



Original Article

Assessment of the Diagnostic Skills of General Dentists in Different Types of Orthodontic Malocclusions

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Main Points

- Except for the Class II camouflage case, the answers indicating the need for orthodontic treatment were higher in all malocclusions.
- Only patients indicated as surgery patients by the orthodontists were chosen for orthognathic surgery by the general dentists, in Class II cases.
- The answers indicating orthognathic surgery were high for both surgery and facemask patients, in Class III cases.
- The general dentists chose both unesthetic profile and irregular teeth as reasons for surgery, except for the open bite camouflage case.
- The general dentists chose protruded mandible for the Class III case, and retruded mandible for the Class II case, as reasons for orthognathic surgery.

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ABSTRACT

Objective: One of the biggest problems in publicly funded dental clinics is the patient waiting list. The appropriate referral plays a key role in avoiding an increase in the number of patients on this waiting list. This study aimed to assess general dentists' diagnostic skills and approaches for different malocclusions.

Methods: A questionnaire was prepared using photos of 8 patients previously treated for different malocclusions. One hundred twenty general dentists (83 female, mean age: 24 ± 1.18 years; 37 male, mean age: 24 ± 1.95 years) participated in the survey and were asked to decide whether the patient needed orthodontic treatment or orthognathic surgery, and to provide the reason for surgery (irregular teeth, or both unesthetic profile and irregular teeth), and the cause of the unesthetic profile (mandibular protrusion, mandibular retrusion, maxillary protrusion, maxillary retrusion).

Results: The answers suggesting the need for orthodontic treatment were significantly higher for all malocclusions except for the Class II camouflage case. Of the Class III cases, the general dentists chose orthognathic surgery for both surgery and facemask cases (93.1%, 66.4% respectively). For the severe open bite case, orthognathic surgery was chosen with a ratio of 81.2%, and orthognathic surgery was decided as not necessary for the mild open bite case (74.8%). Among the surgery cases, mandibular retrusion for the Class II case (94.6%), mandibular protrusion for Class III case (95.4%), and maxillary retrusion for the severe open bite case (44.6%) were the maximum reported reasons.

Conclusion: The distinction between camouflage and surgical treatment was better made by dentists in Class II and open bite cases than in Class III cases.

Keywords: Diagnosis, referral, malocclusion

INTRODUCTION

Malocclusion is a term that defines the deviations from the ideal occlusal relationship. However, unlike the clinicians, patients usually demand orthodontic treatment primarily for esthetic reasons, rather than for the actual malocclusion. For many centuries, facial attractiveness has been desired as a physical character in almost all societies.¹ Therefore, a treatment plan should improve facial esthetics to meet the patient's expectations and correct the malocclusion, along with any dysfunction. While treating patients with skeletal discrepancies, treatment options may include camouflage, functional treatment, or orthognathic surgery, depending on the patient's

age, the severity of the malocclusion, facial esthetics, and the patient's demand.

Measuring the amount of malocclusion and treatment needed is important for public health, since the malocclusion and its unesthetic outcomes may affect the quality of life, such as psychological development, social skills, etc.^{2,3} In particular, when public funds cover the orthodontic treatment in certain countries, that information becomes very critical to ensure that all social classes have equal access to oral health care. One of the biggest problems in publicly funded dental clinics is the patient waiting lists. An appropriate referral plays a key role in avoiding a longer waiting list, which is time-consuming for both patients and the clinicians. A study conducted by O'Brien et al.⁴ showed that up to 45% of the orthodontic referrals could be classified as inappropriate.

Many orthodontic indices and methods have been developed as measuring tools to identify the treatment need and give priority to those who have a greater need for orthodontic treatment.^{5,6} The Index of Orthodontic Treatment Need (IOTN), which is the most common index, was developed by Brook and Shaw,⁶ and then the esthetic component (AC) of the IOTN was added by Richmand et al.⁷ to classify patients into 3 broad groups: no need for treatment; possible treatment need/borderline need; and definite treatment need. Several studies show that IOTN and AC are reliable indices in the decision-making process.^{8,9} However, there are also missing parts of that index—for example, open bite and reverse overjet photos are not included. On the other hand, Hunt et al.¹⁰ reported in their cohort study that the current

use of the AC cutoff score does not reflect lay people's dental esthetic expectations. Moreover, although Grzywacz¹¹ reported a significant agreement in the AC ratings between the professionals and 12-year-old children, they suggested moving the grade III-IV cases to "borderline need," which are normally in the "no treatment needed" grade, would be more realistic. In the present study, instead of the IOTN-AC index, we prepared a questionnaire with different malocclusion photos, ranging from mild to severe, to assess the diagnostic skills and treatment approaches of general dentists, and evaluate whether they can diagnose the orthodontic problem considering the severity of malocclusion and the patients' age, and direct patients correctly for orthodontic treatment to our publicly funded hospital.

METHODS

In the present study, a questionnaire was prepared using the photos of 8 previously treated patients (Figures 1-3), which were selected from the archive of Marmara University, Department of Orthodontics, Istanbul, Turkey, and their ideal treatments were planned by 3 orthodontists according to photographic, model, and radiological analyses as Class II functional treatment, Class II orthognathic surgery, Class II camouflage treatment, Class III facemask treatment, Class III orthognathic surgery, Class III camouflage treatment, camouflage treatment for mild open bite, and orthognathic surgery for severe open bite. The color images were converted into grayscale using Adobe Photoshop (CS2 Version 9.0, Adobe Systems Incorporated, San Jose, CA, USA). The cephalometric values of the patients are given in Table 1. The study was approved by Marmara University, Faculty of Dentistry, the Ethical

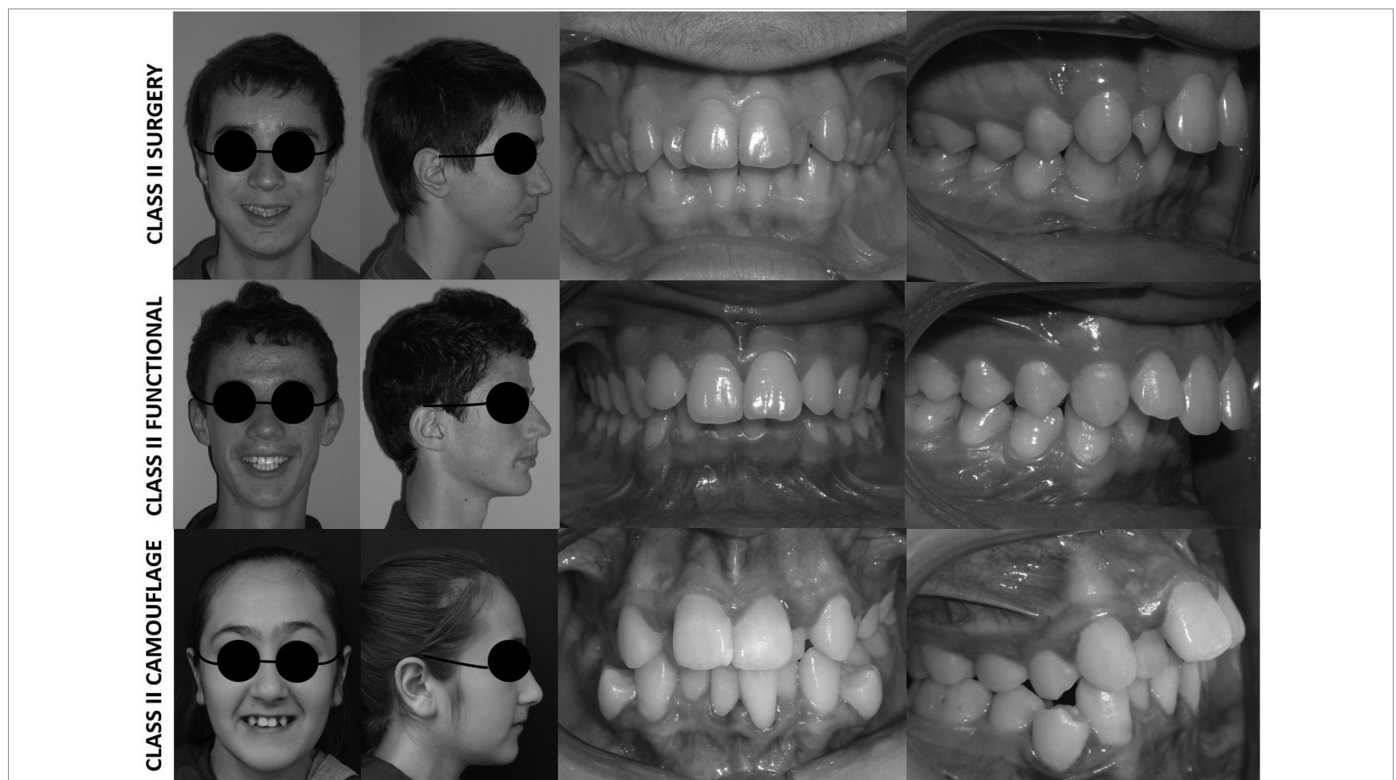


Figure 1. The extraoral and intraoral pictures of the patients with Class II malocclusion.

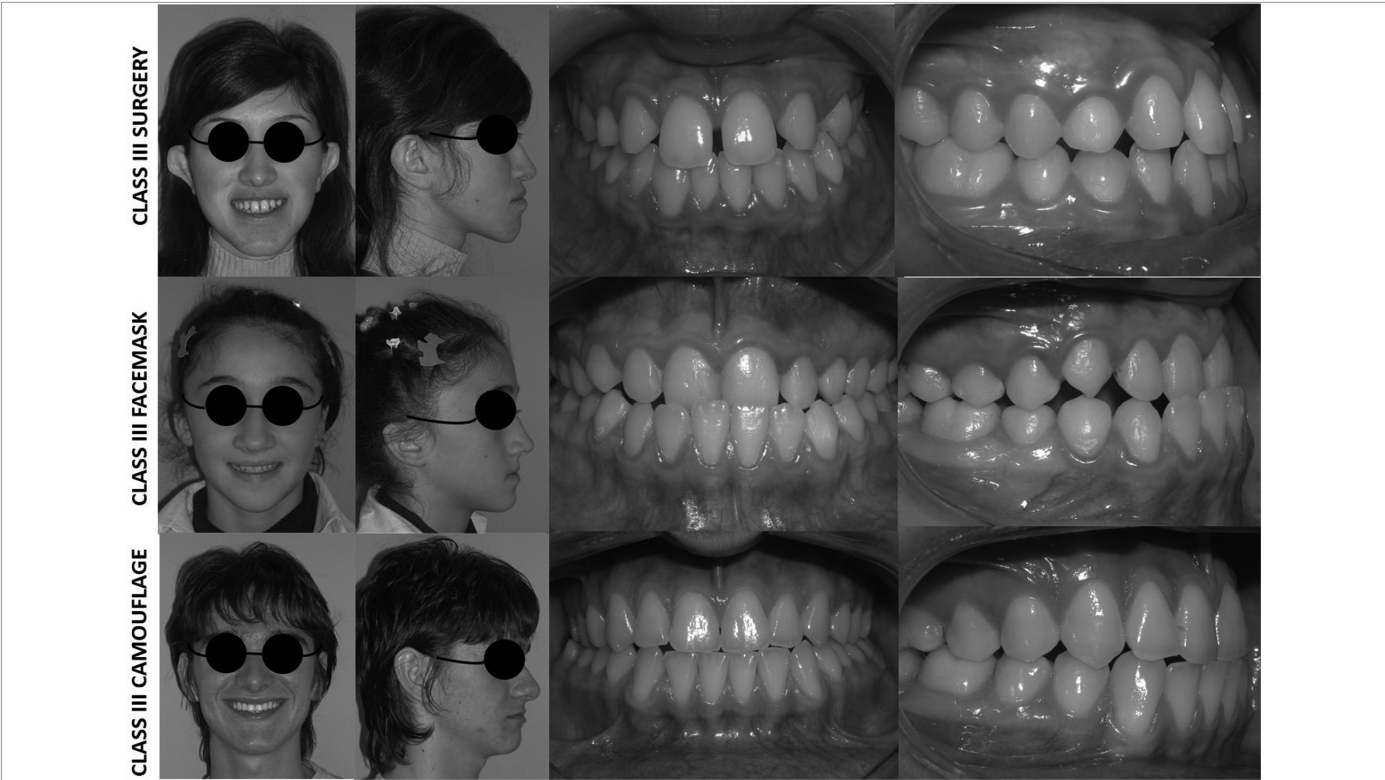


Figure 2. The extraoral and intraoral pictures of the patients with Class III malocclusion.

Committee of Clinical Research (June 1, 2020, 2020/25, Istanbul, Turkey). Informed consents were signed by all of the patients whose photographs were used for the questionnaire and by the dentists willing to participate in this study.

One hundred twenty recently graduated general dentists (83 female, mean age 24 ± 1.18 ; 37 male mean age 24 ± 1.95) took part in the survey, and they were asked to evaluate each patient's photos together with the age and decide whether the patient

needed orthodontic treatment or not. If the answer was "yes," they were asked whether the patient needed orthognathic surgery or not; if the answer was "yes" for this question too, they were asked the identify the reason (irregular teeth or both unes-
thetic profile and irregular teeth) for which the patients need surgical treatment; and finally, the last question asked them to identify the reason, if the profile was unes-
thetic (mandibular protrusion, mandibular retrusion, maxillary protrusion, or maxil-
lary retrusion) (Figure 4).



Figure 3. The extraoral and intraoral pictures of the patients with open bite malocclusion.

Table 1. Cephalometric measurements for the patients

Cases	Age (years)	Vertical Parameters			Sagittal Parameters				Dental Parameters		
		Σ (°)	FMA (°)	Maxillary height (°)	SNA (°)	SNB (°)	N-A (mm)	ACB/Corpus	U1-SN (°)	IMPA (°)	Holdaway ratio
Class II surgery	18	400	29	60	78	71	-2	78/78	101	98	8/4
Class II camouflage	14	388	27	59	87	81	2	66/70	113	93	5/5
Class II functional	15	392	23	59	79	75	1	76/80	108	90	4/6
Class III surgery	19	397	29	60	82	86	-3	71/82	115	74	3/0.5
Class III facemask	10	394	30	59	81	83	-2	71/79	105	85	4/2
Class III camouflage	17	392	22	59	80	82	-1	71/78	105	91	4/2
Open bite surgery	18	412	37.5	65	79	76	2	73/79	106	81	8/2.5
Open bite camouflage	13	408	39	63	82	78	2	72/75	100	91	6/3

Statistical analysis was performed using IBM SPSS Statistics 22 (IBM SPSS, Turkey). The chi-square test was performed to compare the data, and the significance level was set at $P < .05$.

RESULTS

Among all cases, according to the first question asking whether orthodontic treatment was needed, the only treatment for which there was no significant difference between the answers was the Class II camouflage treatment case (treatment was needed, 57.5%; not needed, 42.5%; $P > .05$). For all the other cases, the ratio of answers describing the need for treatment was significantly higher (Table 2).

When the need for orthognathic surgery was evaluated, all the results were statistically significant. In more detail, among the

Class II cases, only the patient indicated as a surgery patient by the orthodontists was chosen for orthognathic surgery by the general dentists (66.7%) (Figure 5). For Class II camouflage or functional treatment cases, the percentages of those who reported that there was no need for orthognathic surgery were 94.2% and 80.9% respectively (Table 2, Figures 6 and 7). Of the Class III cases, patients indicated as requiring orthognathic surgery and facemask treatment, the answers regarding the need for orthognathic surgery were chosen (93.1%, 66.4% respectively) (Table 2, Figures 8 and 9), and for the camouflage case, the answer was that there was no need for orthognathic surgery (62.2%) (Table 2, Figure 10). In the presence of open bite malocclusion, the severe case which required orthognathic surgery was answered as "orthognathic surgery needed" (81.2%) (Figure 11), and the mild case for which camouflage treatment was enough, was described as not needing orthognathic surgery (74.8%) (Table 2, Figure 12).

There was no statistically significant difference only for the open bite camouflage case, with respect to the answers given to the question of whether orthognathic surgery was needed because of irregular teeth, or both an unesthetic profile and the irregular teeth. In all the other groups, both unesthetic profile and irregular teeth were chosen as reasons for orthognathic surgery (Table 2).

Mandibular retrusion for the Class II case (94.6%), mandibular protrusion for the Class III case (95.4%), and maxillary retrusion for the severe open bite case (44.6%) were mostly reported (Table 2) as the reason for orthognathic surgery.

DISCUSSION

Many external (hair color, make-up) and internal (skin, teeth and lip color) factors may affect the individual's concept of beauty.^{12,13} Therefore, the color images were converted into gray-scale in the present study. Black and white photographs have the

1. Does this patient need orthodontic treatment?
 - a. Yes
 - b. No

If the answer is "no", please skip to the other page.
2. Does this patient need orthognathic surgery?
 - a. Yes
 - b. No

If the answer is "no", please skip to the other page.
3. For which of the following reasons does this patient need orthognathic surgery?
 - a. Unaesthetic profile and the alignment of the teeth
 - b. Unaesthetic alignment of the teeth

If the answer is "b", please skip to the other page.
4. What is the reason for unaesthetic profile?
 - a. Forward position of mandible
 - b. Backward position of mandible
 - c. Forward position of maxilla
 - d. Backward position of maxilla

Figure 4. An example of the questionnaire

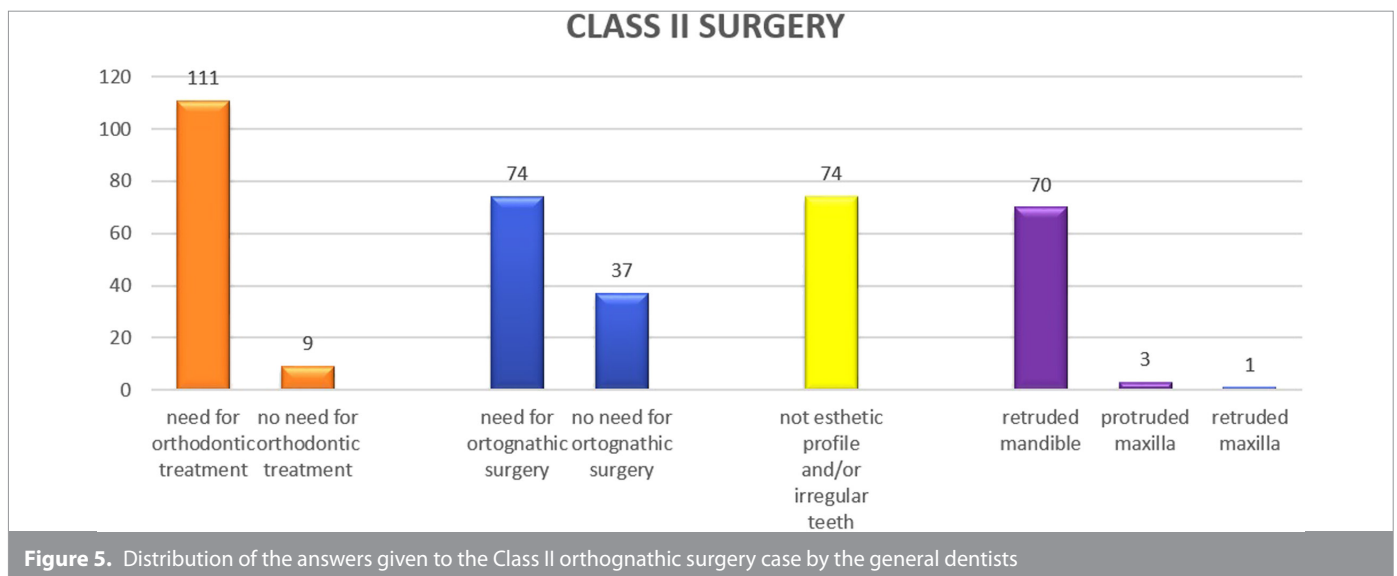
Table 2. Evaluation of the answers given for the questionnaire

	Class II Camouflage n (%)	Class II Surgery n (%)	Class II Functional n (%)	Class III Surgery n (%)	Class III Camouflage n (%)	Class III Facemask n (%)	Open bite Camouflage n (%)	Open bite Surgery n (%)
Need for orthodontic treatment	69 (57.5)	111 (78.3)	94 (78.3)	116 (96.6)	103 (85.8)	115 (95.8)	111 (92.5)	112 (93.3)
No need for orthodontic treatment	51 (42.5%)	9 (7.5)	26 (21.7)	4 (3.3)	17 (14.2)	5 (4.2)	9 (7.5)	8 (6.7)
¹ P	NS	**	**	**	**	**	**	**
Need for orthognathic surgery	4 (5.8)	74 (66.7)	18 (19.1)	108 (93.1)	39 (37.8)	77 (66.4)	28 (25.2)	91 (81.2)
No need for orthognathic surgery	65 (94.2)	37 (33.3)	76 (80.9)	8 (6.9)	64 (62.2)	39 (33.6)	83 (74.8)	21 (18.8)
¹ P	**	**	**	**	**	**	**	**
Unesthetic profile and irregular teeth	4 (100)	74 (100)	16 (88.9)	108 (100)	38 (97.4)	76 (98.7)	16 (57.1)	83 (91.2)
Irregular teeth	0 (0)	0 (0)	2 (11.1)	0 (0)	1 (2.6)	1 (1.3)	12 (42.9)	8 (8.8)
¹ P	*	**	**	**	**	**	NS	**
Protruded mandible	0 (0)	0 (0)	2 (12.5)	103 (95.4)	22 (57.9)	48 (63.1)	3 (18.8)	28 (33.8)
Retruded mandible	4 (100)	70 (94.6)	8 (50)	0 (0)	0 (0)	2 (2.7)	3 (18.8)	9 (10.8)
Protruded maxilla	0 (0)	3 (4.05)	6 (37.5)	1 (0.9)	1 (2.6)	0 (0)	5 (31.2)	9 (10.8)
Retruded maxilla	0 (0)	1 (1.4)	0 (0)	4 (3.7)	15 (39.5)	26 (34.2)	5 (31.2)	37 (44.6)
¹ P	**	**	*	**	**	**	NS	**

¹Chi-square test.

*P < .05, **P < .01.

NS, not significant.



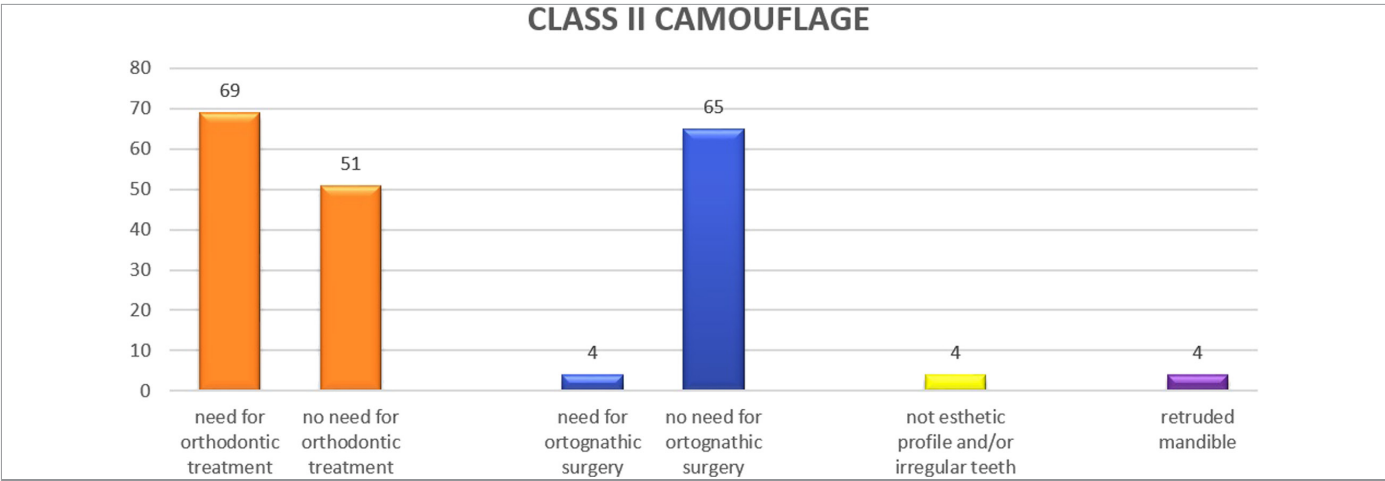


Figure 6. Distribution of the answers given to the Class II camouflage treatment case by the general dentists

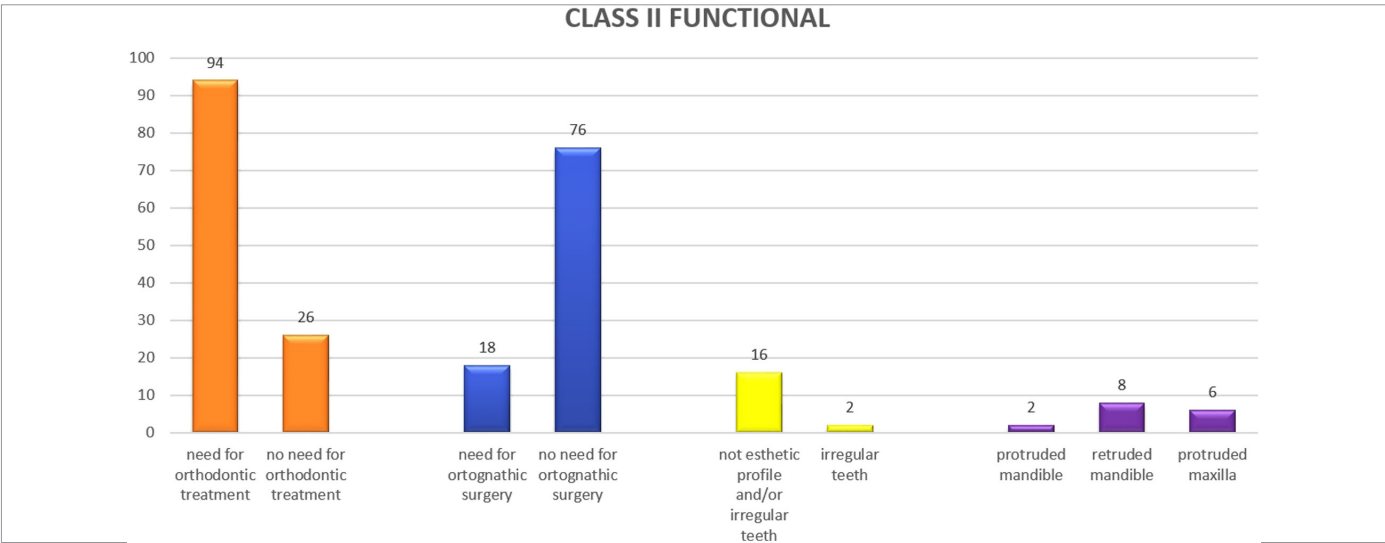


Figure 7. Distribution of the answers given to the Class II functional treatment case by the general dentists

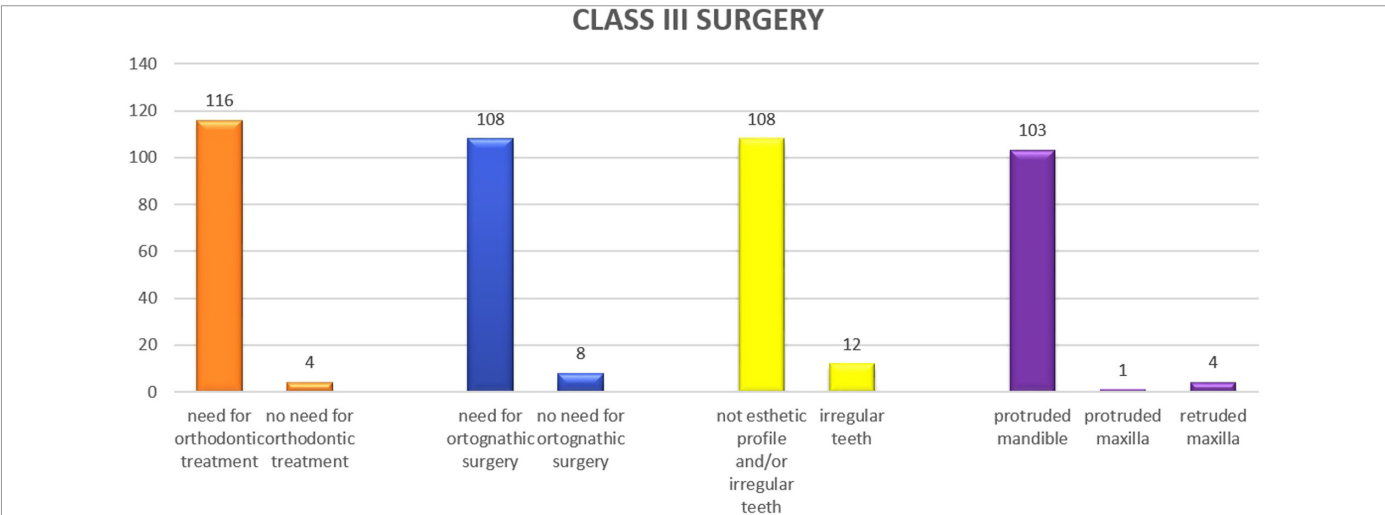
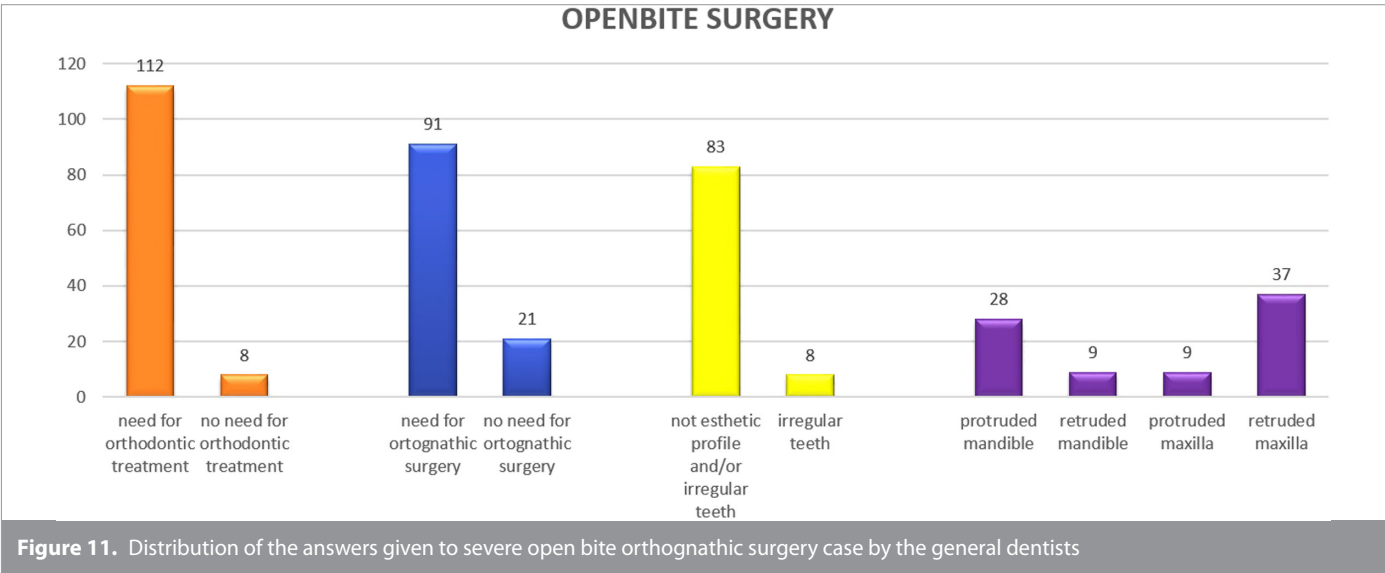
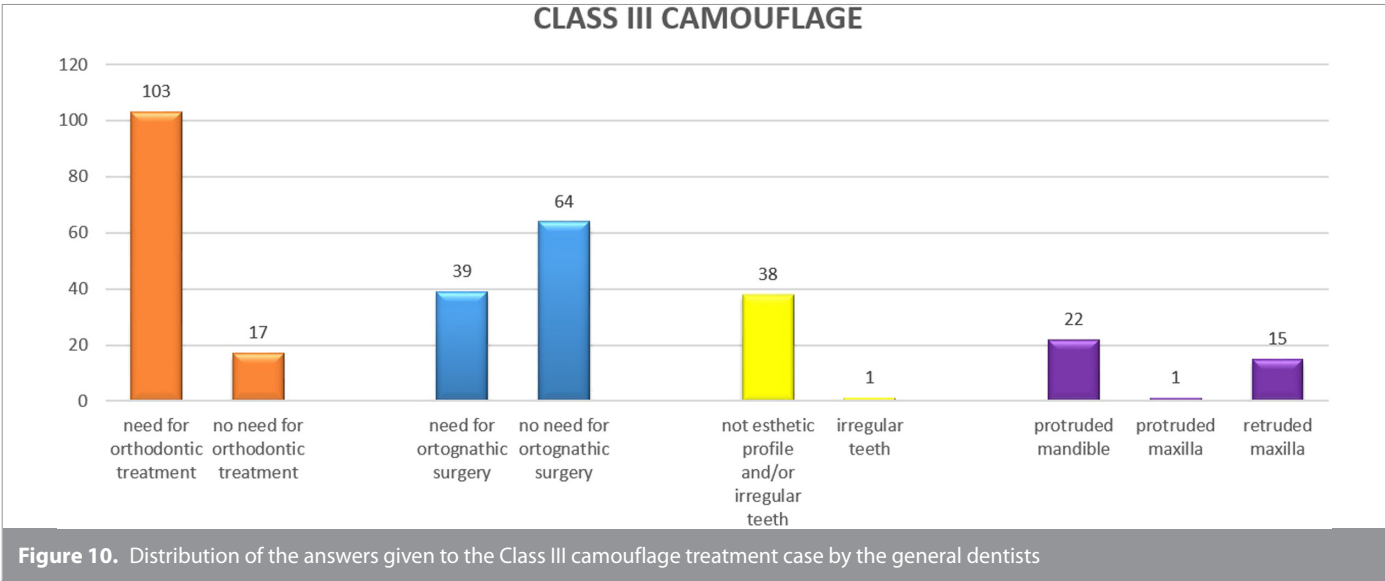
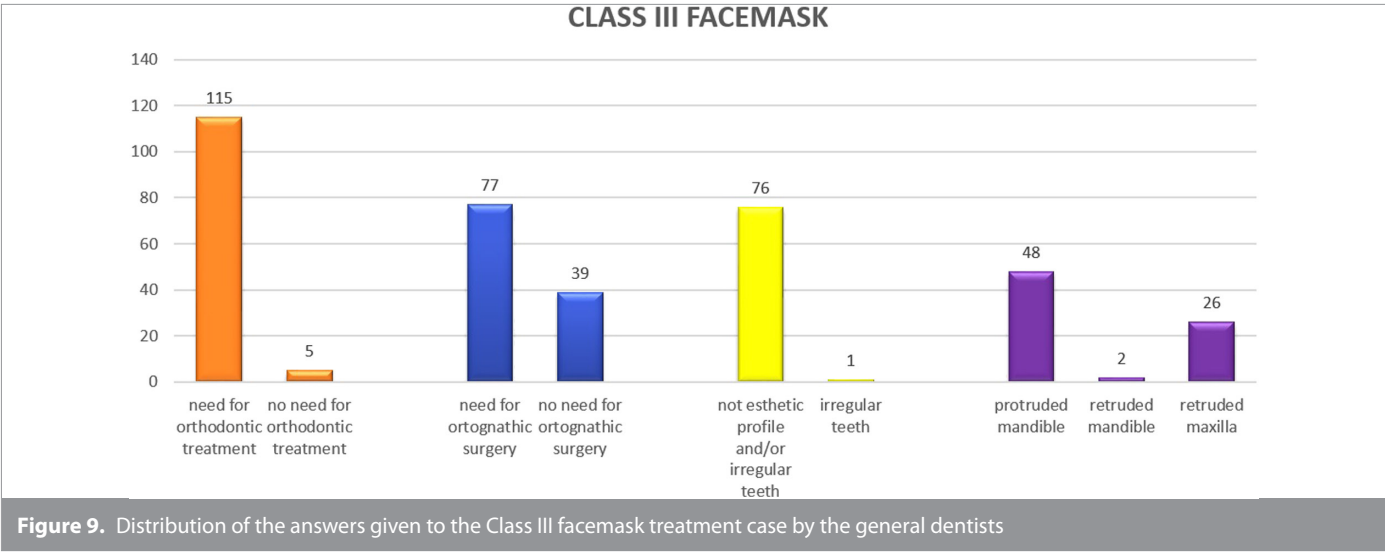
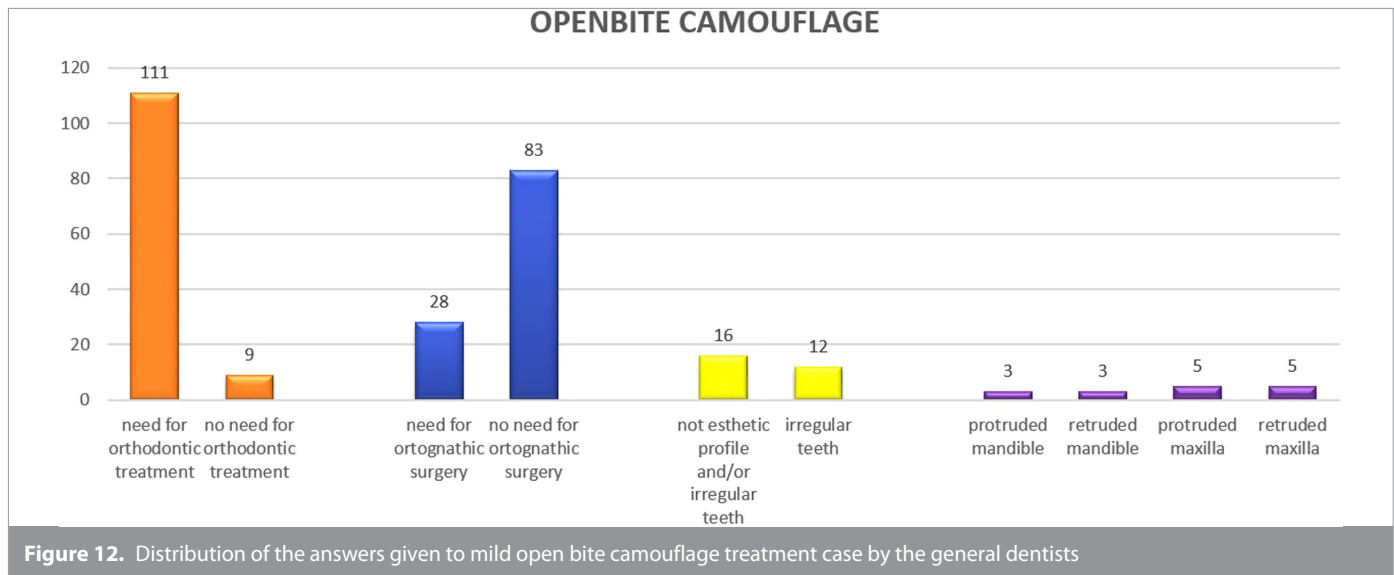


Figure 8. Distribution of the answers given to the Class III orthognathic surgery case by the general dentists





advantages of objectivity and simplification of facial esthetics by discarding those factors, and ensures that the participants can answer only by focusing on the profile and the malocclusion without being affected by other characteristics.

In dentistry, orthodontic patients are usually referred to orthodontists for treatment. In some countries, the government covers orthodontic treatment financially only in public hospitals, which creates long waiting lists. To ensure equity in all social classes and to minimize waiting lists, appropriate referral plays an important role. O'Brien et al.⁴ showed that up to 45% of the orthodontic referrals could be classified as inappropriate. It is suggested that referral guidelines can help general dentists to select suitable patients for referral to a specialist.¹⁴ However, O'Brien et al.¹⁵ reported that referral guidelines did not significantly influence the behavior of the general dental practitioners. Orthodontic referrals usually come from pediatric and general dentists. While orthodontists receive additional education to diagnose and treat different dental and skeletal malocclusions, the education of general dentists in orthodontics is only limited in dental school.¹⁶ All practitioners are advised to know treatment possibilities and the correct timing of application for orthodontic malocclusions.¹⁷ In West Sussex, 52% of the general dentists could diagnose orthodontic treatment needed; however, only 20% of them were able to decide the appropriate referral time.¹⁸ Similar to their results, Chew and Aw¹⁹ reported that the majority of the referred patients did need treatment; however, many of these patients were too young for the orthodontic treatment. In their sample, about 40% of the subjects were in the mixed dentition stage when referred, and only about 16% of these children were indicated for interceptive treatment in the mixed dentition stage.¹⁹ Many other studies show a high level of agreement in terms of an accurate orthodontic diagnosis among pediatric dentists, general dentists, and orthodontists.²⁰⁻²² Petersen and Dahlström²³ also concluded that general dentists and orthodontists rated IOTN from intraoral photographs in a similar way.

On the contrary, in a study that evaluates orthodontic knowledge of undergraduates in British dental schools, 75% did not

expect their new graduates to be able to plan orthodontic treatment. They believed that undergraduate education should be focused on the diagnosis of a malocclusion, rather than treatment planning.²⁴ In another study, a poor agreement was found in profile identification between the clinicians, and the first-year dental students, third-year dental students, and patient groups.²⁵ Heath et al.²⁶ reported that perceptions of case complexity were similar between orthodontists, general dentists, orthodontic residents, and dental students for patients in mild cases, however orthodontic training influences the ability to recognize case complexity in moderate to severe cases. Their results also showed that most professionals believe that they had inadequate orthodontic training during their undergraduation studies. Similarly to Heath et al.²⁶ another study showed that the perceived treatment needs for normal occlusion to mild maxillary protrusion were not related to the level of expertise; however, for moderate to severe maxillary protrusion, the perceived treatments were different among dental students, residents, and orthodontists.²⁷ In the present study, we believed that the recently graduated general dentists would be able to diagnose dental and skeletal malocclusions with all their complexities as the orthodontists do, and decide on the treatment type according to the severity of discrepancy, patients' age, and the jaw that was the source of the problem.

One hundred twenty general dentists participated in our survey. Although the ratios of male and female participants were different, studies have shown that there was no significant difference between the male and female participants regarding their perceptions.^{23,28}

In the literature, there are studies reporting the differences between professionals and lay people in the perception of dental esthetics using the AC assessments.¹⁰ Furthermore, the fact that the IOTN-AC index does not include the open bite and reverse overjet photos is a major omission. Therefore, in our study, a special questionnaire was used instead of the ICON-AC index, in order to assess whether general dentists are able to diagnose the malocclusions directly according to the type of malocclusion,

severity, and patients' age, instead of trying to compare patients to 10 photos, as in the ICON-AC index.

According to our results, for all cases except the Class II camouflage case, answers describing the need for orthodontic treatment were significantly higher; which coincided with the orthodontists' plan in the present study and also with the literature findings.²⁰⁻²² Among the Class II cases, only the patient indicated as requiring surgery by the orthodontists was chosen for orthognathic surgery by the general dentists (66.7%); camouflage and functional treatment patients were indicated for orthodontic treatment at only 94.2%, and 80.9%, respectively. This result might be explained by the increased knowledge about the functional treatment in Class II cases among the general dentists in the present study, as it was reported by Aldrees et al.,²⁰ that pediatric and general dentists suggested functional appliances more than the orthodontist did for early treatment. Of the Class III patients, the need for orthognathic surgery was chosen for both patients indicated as orthognathic surgery and facemask treatment, with a ratio of 93.1% and 66.4% respectively. These results might be explained by the literature findings of studies conducted in different countries, showing that the profiles in the range of Class II patterns are more favorable than the Class III pattern.^{28,29} This trend was also observed in those who needed surgical treatment. Profiles with mandibular prognathism have a more limited acceptable range. Soh et al.³⁰ reported that overjet was the major occlusal trait that influenced perceptions of dental esthetics; the greater the reverse overjet, the lower the dental esthetic ratings given. Hamdan et al.³¹ concluded that Class III malocclusion has a greater esthetic impairment compared to the open bite, and Abu Alhaija and Al-Khateeb³² also reported that severe reverse overjet is esthetically more unacceptable. Furthermore, in their study, Aldrees et al.²⁰ showed that compared with the orthodontists, the pediatric dentists and general dentists did not select facemasks with a high frequency. These situations might be the reason why the general dentists in our study recommended orthognathic surgery more for the Class III patients than the Class II patients, and also for those who could be treated with a facemask appliance. In the presence of open bite malocclusion, general dentists preferred orthognathic surgery for severe cases, and the camouflage treatment for mild cases, with ratios of 81.2% and 74.8% respectively. Our findings coincided with the literature findings which showed that mild open bite that could be treated orthodontically was more acceptable for both laypeople and dental professionals; according to given scores, while mild open bite was in the "no need for treatment or borderline need" category, severe open bite that was beyond the orthodontic limits was considered as esthetically unacceptable.³²

General dentists reported that an unesthetic profile and irregular teeth were the reasons necessitating orthognathic surgery, except for the mild open bite case in the present study. Among the orthognathic surgery cases, mandibular retrusion was determined as a reason for Class II malocclusion by the orthodontists, which coincided with the general dentists' results (94.6%). In addition, Class III malocclusion occurred

due to maxillary retrusion; however, general dentists chose mandibular protrusion as the reason for orthognathic surgery (95.4%).

In the present study, only Class II, Class III, and open bite cases were used for assessment among the group of recently graduated general dentists who would start to refer orthodontic patients to specialists as a part of their future clinical lives. However, it is also known that the ability to diagnose a case may increase with experience. Therefore, further studies with larger sample sizes from different levels of expertise would also contribute to the literature.

CONCLUSION

- No significant difference for the Class II camouflage case was found in terms of the need or not for orthodontic treatment.
- For Class III patients, the general dentists indicated the need for orthognathic surgery for both the orthognathic surgery patients and the facemask treatment patients.
- While the general dentists chose camouflage treatment for the mild open bite case, they chose orthognathic surgery for the severe open bite cases.
- Both the unesthetic profile and irregular teeth were chosen as the reasons for orthognathic surgery. Mandibular retrusion for Class II patients (94.6%), mandibular protrusion for Class III patients (95.4%), and maxillary retrusion for open bite surgery cases (44.6%) were the most reported.

Ethics Committee Approval: Ethical Committee approval was received from the Ethics Committee of Marmara University, (Approval No: 2020/25).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Peer Review: Externally peer-reviewed.

Author Contributions: Concept - H.N.Y., E.Ö.Ö.; Design - H.N.Y., E.Ö.Ö.; Supervision - H.N.Y., E.Ö.Ö.; Data Collection and Processing - H.N.Y., E.Ö.Ö., G.K.; Analysis and Interpretation - E.Ö.Ö., G.K.; Literature Review- G.K.; Writing and Critical Review - E.Ö.Ö., H.N.Y., G.K.

Conflict of Interest: The authors have no conflict of interest to declare.

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