

ORIGINAL SCIENTIFIC ARTICLE

The change in self-efficacy of novice dentists in Endodontics within the first year following graduation from Aarhus University or the Academic Centre for Dentistry Amsterdam

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Abstract

Aim: To understand whether the self-efficacy of novice dentists in Endodontics changes within the first year following their graduation, and to reveal factors related to a possible change.

Methodology: Data were obtained from dental graduates from Aarhus University, Denmark or from the Academic Centre for Dentistry Amsterdam, the Netherlands. The 60 participants filled out the Endodontic General Self-Efficacy Scale questionnaire close to their graduation (baseline) and 1 year following their graduation (follow-up). Additionally, data on their experience in Endodontics within the first year following graduation were gathered, as well as data on their work environment, their referral behaviour and the postgraduation education they attended. For comparisons, chi-square tests, Fisher's exact tests, Mann-Whitney tests, and *t*-tests were used. Referral behaviour and the change in self-efficacy were studied by multiple regression analyses.

Results: Most participants showed an increase in self-efficacy after graduation. The increase in self-efficacy was higher for those whose baseline self-efficacy was lower, and lower for those whose baseline self-efficacy was higher. Self-efficacy increased with experience in performing root canal treatments within the first year following graduation. Participants with higher average self-efficacy (i.e. mean of baseline and follow-up self-efficacy) referred patients for endodontic surgery more often than participants with lower average self-efficacy did.

Conclusions: The self-efficacy of novice dentists in Endodontics generally increased within the first year following their graduation. The increase in self-efficacy was greater for those who had low self-efficacy at graduation than for those who already had high self-efficacy. Performing root canal treatments was an important factor in increasing self-efficacy.

KEYWORDS

education, endodontics, novice dentist, referral, root canal treatment, self-efficacy

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INTRODUCTION

Despite the fact that undergraduate dental education prepares students for their role as dentists, transitioning from dental school to independent practice is challenging (ESE, 2013; Field et al., 2017; Musaeus, 2018). Lack of clinical experience in performing root canal treatments during undergraduate dental education is considered to be a problem, which may add to the various challenges of the transition into general practice (Dahlström et al., 2017; Davey et al., 2015). Although novice dentists are regarded as being competent in performing uncomplicated root canal treatments upon graduation, this may not always be their own perception (Dahlström et al., 2017; Davey et al., 2015; ESE, 2013; Murray & Chandler, 2014). Many dentists find it difficult to accomplish a good quality and economically viable root canal treatment, and feel frustrated about this (Dahlström et al., 2017). Although they have unpleasant associations with root canal treatment, they have to deal with these regularly in their practice (Dahlström et al., 2017). As it is unachievable to be exposed to every possible situation during undergraduate dental training, novice dentists have to trust their capabilities and rely on transfer. Hence, it is important that novice dentists feel that they have developed sufficient knowledge and skills to cope with challenges they meet whilst practising dentistry, including the ones that they have not yet dealt with during their undergraduate training.

One's performance on work-related demanding tasks, and whether one will use the academic competencies one has achieved, could be predicted by one's self-efficacy (Gist & Mitchell, 1992; Pajares & Miller, 1994; Zimmerman, 2000). Self-efficacy combines one's perceived competence with confidence in their abilities, and also takes environmental factors that may influence performance into account (Gist & Mitchell, 1992; Oney & Oksuzoglu-Guven, 2015). Self-efficacy can be defined as the belief and self-assurance that you will be able to perform specific tasks successfully, and it is an important motivational construct (Gist & Mitchell, 1992). People with high self-efficacy undertake challenging tasks more readily and pursue greater perseverance than people with low self-efficacy do, and the chances that a task is performed successfully are higher when performed by people with high self-efficacy (Bandura, 2006; Zimmerman, 2000). Besides, a high level of self-efficacy improves the degree of skill retention (Gist & Mitchell, 1992). Hence, novice dentists should not only be competent, but also be self-efficacious.

At the end of their undergraduate dental training, a certain level of competence is assured, but the level of self-efficacy varies amongst students (Baaij et al., 2020). Their self-efficacy may increase with performing root canal treatments on patients during undergraduate training,

but it also may decrease if those root canal treatments are difficult (Baaij et al., 2020). Novice dentists may face root canal treatments of various levels of difficulty in their practices, and the conditions under which the tasks are to be performed may be different from those in dental school. Besides, the novice dentist may be influenced by their colleagues. Other dentists might function – deliberately or unconsciously – as role models for the novice dentist and hence persuasion or modelling might occur, which can influence their self-efficacy (Gist & Mitchell, 1992). Another factor that can influence self-efficacy is the normative feedback that the novice dentist may receive from various sources (Gist & Mitchell, 1992; Wulf et al., 2010). Self-efficacy may thus change after graduation. A change in self-efficacy may lead to a change in performance, and this may result in ongoing positive professional development, however, it may also result in an exacerbation cycle that may be difficult to reverse (Bandura & Schunk, 1981; Gist & Mitchell, 1992). The aim of the present study was to understand whether the self-efficacy of novice dentists in Endodontics changes within the first year following their graduations from Aarhus University (AU), Denmark or from the Academic Centre for Dentistry Amsterdam (ACTA), the Netherlands, and to reveal factors related to a possible change.

MATERIALS AND METHODS

The research protocol of this study was independently reviewed and approved by the ethics committee of ACTA under the reference number 2017014.

The present study is a follow-up to a previous study on the self-efficacy of undergraduate dental students from AU or ACTA (Baaij et al., 2020). The students who participated in that study were contacted 1 year following their graduations, and were invited to participate in this follow-up study. Participants gave informed consent. Participation comprised filling out a questionnaire that contained the Endodontic General Self-Efficacy Scale (Baaij & Özok, 2018; Baaij et al., 2020) and additional questions on their experience in Endodontics after graduation, their work environment, their referral behaviour and the postgraduation education they attended (Table S1). The questionnaires were in their national languages. The data were collected and processed anonymously.

The response rate was 30%. People who participated in the follow-up study (i.e. the present study) were similar to those who participated only in the previous study (Baaij et al., 2020) (Table 1). The graduates from ACTA were divided into two groups: 'ACTA standard' and 'ACTA extended'. Whilst the graduates from both groups followed the regular endodontic programme before their

graduation, the graduates from the latter group followed an additional elective course in Endodontics during the final year of their undergraduate training. Hence, there are three programmes from which the participants could have graduated: AU, ACTA standard, or ACTA extended.

Data treatment and statistical analyses

The data obtained close to the participants graduation in the previous study (Baaij et al., 2020) were regarded as the baseline registration for the present study. The data obtained in the present study, 1 year after the graduation of those participants, was the follow-up registration.

Self-efficacy was determined by summing up the scores from the 10 questions of the Endodontic General Self-Efficacy Scale (i.e. total self-efficacy score). Baseline self-efficacy is the total self-efficacy score at graduation. Follow-up self-efficacy is the total self-efficacy score 1 year following graduation. The change in self-efficacy was calculated by subtracting the baseline total self-efficacy score from the follow-up total self-efficacy score. Average self-efficacy was calculated by dividing the sum of baseline and follow-up total self-efficacy scores by two. The relationship between the baseline self-efficacy and the follow-up self-efficacy was initially studied by a Bland-Altman plot (Kirkwood & Sterne, 2003) and then described by an errors-in-variables model fitted by orthogonal regression (Deming regression) (Cornbleet & Gochman, 1979).

For comparisons of programmes, chi-square tests, Fisher's exact tests, Mann-Whitney tests, and *t*-tests were

used. Predictors of the change in self-efficacy were studied by linear regression and multiple regression analyses. To this end, categorical independent variables were dichotomized due to the modest sample size. Referral behaviour was also studied by multiple regression analyses. The results of the multiple regression analyses were presented as regression coefficients with standard errors or as partial correlation coefficients. Stata Release 15 (Stata Corp. 2017, College Station, TX, USA) was used for all statistical analyses.

RESULTS

All participants completed the Endodontic General Self-Efficacy Scale questionnaire. Since the change in self-efficacy for the graduates of each school was similar, the data were combined (Figure 1).

Self-efficacy of most of the participants increased within the first year following graduation (Figure 1a). The correlation between the change in self-efficacy and average self-efficacy was statistically significant ($\rho = -0.32$, $p = .01$). The increase in self-efficacy was higher for those whose baseline self-efficacy was lower, and lower for those whose baseline self-efficacy was higher. The 'Deming-regression-line' (Figure 1b) shows the relationship between follow-up and baseline self-efficacy. The line has intercept 11.7 (se =2.6) and slope 0.69 (se =0.09) and was obtained from an errors-in-variables model fitted by orthogonal regression. The expected change in self-efficacy was 8.6 for those with baseline self-efficacy of 10 (i.e. the lowest possible total self-efficacy score), and it was -0.8

TABLE 1 Responders participated both close to their graduation (i.e. baseline) and a year following their graduation (i.e. follow-up), whereas non-responders participated close to their graduation (i.e. baseline) only

	Responders	Non-responders	<i>p</i> -value
Total <i>n</i>	60	138	
School <i>n</i> (%)			
ACTA	33 (28)	83 (72)	.50
AU	27 (33)	55 (67)	
Group (ACTA only) <i>n</i> (%)			
Standard	21 (25)	63 (75)	.07
Extended	12 (43)	16 (57)	
Root canal treatments performed during undergraduate dental training mean (sd)			
Root canals	9.2 (4.3)	8.6 (4.7)	.25
Teeth	4.2 (2.4)	4.6 (1.8)	.05
Incisors	0.7 (0.9)	0.6 (0.9)	.18
Canines	0.5 (0.7)	0.5 (0.8)	.73
Premolars	1.6 (1.1)	1.4 (1.2)	.30
Molars	1.9 (1.2)	1.7 (1.2)	.33
Baseline self-efficacy mean (sd)	25.9 (5.6)	25.3 (4.6)	.34

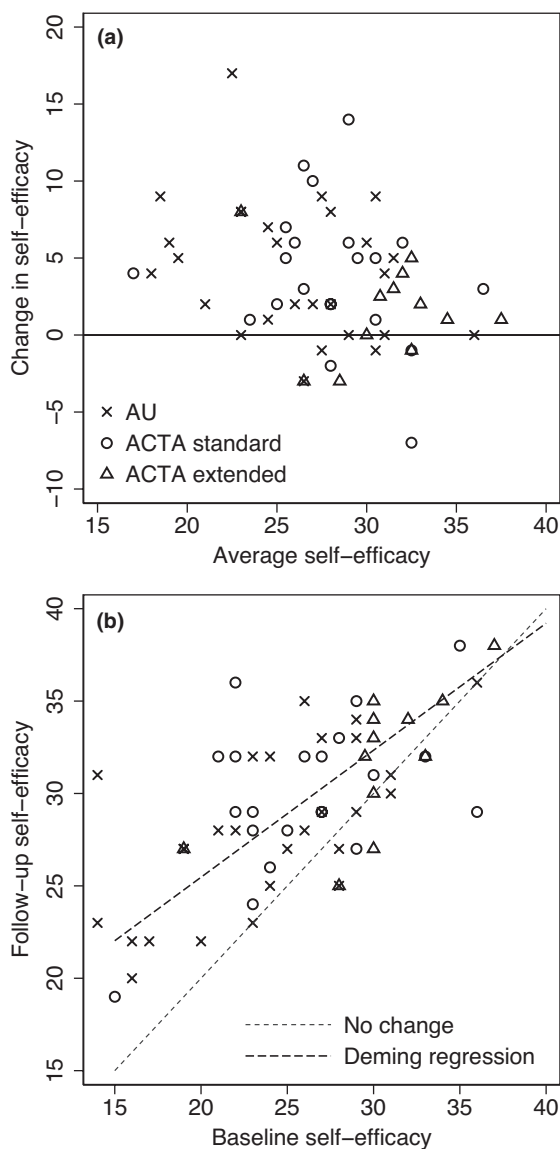


FIGURE 1 (a) A Bland-Altman plot showing the change in total self-efficacy score (follow-up score minus baseline score) plotted against the average of the total self-efficacy score at follow-up and the total self-efficacy score at baseline. (b) Total self-efficacy score at follow-up plotted against total self-efficacy score at baseline

for those with baseline self-efficacy of 40 (i.e. the highest possible total self-efficacy score).

Table 2 presents the results of linear regression analyses with independent variables from the baseline registration. When corrected for baseline self-efficacy, none of these variables had a significant impact on the change in self-efficacy. Results of linear regression with independent variables from the follow-up registration are shown in Table 3. The change in self-efficacy was positively associated with the amount of experience in performing root canal treatment after graduation. These results did not change substantially when corrected for programme or for baseline self-efficacy (results not shown).

The median number of primary root canal treatments performed within the first year following graduation was 25, and the median number of retreatments was 1. Graduates from AU performed more primary root canal treatments than graduates from ACTA did (Mann-Whitney test: $p < .001$), and they referred fewer cases to another practitioner (Mann-Whitney test: $p < .001$) (Table 4). Although the number of referrals for primary root canal treatments was negatively correlated with the number of primary root canal treatments that the novice dentists performed themselves (correlation = -0.28 , $p = .03$), no correlation was found after correction for the programme from which the novice dentists had graduated (Table 5). Both the number of root canal treatments performed and novice dentists' average self-efficacy were positively correlated with the number of cases they referred for endodontic surgery (Table 5).

Graduates from ACTA performed emergency treatments more frequently than graduates from AU did (Fisher's exact test: $p = .008$). Treatment following dental trauma was rarely performed by the graduates from both AU or ACTA, but graduates from AU performed consultations following dental trauma more frequently compared with the graduates from ACTA (Fisher's exact test: $p = .005$) (Figure 2). Experience with emergency treatments, or providing care following dental trauma was not associated with the change in self-efficacy (Table 3).

Approximately 70% of the participants, both graduates from AU or ACTA, had similar materials available in the practice to the ones which were available during their undergraduate dental training (Fisher's exact test: $p = .58$). Availability of familiar equipment was not associated with the change in self-efficacy (Table 3). The items participants reported that they missed in the practice are listed in Table S2.

The frequency of encountering problems was similar for graduates from AU or ACTA (Table S3). Encountering difficulties in diagnosing endodontic cases, difficulties in determining the prognosis of a tooth, complications whilst performing root canal treatment, or post-operative complaints from patients were not associated with the change in self-efficacy (Table 3).

Most graduates from ACTA worked in group practices, three worked in solo practices as well, and two graduates worked exclusively in solo practices. Graduates from ACTA had less on-site access to help from colleagues than graduates from AU did (Table S4). Availability of help was not associated with the change in self-efficacy (Table 3).

Postgraduation education in Endodontics was undertaken by 16 graduates from AU, and 12 from ACTA

TABLE 2 Results of linear regression analyses and multiple regression analyses with independent variables from the baseline registration and the change in total self-efficacy score (i.e. total self-efficacy score at follow-up minus total self-efficacy score at baseline) as dependent variable

Independent variables	Unadjusted			Adjusted for baseline self-efficacy		
	Coeff.	SE	p-value	Coeff.	SE	p-value
School (ref =ACTA)	1.15	1.12	.31	-0.74	0.92	.42
Group (ACTA only, ref =standard)	-2.33	1.51	.13	-0.19	1.35	.89
Number of teeth treated in school	-0.23	0.31	.47	0.14	0.25	.58
Number of canals treated in school	-0.27	0.13	.04	-0.04	0.11	.74
Number of molars treated in school	-0.79	0.48	.10	-0.27	0.39	.49

Note: 'Coeff.' is the regression coefficient; 'SE' is the standard error.

Each independent variable was analysed separately.

TABLE 3 Results of linear regression analyses with independent variables from the follow-up registration and the change in total self-efficacy score (i.e. total self-efficacy score at follow-up minus total self-efficacy score at baseline) as dependent variable

Independent variable	Coeff.	SE	p-value
Performed root canal treatments			
Primary treatment	0.05	0.02	.001
Retreatment	0.34	0.20	.09
Total (i.e. primary treatment + retreatment)	0.05	0.02	.002
Encountered difficulties in diagnosing ^a	0.10	1.17	.93
Encountered difficulties in determining the prognosis ^a	-1.22	1.14	.29
Encountered complications ^a	0.25	1.17	.84
Encountered post-operative complaints ^a	1.87	1.25	.14
Frequency of emergency treatment ^b	1.10	1.17	.35
Frequency of consultation following dental trauma ^c	0.63	1.41	.66
Frequency of treatment following dental trauma ^d	0.58	1.34	.67
Colleagues available for help when difficulties were encountered whilst performing root canal treatment ^e	-2.06	1.13	.07
Colleagues available to discuss an endodontic case if necessary ^e	-2.75	2.26	.23
Materials similar to those at school ^f	-0.07	1.24	.96

Note: 'Coeff.' is the regression coefficient; 'se' is the standard error.

Each independent variable was analysed separately.

^aRarely, never. Ref =often, sometimes.

^bWeekly, monthly, rarely, never. Ref =daily.

^cMonthly, rarely, never. Ref =daily, weekly.

^dRarely, never. Ref =daily, weekly, monthly.

^eSometimes, never. Ref =always.

^fNo. Ref =yes.

(Fisher's exact test: $p = .10$), and included courses, congresses, lectures or symposia. Time allocated to this post-graduation education varied from 2 to 120 h. The graduates from ACTA standard programme or ACTA extended programme undertook similar amount of postgraduation education (Mann-Whitney test: $p = .69$).

DISCUSSION

This study included novice dentists from two countries who were graduates from three different undergraduate endodontic programmes. These factors appeared to have little influence on the change in self-efficacy (Tables 2

TABLE 4 Management of endodontic cases within the first year following graduation: the amount of root canal treatments that novice dentists performed themselves, and the number of cases they referred to a colleague

Undergraduate programme that the participants had graduated from															
ACTA standard						ACTA extended						AU			
	Median	Q1	Q3	Range	Median	Q1	Q3	Range	Median	Q1	Q3	Range	Q1	Q3	Range
Treatments performed by novice dentist:															
Primary treatment	20	12.5	30	0-60	15	11	26.5	6-100	40	25	65	0-150			
Retreatment	0	0	1.5	0-3	1	0	2.5	0-10	3	1	5	0-10			
Referrals by novice dentist for:															
Primary treatment	5.5	1.5	12.5	0-30	2	0.5	10	0-25	0	0	2	0-10			
Retreatment	7.5	3	20	0-30	2.5	0.5	10	0-25	0	0	1	0-10			
Endodontic surgery	1	0	3	0-10	2.5	0	5	0-10	3	1	5	0-20			
Other	0	0	1	0-3	1.5	0	4	0-5	0	0	1	0-3			

Note: 'Q1' is the lower quartile.

'Q3' is the upper quartile.

TABLE 5 Partial correlations between the referrals novice dentists' made and the number of primary root canal treatments they performed themselves within the first year following graduation, the change in their self-efficacy, and their average self-efficacy

Referrals for:	Primary treatments performed		Change in self-efficacy		Average self-efficacy	
	Part. corr.	<i>p</i> -value	Part. corr.	<i>p</i> -value	Part. corr.	<i>p</i> -value
Primary treatment	-0.11	.42	-0.07	.58	-0.02	.88
Retreatment	0.18	.18	-0.04	.75	0.08	.55
Endodontic surgery	0.54	<.001	0.75	.39	0.28	.04
Other (trauma, resorptions)	-0.12	.40	-0.24	.09	0.04	.80

Note: 'Part. corr.' is the partial correlation.

The partial correlations are correlations adjusted for the undergraduate programme that the participants had graduated from, that is, the pooled within programme correlations between the type of referral and the dependent variable.

and 3). Although the response rate in the present study may be considered low, the responders seemed to resemble the non-responders (Table 1), and therefore, it is expected that the findings in the present study would not have changed substantially if the participation rate had been higher (Draugalis et al., 2008). The sample comprised novice dentists with varying clinical experience in Endodontics prior to graduation, and varying baseline self-efficacy (Baaij et al., 2020). Floor and ceiling effects, since self-efficacy has a lower and upper limit, as well as measurement error, were anticipated, but seemed not to fully explain the change in self-efficacy (Figure 1) (Bland & Altman, 1995; Gist & Mitchell, 1992; Kirkwood & Sterne, 2003). Besides, increase in self-efficacy is controlled by one's performance, and therefore an inaccurate increase in self-efficacy seems unlikely since it is expected to be corrected automatically when performance lags behind (Gist & Mitchell, 1992).

Endodontic self-efficacy increased with the number of root canal treatments performed within the year following graduation, and the increase in self-efficacy also depended on the level of self-efficacy that had been built-up until graduation (Tables 2 and 3 and Figure 1). Obviously, a high baseline self-efficacy leaves less room for an increase in self-efficacy than a low baseline self-efficacy (Gist & Mitchell, 1992). The value of performing root canal treatment on patients during undergraduate dental training is to transition from competent to self-efficacious more readily (Baaij et al., 2020). The novice dentists who participated in this study had stated previously that they would have liked to have more clinical experience with root canal treatments during their undergraduate education (Baaij et al., 2020). One might question, however, whether that is actually necessary, as part of the process of building self-efficacy may take place following graduation. At many dental schools, there is a lack of root canal treatments of a suitable difficulty level for the undergraduate students (Divaris et al., 2008). It could be speculated that it would be better to accept less experience with performing root canal

treatments on patients prior to graduation than allowing students with limited clinical experience to perform difficult root canal treatments on patients (Baaij et al., 2020). Difficult root canal treatments may evoke a negative experience that may decrease one's self-efficacy, especially in the early phase of building it (Bandura, 1977; Tanalp et al., 2013). Performing a retreatment in the year following graduation was, however, not negatively associated with the change in self-efficacy (Table 3). Participants who performed retreatments following graduation performed high numbers of primary root canal treatments as well (Spearman's $\rho = 0.80$, $p < .001$). Self-efficacy is usually higher when experience accumulates, and then the impact of a negative experience on one's self-efficacy diminishes; the number of positive experiences will probably outgrow the number of negative ones (Bandura, 1977). Besides, an increase in self-efficacy may lead to an improvement in performance (Gist & Mitchell, 1992). Undertaking more challenging tasks at this stage may be less prone to cause negative experiences and may even contribute to a positive professional development (Bandura & Schunk, 1981). This might explain the noteworthy finding that some of the participants who did not have experience with performing retreatments prior to graduation did manage to perform retreatments after graduation. They may gradually have pushed their goals.

The duration of undergraduate dental education in Denmark is 5 years, whereas it is 6 years in the Netherlands. In Denmark, dental graduates are not allowed to own a private practice before they have had 1 year full-time employment, including both private and public practice. That implies that they have access to support from a more experienced colleague during their first year of transition. In the Netherlands, however, newly graduated dentists can immediately obtain authorization to practice dentistry independently. It is nevertheless common for novice dentists in the Netherlands to start working in group practices with other dentists. One would assume that the availability of a colleague who could offer help when it

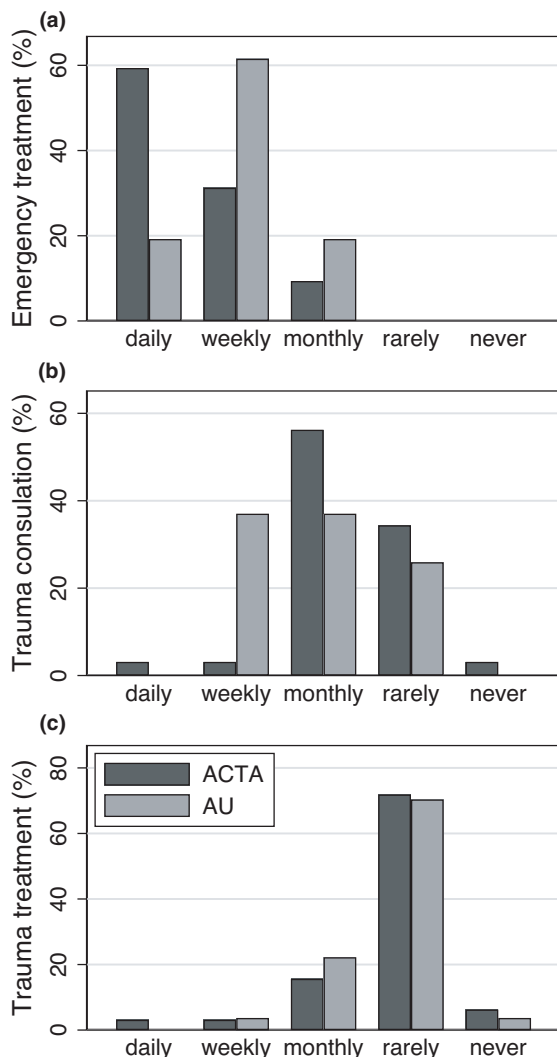


FIGURE 2 (a) Frequency of emergency treatment by novice dentists within the first year following graduation from the Academic Centre for Dentistry Amsterdam (ACTA) or Aarhus University (AU). (b) Frequency of consultations following dental trauma by novice dentists within the first year following graduation from ACTA or AU. (c) Frequency of treatments following dental trauma by novice dentists within the first year following graduation from ACTA or AU

is needed would give more confidence to the novice dentist, and would be positively associated with the change in self-efficacy. Although the findings from the present study may suggest such a positive effect, it was not statistically significant. Besides, when a colleague helps to overcome a difficulty, this does not necessarily contribute to the novice dentist's feeling of being capable of performing a similar difficult task without any help. The novice dentist may give the credit to their helping colleague instead of to themselves when appraising their performance.

A reason that the novice dentists in Denmark performed more root canal treatments and referred less in comparison to the novice dentists in the Netherlands might be that there

are less referral possibilities for a root canal treatment in Denmark. Ideally, a practitioner should refer a patient when they lack the necessary skills to perform the indicated treatment themselves. A practitioner may also decide to refer when they believe that they lack the necessary skills, regardless of whether that belief is accurate or not. Such belief may be reflected in lower self-efficacy; the novice dentists with low self-efficacy may overrate required skills, or doubt their own skills (Gist & Mitchell, 1992; Wulf et al., 2010). Those skills might include not only the skills in performing different types of endodontic treatments, but also the skills in diagnostics and treatment planning.

Decision-making is influenced by the practitioner's knowledge and confidence in treatment options (McCaul et al., 2001). Self-efficacy influences individual choices and outcome expectancies and might also be a factor influencing the choice of treatment (Bandura, 2006; Gist & Mitchell, 1992). Self-efficacy, however, is the belief that one will be able to successfully perform the treatment regardless whether that treatment in itself will lead to a good prognosis or not (i.e. regardless of the outcome expectancies), and it should, therefore, not necessarily influence the treatment choice. In the interest of the patient, the choice of treatment should be based on outcome expectancies that are based on evidence.

The novice dentists in the present study were not educated to the level of competency to perform endodontic surgery on patients during their undergraduate education. It is therefore expected that the participants referred their patients when they selected this treatment option. Novice dentists with more experience and higher self-efficacy decided more often to refer for endodontic surgery. They may have had a more realistic perception of their skills as well as of their limits, and may make a more realistic distinction between operator-dependent factors and what the external factors contributing to the prognosis are; their high self-efficacy may remain high even if they have to refer a patient because the treatment that they had performed appears unsuccessful (Gist & Mitchell, 1992; Ng et al., 2011). One might speculate that the choice of treatment and referral behaviour may be influenced by the combination of practitioners' skills, their experience and self-efficacy, and their knowledge about and confidence in treatment options (Taha et al., 2019).

CONCLUSION

The self-efficacy of novice dentists in Endodontics generally increased within the first year following their graduation. The increase in self-efficacy was greater for those who had low self-efficacy at graduation than for those who already had high self-efficacy. Performing root canal treatments was an important factor in building up self-efficacy.

CONFLICT OF INTEREST

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

ETHICAL STATEMENT

This study has been independently reviewed and approved by an ethical board. The research was undertaken with the understanding and consent of each participant and in full accordance with ethical principles.

AUTHOR CONTRIBUTIONS

All authors contributed substantial to: conception and design of, or acquisition of data or analysis and interpretation of data; drafting the article or revising it critically for important intellectual content; and final approval of the version to be published.

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