

Preoperative fundus examination in patients with diabetes scheduled for surgery

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ABSTRACT

This study aimed to show the proportion of fundus examinations in patients with diabetes who were scheduled for surgery. We retrospectively analyzed 455 consecutive patients with diabetes admitted for surgery. Just 49% had fundus examinations before hospitalization. The decision tree analysis showed that the type of family doctor was the first split associated with fundus examination; patients treated by a diabetes specialist were more likely to receive the examination. In this subgroup, glycosylated hemoglobin levels $\geq 8.0\%$ and age ≥ 71 years were associated with a lower proportion of receiving the examination. In patients whose family doctor was not a diabetes specialist, glycosylated hemoglobin levels $< 7.2\%$ and body mass index $< 27.4 \text{ kg/m}^2$ without severe comorbidities were associated with a higher proportion of receiving the examination. In conclusion, half of patients scheduled for surgery did not receive fundus examinations. A high-risk population for not receiving the examination varied with the consultation setting.

INTRODUCTION

When surgery is scheduled in patients with diabetes, preoperative assessment of diabetes-related complications is generally recommended¹. Untreated proliferative retinopathy will potentially progress during a perioperative period^{2,3}, which clinically justifies its screening in advance of surgery. However, fundus examination is often a practical challenge because of the necessity to consult an ophthalmologist apart from regular visits for diabetes treatment⁴. The present study aimed to show the proportion of fundus examinations before hospitalization and to explore its associated factors in patients with diabetes undergoing surgery.

METHODS

We retrospectively analyzed consecutive patients with diabetes admitted for surgery in Osaka University Hospital in Japan between October 2015 and March 2019, whose diabetes was treated at other hospitals or clinics before the hospitalization, and whose perioperative glycemic control had consultations with our department of diabetology. We excluded patients undergoing any ophthalmic surgery, because these patients were likely to have fundus examinations routinely as the preoperative assessment of the surgical site. Of a total of 714 eligible patients, 455 patients had data of receiving fundus

examinations, and the data were missing for the remaining 259 patients. Baseline characteristics of the 455 patients whose data of fundus examinations were available are shown

Table 1 | Characteristics of patients with data of fundus examination available ($n = 455$)

Variable		Missing data
Age (years)	68 ± 12	
Men, n (%)	277 (61%)	
BMI (kg/m^2)	25.1 ± 5.0	
HbA1c (%)	7.5 ± 1.3	33 (7%)
Fundus examination, n (%)	221 (49%)	259 (36%)
ASA score, n (%)		2 (0.4%)
1	33 (7%)	
2	252 (56%)	
3	163 (36%)	
4	5 (1%)	
Type of family doctor		
Diabetes specialist, n (%)	175 (48%)	87 (19%)
Type of surgery		
Cancer, n (%)	192 (42%)	
Cardiovascular disease (n) (%)	139 (31%)	
Others, n (%)	124 (27%)	

Date are shown as the mean ± standard deviation or frequency (percentage).

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in Table 1, and those of the remaining 259 patients are shown in Table S1.

To explore clinical variables associated with receiving fundus examinations before hospitalization, we first developed a decision tree, using the R package *rpart* (R Development Core Team, Vienna, Austria), in the 455 patients whose data for the examinations were available from medical records. We adopted the decision tree analysis, because this analysis can handle non-linear relationships, exploring potential thresholds of covariates, and can flexibly treat potential interaction effects among covariates. The candidates for risk factors were age, sex, body mass index (BMI), glycosylated hemoglobin (HbA1c) measured as National Glycohemoglobin Standardization Program values, comorbidity status assessed by the American Society of Anesthesiologists (ASA) score and types of family doctors. The depth and branch were determined by the default settings of *rpart*. We subsequently analyzed these 455 patients, handling missing data with the multiple imputation method, and assessed the proportion of receiving fundus examinations in respective subgroups of the constructed decision tree. The intergroup difference in proportion was evaluated by the χ^2 -test. We finally validated the proportion, analyzing the whole 714 patients with the use of the multiple imputation method. All statistical analysis was performed using R version 3.6.1 (R Development Core Team).

The study was in accordance with the Declaration of Helsinki and approved by the institutional review board of Osaka University Hospital (date of approval, 13 June 2019; approval number 16136-4). The study was considered exempt from informed consent of participants, in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects in Japan. Instead, relevant information regarding the study was open to the public, and opportunity for refusal was ensured.

RESULTS

Of the 455 patients, 211 patients (49%) underwent fundus examinations before hospitalization. Figure 1a shows the developed decision tree. The tree had a depth of four branches and divided patients into seven subgroups. The first branch was whether or not the family doctor was a diabetes specialist. In the subgroup treated by a diabetes specialist, HbA1c levels $\geq 8.0\%$ and age ≥ 71 years were associated with a low proportion of the examination. In contrast, in the subgroup whose family doctor was not a diabetes specialist, ASA scores < 3 points, HbA1c levels $< 7.2\%$ and BMI $< 27.4 \text{ kg/m}^2$ were associated with a high proportion of the examination.

The multiple imputation-based proportion in the seven groups of the developed tree is shown in Figure 1b. The accuracy of the tree model was estimated to be 66% (95% confidence interval 61–71%). In patients treated by a diabetes specialist, group 3 (HbA1c levels $\geq 8.0\%$ and age ≥ 71 years) had a lower proportion of receiving fundus examinations ($P < 0.001$ vs groups 1 and 2). Lower BMI levels ($< 27.4 \text{ kg/m}^2$)

was not significantly associated with the proportion of receiving fundus examinations in this population ($P = 0.761$). In contrast, for those whose family doctor was not a diabetes specialist, group 4 (ASA scores < 3 points, HbA1c levels $< 7.2\%$ and BMI $< 27.4 \text{ kg/m}^2$) had a higher proportion of receiving fundus examinations ($P = 0.002$ vs groups 5–7). Similar findings were observed in the analysis of the whole 714 patients (Figure S1).

DISCUSSION

The current study showed that only approximately half of patients scheduled for surgery had fundus examinations, indicating room for improvement in clinical practice.

The decision tree analysis identified the type of family doctor as the first split associated with fundus examination. Patients treated by a diabetes specialist more frequently received the examination, which was consistent with previous reports⁵. Subsequent tree branches showed that clinical variables associated with the examination were not identical between those treated by a diabetes specialist and those by a non-specialist. Previous studies simply used a first-degree regression analysis, without assuming the difference of associated factors between doctor types^{4–7}. This is the first study showing a different association between diabetes specialists and non-specialists.

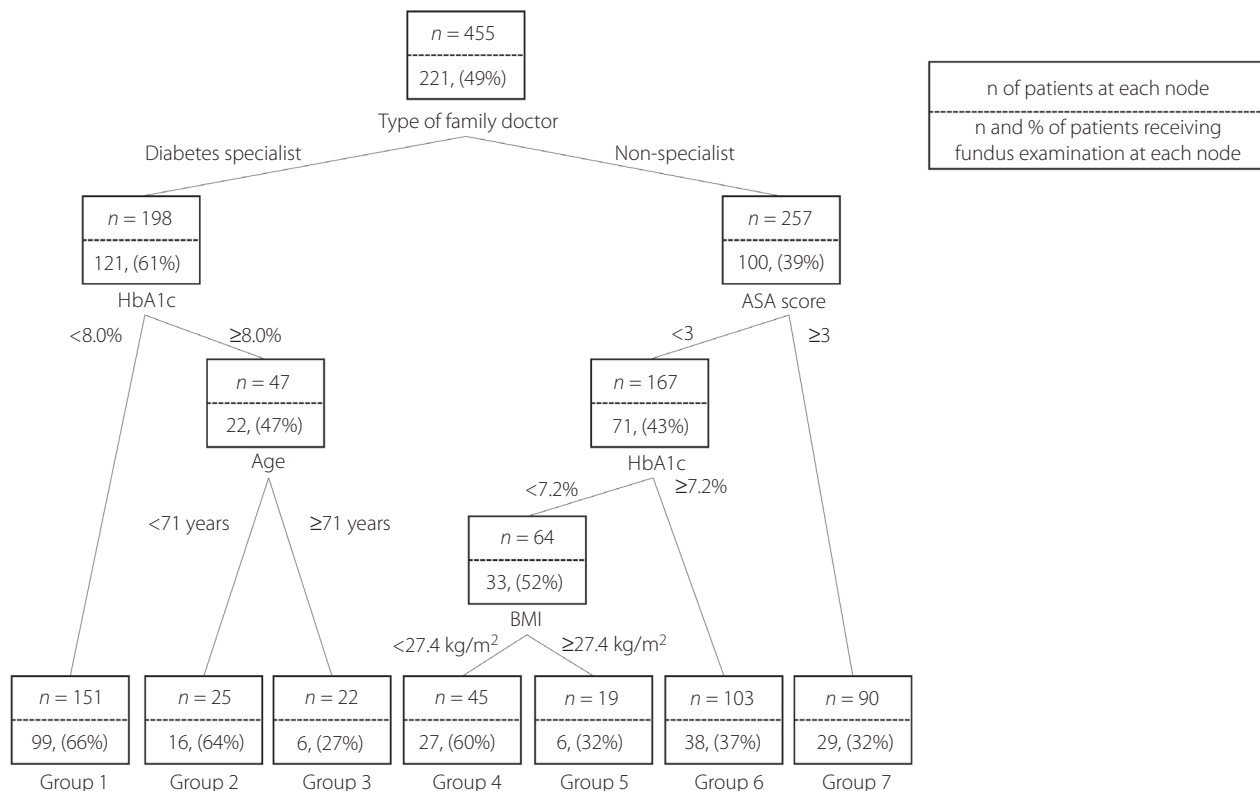
In patients treated by a doctor other than a diabetologist, low ASA scores, low HbA1c levels and low BMI were related to a high proportion of fundus examinations. Patients with a high ASA score might be often treated by a specialized doctor for their severe comorbidities, rather than by a general physician. The priority on fundus examination might be set low during the specialized consultation. The other two factors – high HbA1c levels and high BMI – might reflect patients' poor adherence to treatment; such patients might less likely follow their doctor's instruction to have the examination in general practice.

In contrast, in a population treated by a diabetes specialist, HbA1c levels $\geq 8.0\%$ and age ≥ 71 years less frequently received fundus examinations. Clinical guidelines recommend that old patients who are otherwise healthy should achieve lower HbA1c goals to prevent diabetes-related complications, whereas frail patients should reasonably have less stringent goals^{8–10}. Individuals with high HbA1c levels and old age might consist mainly of those who were so frail that their family doctor relaxed glycemic goals, paying less attention to complications in clinical practice. Individuals with high HbA1c levels might also indicate patients' poor adherence to treatment.

The current findings showed that a high-risk population for not receiving fundus examination would vary with the consultation setting. Different approaches would be required for the improvement.

The present study had several limitations. First, the current cross-sectional study did not prove a causal relationship between clinical variables and fundus examination. Second, this was a single-center study carried out in Japan, which would

(a)



(b)

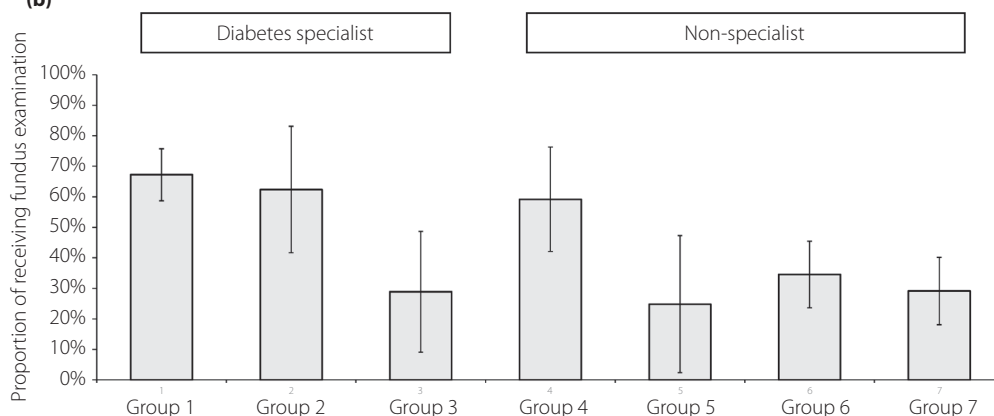


Figure 1 | Fundus examination before hospitalization and its associated factors. (a) Decision tree developed in the 455 patients whose data about fundus examination before hospitalization were available. Upper numbers in boxes represent the number of patients at each node. Lower numbers represent the number and proportion of patients receiving fundus examination at each node. For example, in the first node, of the 455 patients, 221 (49%) patients received the examination. It should be noted that when data were missing on the split variables, the patients were classified using the rest surrogate variables according to the algorithm of the R package *rpart*. (b) Multiple imputation-estimated proportion of receiving fundus examination in respective subgroups of the constructed decision tree model. The groups 1–7 corresponded to those in (a). The model performance of the developed decision tree was not different among the surgery types ($P = 0.516$). ASA, American Society of Anesthesiologists; BMI, body mass index; HbA1c, glycated hemoglobin.

require external validation. Third, detailed data were unavailable on patients' adherence to treatment, frailty, glycemic goals set by their family doctor, smoking, alcohol consumption and physical activity. Fourth, it remained unknown whether the

similar results would be found in a population not limited to those undergoing surgery. Finally, we did not prepare the training data and the validation data separately. Future studies will be required to validate the current findings.

In conclusion, only approximately half of patients with diabetes scheduled for surgery had fundus examinations before hospitalization. Clinical variables associated with the examination were different between the types of family doctors.

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DISCLOSURE

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1 | Characteristics of patients with missing data of fundus examination ($n = 259$).

Figure S1 | Estimated proportion of receiving fundus examinations in respective subgroups into which the whole patients ($n = 714$) classified according to the constructed decision tree model.