2011, 239 HIV-infected patients underwent a total of 565 tooth extractions at the Department of Oral and Maxillofacial Surgery at the National Center for Global Health and Medicine. Patients were selected to assess the association between the CD4 count and postoperative complications. The inclusion criteria were as follows: i) CD4 count assessed just before tooth extraction, ii) age >18 years, and iii) attendance to the AIDS Clinical Center for regular medical checkups. Based on these criteria, we excluded one 8-year-old child and seven other patients who did not fulfill the inclusion criteria, and 231 patients were included in the study.

The primary endpoint of this study was the occurrence of complications after tooth extraction. Since some patients underwent more than one extraction during the study period, it was important to set criteria for the selection of the tooth extraction to be included in this study. Surgical stress associated with tooth extraction is known to be higher in cases with bone excavation, especially for impacted mandibular third molars (13). Furthermore, the risk of complications (e.g., postoperative infection and alveolar osteitis) is relatively higher in molars than in incisors (14). Thus, to select a tooth extraction site with the worst surgical stress, we used the following selection criteria: i) complete bone-impacted wisdom tooth, ii) surgical tooth extraction involving bone excavation/root separation, iii) priority to posterior teeth, and iv) priority to mandibular teeth. To study the effects of risk factors associated with postoperative complications, we obtained data on various clinical parameters (see below) measured during a maximum period of 3 months before the date of tooth extraction. This period was selected because any analysis of postoperative complications is affected by background factors, such as physical factors [oral hygiene state (15,16), diabetes mellitus (17)] and clinical status (e.g., CD4 count). Furthermore, at our clinical facility, such patients undergo an assessment of CD4 counts every 1 to 3 months. To study the incidence of postoperative complications, we recorded all complications occurring in the first 2 weeks after tooth extraction.

This research was reviewed and approved by the Human Ethics Review Committee of the National Center for Global Health and Medicine (NCGM-G-001476-00). The study protocol included the provision of routine clinical services. Therefore, a signed consent form was not obtained from each patient for the publication of the clinical data. In accordance with the ethics guidelines of our institution, we notified the AIDS Clinical Center and the Department of Oral and Maxillofacial Surgery outpatients regarding this research, in writing, to the effect that their consent with regard to the objective of this research was deemed to have been obtained if they did not state their opposition within a fixed period of time.

Variables and measures: Data regarding clinical characteristics, including age at the time of tooth extraction, sex, history of antiretroviral therapy (ART), HIV-RNA level, underlying disease(s), white blood cell count, neutrophil count, platelet count, CD4 count, causative disease, site, reason, operative method for tooth extraction, and postoperative complications, were retrieved from the medical records.

Statistical analysis: For statistical analysis, patients were divided into 2 groups based on the latest CD4 count before tooth extraction, using a cutoff count of 200/μL; the CD4 < 200/μL and CD4 ≥ 200/μL groups. Fisher's exact test was used for comparison of rates, while differences between continuous variables were assessed by t-test. All data were summarized as the mean ± standard deviation. A two-sided t-test with a P value less than 0.05, was considered to denote the presence of statistical significance.

As described above, the primary endpoint was the rate of postoperative complications after tooth extraction in patients with HIV infection. For this purpose, we compared the rate of postoperative complications between the CD4 < 200/μL and CD4 ≥ 200/μL groups. The 95% confidence interval (CI) for each complication in each group was calculated, and the difference was compared using Fisher's exact test (18). Furthermore, we calculated the adjusted odds ratio and the 95% CI, and used multiple logistic regression analysis to compare the risk factors of such complications. We applied the following parameters as covariates in multiple logistic regression: platelet count, medical history of ART, HIV-RNA, caries, pericoronitis, surgical extraction with gum incision or bone excavation, and diabetes mellitus.

We aggregated the background information of the patients with or without postoperative complications and compared them. With regard to discrete values, we calculated the number of experiments and ratios and executed Fisher's exact test in order to investigate whether a difference in ratio appeared between the groups. We calculated descriptive statistics such as the number of experiments, average, standard deviation, minimum, median, and maximum in terms of continuous variables. Further, we conducted a 2-sample t-test to investigate whether any difference existed between the mean population of each group. We indicated the number of postoperative complication cases and the ratio by every 200/μL CD4 count. The rate of complications in the HIV-infected patients was compared with that reported in previous studies. All statistical analyses were performed using SAS version 9.4 for Windows (SAS Institute Inc.; Cary, NC, USA).

RESULTS

Differences between the CD4 < 200/μL and CD4 ≥ 200/μL groups: The study cohort comprised 61 (26%) patients with CD4 counts < 200/μL, and ≥ 200/μL in the remaining 170 (74%) patients. The following background factors were significantly different between the two groups: use of anti-HIV agent, diabetes mellitus as underlying disease, caries, pericoronitis, and surgical

Table 1. Differences in background factors between HIV-infected patients with CD4 count of < 200/μL and those with CD4 ≥ 200/μL

	CD4 count, < 200/μL (*n* = 61)		CD4 count, ≥ 200/μL (*n* = 170)		Total	*P* value
	n	%	*n*	%		
Sex (M/F)	57/4	93.4/6.6	163/7	95.9/4.1	220/11	0.4868
Age, median (range)	42 (22–72)		39 (19–72)			0.1426
ART (yes/no)	42/19	68.9/31.1	141/29	82.9/17.1	183/48	0.0269*
Laboratory data						
WBC count (/μL), median (range)	4430.0 (1120–13280)		5130.0 (2130–80720)			0.1132
Neutrophil count (/μL), median (range)	2500.0 (66–12882)		2830.0 (621–9686)			0.9787
Platelet count (/μL), median (range)	16.5 (3.7–51.6)		20.5 (3.3–39.3)			0.0040*
HIV-RNA (copy/mL) (< 50/≥ 50)	19/42	31.1/68.9	108/62	63.5/36.5	127/104	< 0.0001*
Clinical history						
Congenital coagulopathies[1)] (yes/no)	4/57	6.6/93.4	14/156	8.2/91.8	18/213	0.7871
Diabetes mellitus[2)] (yes/no)	8/53	13.1/86.9	7/163	4.1/95.9	15/216	0.0287*
Antithrombotic (yes/no)	0/61	0/100	1/169	0.6/99.4	1/230	1.0000
Dental history						
Reasons for extraction						
Caries (yes/no)	35/26	57.4/42.6	70/100	41.2/58.8	105/126	0.0359*
Periodontitis (yes/no)	12/49	19.7/80.3	17/153	10.0/90.0	29/202	0.0697
Periapical periodontitis (yes/no)	4/57	6.6/93.4	22/148	12.9/87.1	26/205	0.2388
Pericoronitis (yes/no)	8/53	13.1/86.9	59/111	34.7/65.3	67/164	0.0016*
Type of procedure						
Surgical tooth extraction (yes/no)	14/47	23.0/77.0	68/102	40.0/60.0	82/149	0.0193*

[1)]: Congenital coagulopathies are including hemophilia A, hemophilia B, and von Willebrand disease.
[2)]: Diabetes mellitus is including no poor glycemic control patients with HbA1c over 9.0 mg/dL.
ART, antiretroviral therapy.

Table 2. Comparison of postoperative complications[1)] rate by CD4 count

	No. of patients	Median (range)	Complications	Non-complications	Risk difference (95% CI)	Fisher *P* value
Any CD4 count (/μL)	231	330 (3–1079)	12	219	NA	
CD4 count, < 200/μL	61	121 (3–197)	1 (1.6%)	60 (98.4%)	−4.8312 (−9.7128, 0.0503)	0.1910
CD4 count, ≥ 200/μL	170	400 (202–1079)	11 (6.5%)	159 (93.5%)		

[1)]: postoperative complications: alveolar osteitis, *n* = 10; surgical site infection, *n* = 2.
CI, confidence interval; NA, not applicable.

extraction with gum incision or bone excavation. In addition, platelet count and HIV viral load were significantly different between the two groups (Table 1).

Effects of background factors on postoperative complications: Of the 12 patients who developed postoperative complications (alveolar osteitis, *n* = 10; surgical site infection, *n* = 2), one was part of the 61 CD4 < 200/μL group (1.6%), while the other 11 were from the 170 CD4 ≥ 200/μL group (6.5%). There was no significant difference in the rate of postoperative complications between the CD4 < 200/μL and CD4 ≥ 200/μL groups. (95% CI: [−9.7128, 0.0503], *P* = 0.1910) (Table 2). The results of multiple logistic regression showed no differences in CD4 counts between the two groups (aOR, 9.328; 95% CI, 0.470–185.229; *P* = 0.1431). One factor independently influenced the primary outcome, surgical extraction with gum incision or bone excavation (aOR: 22.037, 95% CI: 1.519, 319.617; *P* = 0.0234) (Table 3).

Comparison of groups by whether postoperative complications appeared or not: We discovered that the factors that influenced the incidence of postoperative complications were age (*P* = 0.0342), pericoronitis (*P* = 0.0062), and surgical extraction with gum incision or bone excavation (*P* = 0.0007). The number of patients with underlying disease was 18 with congenital coagulopathies, 15 with diabetes mellitus, and one with antithrombotic coagulopathy. In patients with inherited bleeding disorders, when they undergo tooth extraction, blood products are administered before and after

Table 3. Analysis of factors that influenced primary outcome

Variable	Adjusted odds ratio	95% CI	*P* value
Intercept	-	-	0.9736
Anti-retroviral therapy	3.786	0.601, 23.838	0.1562
Platelet count (/μL)	1.222	0.353, 4.231	0.7521
HIV-RNA (copy/mL)	1.000	1.000, 1.000	0.2507
CD4 count (/μL), < 200 vs ≥ 200	9.328	0.470, 185.229	0.1431
Diabetes mellitus	< 0.001	< 0.001, > 999.999	0.9682
Caries	2.163	0.257, 18.208	0.4777
Pericoronitis	1.127	0.088, 14.483	0.9271
Surgical tooth extraction	22.037	1.519, 319.617	0.0234

CI, confidence interval.

Table 4. Differences in background factors between HIV-infected patients with postoperative complications appears or not

	Complications (*n* = 12)		Non-complications (*n* = 219)		Total	*P* value
	n	%	*n*	%		
Sex (M/F)	12/0	100/0	208/11	95.0/5.0	220/11	1.0000
Age, median (range)	34.5 (24–54)		39 (19–72)			0.0342*
ART (yes/no)	10/2	83.3/16.7	173/46	79.0/21.0	183/48	1.0000
Laboratory data						
WBC count (/μL), median (range)	4970.0 (2990–6730)		4980.0 (1120–80720)			0.6433
Neutrophil count (/μL), median (range)	2711.0 (1148–4489)		2709.0 (66–12882)			0.6220
Platelet count (/μL), median (range)	20.6 (16.3–30.5)		20.2 (3.3–51.6)			0.6195
HIV-RNA (copy/mL) (< 50/≥ 50)	8/4	66.7/33.3	119/100	54.3/45.7	127/104	0.5544
CD4 count (/μL) (< 200/≥ 200)	1/11	8.3/91.7	60/159	27.4/72.6	61/170	0.1910
Clinical history						
Congenital coagulopathies[1)] (yes/no)	1/11	8.3/91.7	17/202	7.8/92.2	18/213	1.0000
Diabetes mellitus[2)] (yes/no)	0/12	0/100	15/204	6.8/93.2	15/216	1.0000
Antithrombotic (yes/no)	0/12	0/100	1/218	0.5/99.5	1/230	1.0000
Dental history						
Reasons for extraction						
Caries (yes/no)	4/8	33.3/66.7	101/118	46.1/53.9	105/126	0.5539
Periodontitis (yes/no)	1/11	8.3/91.7	28/191	12.8/87.2	29/202	1.0000
Periapical periodontitis (yes/no)	0/12	0/100	26/193	11.9/88.1	26/205	0.3698
Pericoronitis (yes/no)	8/4	66.7/33.3	59/160	26.9/73.1	67/164	0.0062*
Type of procedure						
Surgical tooth extraction (yes/no)	10/2	83.3/16.7	72/147	32.9/67.1	82/149	0.0007*

[1)]: Congenital coagulopathies are including hemophilia A, hemophilia B, and von Willebrand disease.
[2)]: Diabetes mellitus is including no poor glycemic control patients with HbA1c over 9.0 mg/dL.
ART, antiretroviral therapy.

extraction to control bleeding (19). As a result, although one (CD4 count: 668/μL) of the 18 patients had surgical site infection, there was no postoperative bleeding. In 15 patients with diabetes mellitus, prolonged bleeding was observed in only one patient (CD4 count: 790/μL). Neither hereditary hemorrhagic disease nor diabetes was identified as a significant risk factor for postoperative complications in this study (Table 4).

Comparison of postoperative complication rates by CD4 count: In this study, the number of postoperative complications was one out of 61 cases in the CD4 < 200/μL group, with an incident rate of 1.6%, and it was 11 out of 170 cases in the CD4 ≥ 200/μL group, with an incidence rate of 6.5%. Although the incidence rate of the CD4 ≥ 200/μL group was higher by about 5%, no statistically significant difference was observed (95% CI: [−9.7128, 0.0503], $P = 0.1910$) (Table 2): this was 5.2% for all 231 cases. Moreover,

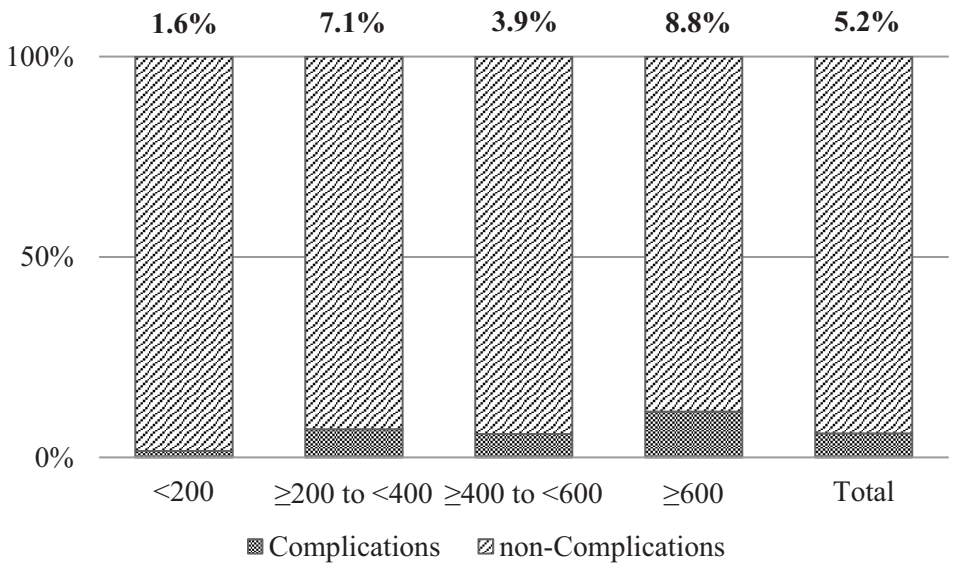

Fig. 1. Postoperative complications rate of every CD4 count 200/μL. It showed the distribution of incident rate of postoperative complications every 200/μL. The highest rate was 8.8% more than 600/μL, just because CD4 count is low, it did not mean a higher postoperative complications rate. Cochran-Armitage Trend test, $P = 0.3050$; alveolar osteitis, $n = 10$; surgical site infection, $n = 2$.

Table 5. Comparison of postoperative complications rate between the present and previous studies

	Robinson et al. (21)	Porter et al. (22)	Glick et al. (12)	Dodson et al. (23)	Dodson (24)	Present study
Year	1992	1993	1994	1994	1997	2019
Country	UK	UK	USA	USA	USA	Japan
HIV patients[1)]						
Total complications rate (%)	5/163 (3.1)	4/100 (4.0)	16/326 (4.9)	9/43 (20.9)	17/76 (22.4)	12/231 (5.2)
Surgical extraction rate (%)	2/14 (14.3)		4/34 (11.8)			10/82 (12.2)
non-HIV patients[1)]						
Total complications rate (%)	3/70 (4.3)	2/68 (2.9)	-	3/101 (3.0)	10/75 (13.3)	-
Surgical extraction rate (%)						

[1)]: Data are number of extractions (percentage).

we verified the distribution of the incidence rate of postoperative complications every 200/μL, and the highest rate, 8.8% (3 out of 34 cases), was observed at more than 600/μL (Fig. 1).

DISCUSSION

In this study, we investigated the risk factors of post-tooth extraction complications in HIV-infected patients in relation to CD4 count. Previous reports concluded that there was no risk of postoperative infection or delayed healing in most dental treatments in patients with a CD4 count over 200/μL (7,8). However, according to our survey, they were not associated with any CD4 count. Therefore, CD4 count alone was not an indicator of post-tooth extraction complications.

The study investigated the association between postoperative complications and CD4 count, so postoperative complications focused on alveolar osteitis and surgical site infection. Diabetes is an underlying disease associated with alveolar osteitis and surgical site infection, but none of the diabetic patients in this study had such cases. Also, none of the 15 diabetic patients had a hemoglobin A1c that exceeded 9.0 mg/dL (20). Although diabetes mellitus was not identified as a significant risk factor for postoperative complications in this study (Table 4), if the control of diabetes mellitus was worse than that in our patient population, the risk of postoperative complications should be considered.

To compare the incidence rate of postoperative complications with prior studies, each rate is displayed in Table 5. The rates of post-extraction complications in HIV-infected patients ranged from 3.1% to 22.4% in previous studies (12,21–24). In three of these studies, the complication rates were not significantly different between patients with or without HIV infection (21,22,24). Dodson et al. (23) reported that the postoperative complication rate in HIV-infected patients was 20.9%, which was significantly higher than that in non-HIV patients (2.9%; relative risk [RR]: 7.0, 95% CI: (2.0. 25.0, $P = 0.001$). However, the same group reported no significant differences between the two in another review study (24). One can infer from the results of Dodson's prospective study that dental

treatment of HIV-infected patients was not conducted proactively in that era, resulting in high surgical stress and the associated high rate of complications. Considering that the former was retrospective, while the latter was prospective, it was probably due to better methodology applied, including least invasiveness, during the tooth extraction procedure. One can infer from the results of the prospective study that dental treatment of HIV-infected patients was not conducted proactively in that era, resulting in high surgical stress and the associated high rate of complications. In addition to the better surgical procedure, since our study was conducted between 2007 and 2011, the general condition of the patient was likely more stable under ART compared with earlier studies (25), suggesting another reason for the differences between the studies. The postoperative complication rates in previous studies cannot be compared with those in the present study because of differences in study populations and analytical methods. However, in previous studies, postoperative complication rates among HIV-infected patients who received highly invasive surgical tooth extraction ranged from 11.8% to 14.3% (12,21), and no significant differences in postoperative complication rates were reported on whole populations and patients with CD4 counts less than 200/μL. In addition, the rate is almost the same (12.2%) in this study.

We compared postoperative complication rates after surgical extraction of the mandibular third molar between patients with and without HIV infection in previous studies. Blondeau and Daniel (26) reported a postoperative complication rate of 6.9% (38/550) among 550 patients who underwent surgical extraction of impacted mandibular third molars; the postoperative complications included alveolar osteitis in 20 patients (3.6%), infection in 12 patients (2.2%), and paresthesia (6 patients; 1.1%). The complication rate after surgical extraction in the present study was 12.2%, and all complications were alveolar osteitis. The overall rate of postoperative complications in the present study was higher than that in the previous study, which might be due to the higher rate of alveolar osteitis in the former study. This difference might be due to immunodeficiency as a result of a decrease in the CD4 count in HIV-infected patients. However, no significant differences were observed among the postoperative complication rates stratified by the CD4 count (Fig. 1). Sabbah et al. also reported that CD4 count had no impact on failure rate (CD4 > 500/μL: 3.8%, 300–500/μL: 8.5%, 200–300/μL: 7%, < 200/μL: 10%) for implants that were as invasive as tooth extraction (27). This is comparable to that observed in the present study, despite differences in the rates of individual complications.

Although it is difficult to discuss dental and medical surgeries in similar terms, Whitney et al. reported that the CD4 count is the best indicator of frequency and mortality of perioperative complications (9). Among the most frequently practiced tooth extraction procedures in dental practice, surgical extraction of the mandibular third molar is the most invasive. Nevertheless, our findings demonstrated no significant relationship between CD4 count and the complication rate after this procedure. Taken together, the present and previous results suggest that the frequency of postoperative complications after highly invasive surgeries, such as those evaluated by Whitney et al., is relatively high when the CD4 count is low. Additionally, in cases of less invasive surgeries such as tooth extraction, in which surgery is limited to the oral cavity, it is unnecessary to postpone tooth extraction even if the CD4 count is low.

There were some limitations to this study. First, we selected only one tooth for each patient. Therefore, we could not examine the risk of multiple tooth extractions performed in a single session on the same day. In addition, we did not investigate the effects of smoking and oral hygiene status. Furthermore, drugs prescribed for underlying diseases other than HIV infection were not included in the risk factor analysis in this study.

In conclusion, the present study indicated that surgical extraction (highly invasive extraction including bone excavation), but not CD4 count, is a significant risk factor for postoperative complications after tooth extraction in HIV-infected patients. In addition, no significant differences were observed among postoperative complication rates stratified by the CD4 count. Based on these results, we recommend that tooth extraction should be conducted in HIV-infected patients based on dental assessment rather than on CD4 count. The tooth extraction should not be postponed until the CD4 count increases to more than 200/μL. We recommend that the timing of tooth extraction (with regard to avoiding postoperative complications) should not be linked to the CD4 count.

Acknowledgments This study was supported in part by the National Center for Global Health and Medicine. We thank Dr. Faiq G Issa (Word-Medex Pty Ltd, Sydney, Australia, www.word-medex.com.au) for careful reading and editing of the manuscript.

Conflict of interest None to declare.

REFERENCES

1. Douek DC, Brenchley JM, Betts MR, et al. HIV preferentially infects HIV-specific $CD4^+$ T cells. Nature. 2002;417:95-8.
2. Egger M, May M, Chêne G, et al. Prognosis of HIV-1-infected patients starting highly active antiretroviral therapy: a collaborative analysis of prospective studies. Lancet. 2002;360:119-29.
3. Kaplan JE, Masur H, Jaffe HW, et al. Reducing the impact of opportunistic infections in patients with HIV infection. New guidelines. JAMA. 1995 274:347-8.
4. Kaplan JE, Hanson DL, Navin TR, et al. Risk factors for primary *Pneumocystis carinii* pneumonia in human immunodeficiency virus-infected adolescents and adults in the United States: reassessment of indications for chemoprophylaxis. J Infect Dis. 1998;178:1126-32.
5. Kaplan JE, Hanson DL, Jones JL, et al. Viral load as an independent risk factor for opportunistic infections in HIV-infected adults and adolescents. AIDS. 2001;15:1831-6.
6. Centers for Disease Control and Prevention. 1993 revised classification system for HIV infection and expanded surveillance case definition for AIDS among adolescents and adults. MMWR Recomm Rep. 1992;41(RR-17):1-19.
7. Glick M. Modification of dental care. In: Glick M, editor. Dental Management of–Patients with HIV. Chicago, IL: Quintessence; 1994. p. 247-55.
8. Ikeda M. Manual of Dental Treatment for HIV-Infected Individuals 2005. Project on AIDS Control Measures supported by the Health and Labor Sciences Research Grant. 2005. Available at < https://api-net.jfap.or.jp/manual/data/pdf/h16.pdf>. Accessed June 3, 2021. Japanese.

9. Whitney TM, Brunel W, Russell TR, et al. Emergent abdominal surgery in AIDS: experience in San Francisco. Am J Surg. 1994;168:239-43.
10. Horberg MA, Hurley LB, Klein DB, et al. Surgical outcomes in human immunodeficiency virus–infected patients in the era of highly active antiretroviral therapy. Arch Surg. 2006;141:1238-45.
11. Deneve JL1, Shantha JG, Page AJ, et al. CD4 count is predictive of outcome in HIV-positive patients undergoing abdominal operations. Am J Surg. 2010;200:694-700.
12. Glick M, Abel SN, Muzyka BC, et al. Dental complications after treating patients with AIDS. J Am Dent Assoc. 1994;125:296-301.
13. Boffano P, Ferretti F, Giunta G, et al. Surgical removal of a third molar at risk for mandibular pathologic fracture: case report and clinical considerations. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;114:e1-4.
14. Trybek G, Chruściel-Nogalska M, Machnio M, et al. Surgical extraction of impacted teeth in elderly patients. A retrospective analysis of perioperative complications - the experience of a single institution. Gerodontology. 2016;33:410-5.
15. Sato J, Goto J, Harahashi A, et al. Oral health care reduces the risk of postoperative surgical site infection in inpatients with oral squamous cell carcinoma. Support Care Cancer. 2011;19:409-16.
16. Igoumenakis D, Gkinis G, Kostakis G, et al. Severe odontogenic infections: causes of spread and their management. Surg Infect. 2014;15:64-8.
17. Fernandes KS, Glick M, de Souza MS, et al. Association between immunologic parameters, glycemic control, and postextraction complications in patients with type 2 diabetes. J Am Dent Assoc. 2015;146:592-9.
18. Chan IS, Zhang Z. Test-based exact confidence intervals for the difference of two binomial proportions. Biometrics. 1999;55:1202-9.
19. Hermans C, Altisent C, Batorova A, et al. Replacement therapy for invasive procedures in patients with haemophilia: literature review, European survey and recommendations. Haemophilia. 2009;15:639-58.
20. Tsai C, Hayes C, Taylor GW. Glycemic control of type 2 diabetes and severe periodontal disease in the US adult population. Community Dent Oral Epidemiol. 2002;30:182-92.
21. Robinson PG, Cooper H, Hatt J. Healing after dental extractions in men with HIV infection. Oral Surg Oral Med Oral Pathol. 1992;74:426-30.
22. Porter SR, Scully C, Luker J. Complications of dental surgery in persons with HIV disease. Oral Surg Oral Med Oral Pathol. 1993;75:165-7.
23. Dodson TB, Perrott DH, Gongloff RK, et al. Human immunodeficiency virus serostatus and the risk of postextraction complications. Int J Oral Maxillofac Surg. 1994;23:100-3.
24. Dodson TB. HIV status and the risk of post-extraction complications. J Dent Res. 1997;76:1644-52.
25. Lohse N, Hansen AB, Pedersen G, et al. Survival of persons with and without HIV infection in Denmark,1995-2005. Ann Intern Med. 2007;146:87-95.
26. Blondeau F, Daniel NG. Extraction of impacted mandibular third molars: postoperative complications and their risk factors. J Can Dent Assoc. 2007:73:325a-e.
27. Sabbah A, Hicks J, MacNeill B, et al. A retrospective analysis of dental implant survival in HIV patients. J Clin Periodontol. 2019;46:363-72.