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Undergraduate Teaching for Using Rotary Nickel-titanium Endodontic Instruments

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Abstract Aim: To evaluate students' perceptions and self-assessment of their experience, theoretical knowledge and practical abilities to use rotary nickel-titanium endodontic instruments. Methodology: A questionnaire was filled by fourth- and fifth-year students in Faculty of Dental Medicine, Sofia, Bulgaria. Data concerning self- assessment of theoretical knowledge and practical experience were gathered. Results: Students' self-assessment of practical experience was not influenced by the time of education. High appreciation for increase of amount/time of practical training and inclusion of more cases and more rotary NiTi systems was determined. University lectures alone or in combination with non-university lectures were found to have greatest influence on students' knowledge of rotary NiTi instruments. University practical lessons were estimated as the main source for acquiring practical skills. In the course of education preference for rotary NiTi instruments remained unchanged, although majority of students felt more confident in usage of hand stainless-steel instruments. A good understanding of general topics related with use of NiTi rotary systems was demonstrated. Almost all respondents estimated work with rotary NiTi instruments as less strenuous and time saving. Conclusion: Students assess implementation of rotary nickel-titanium instrument in undergraduate curriculum as positive. Their practical experience is highly influenced by the university training classes. Majority of students prefer using rotary NiTi instruments, but feel deficiency in confidence for using them. Increased number of lectures and wider variety of topics related to rotary NiTi systems are advocated. Knowledge of more rotary systems has to be incorporated into lectures and practical training.

Keywords: *dental education, dental students, nickel-titanium, root canal treatment, rotary techniques, undergraduate teaching*

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1. Introduction

Nickel-titanium (NiTi) wire was initially reported for use by Walia et al. [1] in 1988 and since then, new brands of NiTi rotary files with improved design [2] and alloy structure [3,4] have been introduced on the market. The implementation of new manufacturing processes [5,6] and different modes of rotation [7,8,9] tries to improve instruments resistance on cyclic fatigue and torsional overloading. Despite the great variety of NiTi rotary instruments available on the market, most of them are famous and highly preferred by practitioners for their super-elasticity, excellent flexibility, improved cutting efficiency and better centering ability [10,11,12,13,14].

Influenced by improvement in knowledge, techniques, materials and educational approaches, undergraduate endodontic teaching has undergone significant changes [15,16,17]. The university endodontic departments/units develop comprehensive theoretical and practical endodontic courses for undergraduates, based on the increasing provision of endodontic care, the introduction of new techniques and instruments and the greater patients' expectations. It is a responsibility of dental schools to examine critically undergraduate endodontic programs and to train their students to undertake and accomplish uncomplicated root canal treatments on graduation [18,19].

The undergraduate practical training in endodontology in our Department of Conservative Dentistry, Faculty of Dental medicine, Sofia, Bulgaria starts in the 6th semester (preclinical course) and continues till the 10th semester (clinical course). At the end of their education students acquire basic knowledge and gain experience in usage of endodontic instruments, shaping techniques, irrigation protocols, methods for root canal filling and restoration of endodontically treated teeth. In 2012 we became a part of the University Grant Program of Dentsply Maillefer for undergraduate for using rotary nickel-titanium instruments. The changes of the program comprise a lecture on characteristics of NiTi rotary instruments (in preclinics), shaping of 3 extracted single-rooted teeth in laboratory classes and endodontic treatment of 8 canals in clinical course with ProTaper Universal (DentsplyMaillefer).

The adoption of a new shaping technique in undergraduate endodontic course requires evaluation of quality of treatment, assessment of students' knowledge, practical skills and perceptions. Based on this information, current problems can be identified and useful solutions can be found.

The purpose of this study was to evaluate students' perceptions and self-assessment of their experience, theoretical knowledge and practical abilities for employing rotary nickel-titaniumendodontic instruments.

2. Materials and Methods

2.1. Participants

Fourth- and fifth-year students in Faculty of Dental Medicine, Medical University, Sofia, Bulgaria were included in this survey in the year 2016. All students in the clinical courses (138 fourth-year and 155 fifth-year students) received a questionnaire and were asked to complete it.

Participation was voluntary and anonymous, with subjects giving verbal consent to participate in the study. No personal data were collected. The actual study was conducted in full accordance with the World Medical Association Declaration of Helsinki and was approved by the Department of Conservative Dentistry in Faculty of Dental Medicine, Medical University, Sofia, Bulgaria.

The time for filling in the questionnaire was not limited. Accompanying information sheet explained the reasons for implementing this survey and the intentions of Department of Conservative Dentistry to improve undergraduate teaching in use of rotary nickel-titanium endodontic instruments.

2.2. Questionnaire

A questionnaire, created for the purpose of this cross-sectional study, was used for the collection of the data. It consisted of seventeen multiple-choice questions – 9 with three possible answers and 8 with statement of only positive or negative attitude. Selection of more than one answer was not allowed.

The questions were divided in two groups. The first group evaluated students' perceptions and experience in preclinical and clinical training for using rotary NiTi instruments. The role and sufficiency of university lectures and practical training lessons were estimated, comparing them with non-university theoretical and practical training resources. Self-assessment of quality and level of students' experience was made in three grades: satisfactory, very good and excellent. The second group questions assessed students' knowledge on general topics to use of rotary NiTi engine- driven techniques.

2.3. Statistical Analysis

All gathered data were analyzed using SPSS 15.0 package. The Paired-Samples T-Test was used to test the hypothesis of no difference between two dependent variables. Cross- tabulation provided information about the relationship between two variables. The level of significance was set at P=0.05.

3. Results

Two hundred and ninety-three students received a questionnaire and 237 of them (80.89%) responded and returned it.

3.1. Perceptions and Self-assessment of Experience in Preclinical and Clinical Training

3.1.1. Self-assessment of Practical Experience According to Educational Course

Participants were asked to estimate the level of their practical training for using NiTi rotary systems in preclinics and clinics. They had to choose between three possible grades: satisfactory, very good and excellent. As shown in Figure 1, in preclinical course above half of the students (57.4%) assessed their practical experience as "satisfactory" and only 8.9% found it "excellent". The proportion of students finding their practical abilities as "very good" (48.1%) increased in clinical course and at the same time, the rate of participants with "satisfactory" experience (40.9%) decreased. Comparison of the results from the two tested periods showed that students' self-assessment of practical experience was not influenced by the time of education (educational course) (P>0.05).

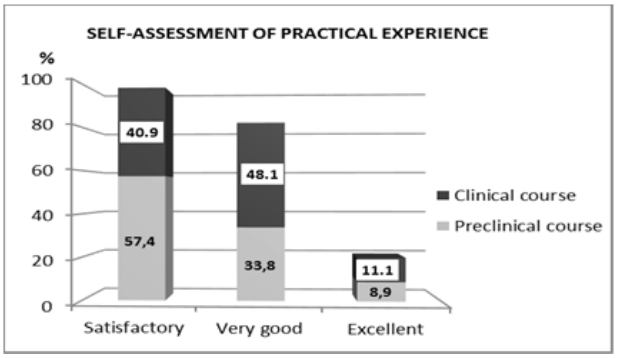

Figure 1. Self-assessment of practical experience in preclinical and clinical course

3.1.2. Sufficiency of Theoretical and Practical Training

Students estimated sufficiency of theoretical and practical training in preclinical course by answering two questions with only positive or negative statement. The first question considered necessity of increase of amount/time of practical training and 91.6% of participants responded positively. The answers of the second question demonstrated extremely high proportion of students (97.5%) appreciating inclusion of more rotary NiTi systems in curriculum. (Figure 2)

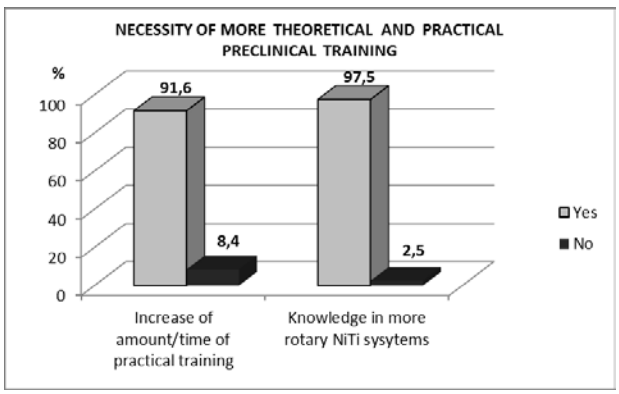

Figure 2. Necessity of more theoretical and practical training in preclinical course

Sufficiency of number of clinical endodontic cases shaped with rotary NiTi systems was evaluated by

defining it as: unsatisfactory, satisfactory and sufficient. Half of the students (50.4%) found it unsatisfactory, 38.1% - satisfactory and 11.4% - sufficient. Prevalence of answers for insufficient number of clinical cases (satisfactory and unsatisfactory) was established.

3.1.3. Students' Knowledge of Rotary NiTi Systems in Relation to Resources for Theoretical and Practical Training

Two of the questions in the questionnaire explored the influence of different resources for theoretical and practical training on students' knowledge and practical skills (Figure 3). Importance of resources for acquiring theoretical knowledge in rotary NiTi systems was estimated by choosing one of three possibilities: only from university lectures; only from non-university lectures and from both university and non-university lectures. A very small percentage of the respondents (7.2%) acquired their theoretical knowledge only from non-university lectures. The importance of university teaching program alone or in combination with non-university courses was estimated almost equally – 43% and 49.8% respectively.

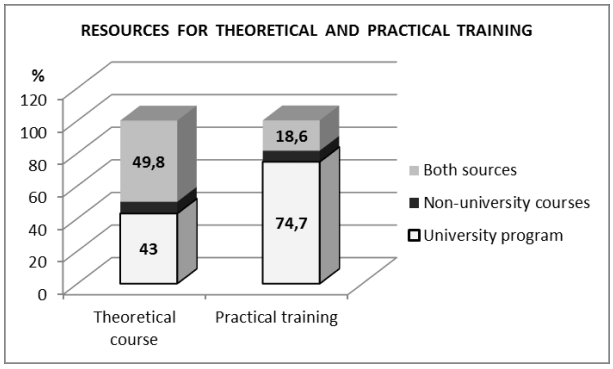

Figure 3. Resources for theoretical and practical training in use of NiTi rotary systems

The influence of resources for acquiring practical experience was estimated by choosing one of three possible answers: only in university practical lessons, only in non-university practical courses and in both university and non-university practical training. The prevalent answer was "only in university practical lessons" (74.7%). Like the answers of the previous question, importance of non-university practical courses was assessed as the lowest (6.8%).

The relationship between students' self-assessment of their practical experience and resources for practical training was examined using cross-tabulation. Students who found the university practical training with greatest importance assessed their practical experience at the end of the preclinical course as follows: satisfactory – 54.8%, very good –37.9% and excellent – 7.3%. The distribution in the group finding non-university courses most influential was as follows: satisfactory - 87.5%, very good – 12.5%, excellent – 0% and in the third group (both, university and non-university courses) - satisfactory – 56.8%, very good – 25%, excellent – 18.2%. (P=0.012).

3.1.4. Preference for Shaping Instruments in Relation to Experience

Answers of two questions demonstrated students' preference for shaping instruments, considering different experience levels (at the end of preclinical and clinical courses). Respondents were expected to choose one of 3 possible answers: hand stainless-steel instruments, hand NiTi instruments and rotary NiTi instruments. The results shown in Figure 4 revealed high preference for shaping root canal space with rotary NiTi instruments in both groups – at the end of preclinical course - 78.8%, and at the end of clinical training - 72.2%. Hand stainless-steel files were pointed as the least preferable instruments – 6.8% (preclinical course) and 7.6% (clinical training). The analysis of the results showed that in the course of education preference for rotary NiTi instruments remained unchanged (P>0.05).

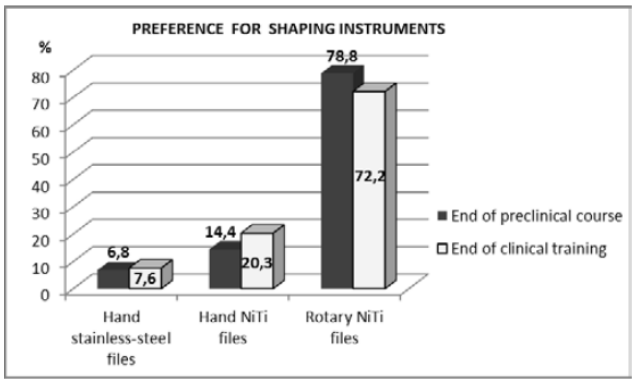

Figure 4. Preference for shaping instruments at the end of preclinical and clinical training

3.1.5. Self-confidence during Shaping Root Canal Space with Different Instruments

Self-confidence during shaping endodontic space with different kinds of instruments was estimated by choosing one of two possible answers: hand stainless-steel instruments and rotary NiTi instruments. Usage of hand NiTi files was not assessed as these instruments were not available in the practical training course. Students felt more confident using hand stainless-steel files (61.7%) and only 38.3% of them consider they can rely on their skills using rotary NiTi files.

A relationship between preference for shaping instruments and students' self-confidence during shaping root canal space with different files was searched. Students preferring hand stainless-steel files felt more confident in use of the same instruments in their practical classes (81.2%). Only 18.8% evaluated their confidence as sufficient when rotary NiTi files were used (P<0.001).

Students preferring rotary NiTi instruments felt more confident in use of hand stainless-steel instruments (56.0%) and 44% - in use of rotary NiTi files.

3.2. Students' Knowledge of General Topics Related to Use of Rotary NiTi Systems

Six questions, with possibility of giving positive or negative answer only, estimated students' knowledge of general topics related with use of NiTi rotary systems.

Proportions of positive and negative answers are summarized in Table 1.

The answers of the first question, considering knowledge of reciprocating systems, revealed that 45.1% of respondents were not acquainted with reciprocal rotation/systems.

Table 1. Students' knowledge about rotary NiTi systems and its use

QUESTION	*ANSWER*	
	YES (%)	**NO** (%)
1. Are you acquainted with reciprocating NiTi rotary systems?	54.9	45.1
2. Does preliminary creation of a glide path increase fracture resistance of NiTi instruments?	90.6	9.4
3. Do you agree that NiTi rotary instruments demonstrate better centering ability and less canal transportation during shaping curved root canals than hand stainless-steel instruments?	47.7	52.3
4. Do you find fracture resistance of NiTi rotary files dependent only on their extreme flexibility and super-elasticity?	48.1	51.9
5. Do you find root canal taper important for efficacy of irrigation?	88.2	11.8
6. Do you find rotary instrumentation less strenuous and time saving?	93.2	6.8

Students demonstrated very good knowledge of positive influence of preliminary creation of a glide path on fracture resistance of rotary NiTi files. Answer "yes" was given by 90.6% of them. A supplementary question specifying knowledge of instruments and ways of achieving a glide path was included. Three answers were suggested: yes, I'm acquainted with them only theoretically; yes, I'm acquainted with them theoretically and practically; no, I'm not acquainted with them. Almost half of respondents (54.4%) had only theoretical knowledge, for 17.3% of them practical experience was added and 28.3% were unaware of the problem.

Better centering ability and less canal transportation of NiTi rotary files was stated by 47.7% of students and 52.3% gave their preferences to hand stainless-steel instruments.

Fracture resistance of NiTi rotary files was found dependent only on their extreme flexibility and super-elasticity by 48.1% of participants. Influence of other factors on fracture resistance was expected by 51.9% of students.

Very good understanding of the influence of root canal taper on efficacy of irrigation was demonstrated by 88.2%. Only 11.8% found it unimportant.

Almost all respondents (93.2%) estimated work with rotary NiTi instruments as less strenuous and time saving.

4. Discussion

Till 2012, shaping of root canals in our practical lessons was performed only with hand stainless-steel instruments. A tendency for predominance of stainless-steel hand files compared to rotary nickel-titanium instruments was manifested in some dental faculties in Western Europe and North America, according to an international endodontic survey in 1999 [15]. Nowadays, canal preparation with rotary nickel-titanium instruments is widely taught and used in French schools [20] and in 63% of German universities [21].

Students' self-assessment of their practical experience at the end of preclinical and clinical course of education was estimated with the first group of questions. The percentage of students evaluating their experience as satisfactory at the end of the two courses was high. With the increase of their practical training, the number of students assessing their skills as very good increased and it reached 48.1%. At the same time, a very small part of students found their training excellent in both examined periods. Unexpectedly, it became obvious that increased practical experience did not influence significantly students' perceptions of their skills. Maybe hours for practical training are not the only factor that should be taken into consideration. Sufficiency of theoretical knowledge and number of treated cases are of great importance, as well.

The answers of the questions referring to amount/time of practical training and implementation of more rotary systems in students' curriculum were considered of great importance for improvement of undergraduate teaching in endodontology. Till now, students got acquainted with only one system for rotary instrumentation (ProTaper Universal, Dentsply, Maillefer) but the investigation results revealed a strong demand (97.5%) for inclusion of more rotary systems in the training course. The time devoted specifically for teaching rotary NiTi systems is fixed in the preclinical course (8 hours). The situation is different in the clinical lessons where students have to finish a certain number of cases and rotary instrumentation with NiTi files is only a part of it. Based on the questionnaire results, a predominant number of respondents evaluated amount/time for practical training in both (preclinical and clinical) courses as insufficient and increase was expected. Similar to our findings was the demand for more teeth for practical training in dental schools in New Zealand [22]. The minimum number of completed root canal treatments necessary for gaining sufficient competency was found highly variable in different dental schools [19]. The European Society of Endodontology does not give any requirements for minimum practical endodontic training necessary for inducing certain level of competence [18]. Therefore, decisions concerning number of treated with rotary NiTi files endodontic cases should be taken very carefully, based not only on students' demands, but in accordance with the requirements for quality and consistency of students' performance and the experience of other universities.

Nowadays, knowledge of different endodontic topics, including rotary NiTi systems, can be acquired not only in university training courses but in non-university lectures and practical courses, as well. The combination of both resources is not an exception and lately it is preferred by many students. A confirmation of this statement can be found in the results of our survey. Almost half of the respondents (49.8%) gained their theoretical knowledge of rotary NiTi instruments from both, university and non-university lectures. The importance of non-university lectures and practical courses alone was the weakest (7.2% and 6.8%, respectively). Surprisingly, it was found that almost 75% of students evaluated university practical training with highest influence on their practical skills. Whatever the source for practical training was, the prevailing number of students assessed their practical experience at the end of the preclinical course as "satisfactory", followed by "very good" and "excellent" grades. It should be kept in mind that collected data in this survey are based on respondents' self-assessment of their skills and not on their real competence. At the same time, it is considered that students' perceptions of the educational process and self-assessment of their clinical skills are a key component in monitoring the quality of academic programs [23] and are basis for future perfection [24].

Like some of the French dental schools [20], root canal instrumentation in our clinical classes was completed mostly manually with stainless-steel hand files and in

certain cases rotary NiTi instruments were used. This made us investigate what were students' preferences for shaping instruments at different educational levels, regardless of program requirements. A prevalence of preference for rotary NiTi instruments was found in both examined periods – at the end of preclinical and clinical courses (78.8% and 72.2%, respectively).

The high preference for rotary NiTi instruments did not correlate very well with the results presenting students' self-confidence during shaping the root canal space with different instruments (hand stainless-steel and rotary NiTi files). Students feeling more confident in usage of hand stainless-steel instruments predominated (61.7%) and only one third of all respondents found themselves confident in use of rotary NiTi instruments. It was not surprising that 81.2% of students preferring stainless-steel files felt more confident in use of the same instruments. Unexpectedly, more than half of the respondents (56%) who preferred rotary NiTi files felt more confident in their work with stainless-steel hand instruments. Probably, most of the students choose rotary NiTi instruments for their excellent characteristics but for now, part of them finds some deficiency in their skills and more training is advisable. The obtained results are consequence of the insufficient number of treated cases with rotary NiTi instruments, as well. Our findings are in agreement with the investigation results of Chirani et al. [20]

Essential basis for acquiring competence in using rotary NiTi systems is sufficient knowledge of topics related with the problem. The results of our study demonstrated good understanding of characteristics of NiTi rotary systems.

Almost half of the students demonstrated insufficient knowledge in the nature of reciprocal rotation, in some features of rotary NiTi files and factors influencing their fractures. These results indicate that more objective oriented teaching is required.

The results from our survey clearly demonstrate that constant improvement of undergraduate teaching in endodontology is necessary, as it is essential for acquiring sufficient competences by general dentists. Similar were the conclusions derived from some other studies [15,25]. The importance of students' theoretical knowledge and clinical experience is clearly pointed at the ESE guidelines for undergraduate endodontic education, as well [18].

5. Conclusion

On the basis of the results obtained from this study, students assess implementation of rotary nickel-titanium instrument in undergraduate curriculum as positive. Their practical experience is highly influenced by the university training classes. Majority of students prefer using rotary NiTi instruments, but sometimes self-confidence is deficient. Increased number of lectures and wider variety of topics related to rotary NiTi systems are advocated. Knowledge of more rotary systems has to be incorporated into lectures and practical training.

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