

ORIGINAL ARTICLE/ARTICOLO ORIGINALE

# Root canal treatment quality in undergraduate program: a preliminar report on NiTi reciprocating files

*Trattamenti canalari eseguiti da studenti del Corso di Laurea in Odontoiatria: un resoconto preliminare sull'uso degli strumenti in lega NiTi azionati con movimento reciprocante*

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## KEYWORDS

Undergraduate  
teaching;  
Reciprocating files;  
Root canal treatment;  
Obturation technique;  
Treatment quality.

## Summary

**Aim:** To verify the root canal treatment quality performed by dental school students with NiTi instrument in reciprocating motion.

**Methodology:** 18 patients were enrolled and 28 root canals were shaped and sealed by reciprocating NiTi Instruments (WaveOne – Maillefer – Baillegues – SUI) and pre-heated guttapercha (Thermafill-Maillefer – Baillegues – SUI). Radiographs were taken before, during and at the end of the endodontic treatment.

**Results:** Root fillings length was adequate in 26 of the 28 root canals evaluated (92,86%). 19 of them (73,08%) presented an extrusion of the endodontic sealer. No instrument breakage was reported.

**Conclusions:** In this very preliminar study, undergraduate students' use of NiTi instruments in reciprocating motion might be a suitable alternative to traditional root canal therapy with low incidence of adverse effects.

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**PAROLE CHIAVE**

Insegnamento studenti;  
Strumenti reciprocanti;  
Trattamento canalare;  
Tecniche di obturazione;  
Qualità del trattamento.

**Riassunto**

**Obiettivi:** Valutare la qualità dei trattamenti endodontici eseguiti da studenti del Corso di Laurea in Odontoiatria con strumenti in lega NiTi azionati con movimento reciprocante

**Materiali e metodi:** Diciotto soggetti con patologie endodontiche sono stati inclusi nello studio; un totale di 28 canali radicolari è stata preso in considerazione e strumentato con strumenti in lega NiTi (WaveOne - Maillefer - Baillegues - SUI) e sigillati con guttaperca pre-riscaldata (Thermafil-Maillefer - Baillegues - SUI).

**Risultati:** In 26 su 28 radici l'esame radiografico è risultato soddisfacente (92,86%). In 19 (73,08%) canali erano presenti estrusioni di cemento canalare. Non si sono verificate rotture.

**Conclusioni:** In questo studio preliminare, l'uso di strumenti azionati con movimento reciprocante da parte di studenti è possibile e potrebbe rappresentare una valida alternativa alle metodiche tradizionali.

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**Introduction**

The development of a top class education in endodontics for dental students passes through an updated teaching standard; in addition, students should demonstrate a good skill level in non-surgical treatments executed on both single and multiple rooted teeth.<sup>1</sup>

Nickel–titanium (NiTi) rotary instruments of various designs have been introduced in the market since almost twenty years and a huge amount of studies reported that root canal systems shaping procedures might be more easy, quick, and predictable if compared to those obtained by stainless steel instruments.<sup>2–4</sup>

It has been reported<sup>5</sup> that the canal filling length in relation to the radiographic apex can invalidate the endodontic treatment outcome, leading to a reduced healing for short root canal fillings (more than 2 mm in relation with the radiographic apex) and for long fillings (those extruding beyond the apex).<sup>6–8</sup> It has been proven that the absence of voids spaces in root fillings is associated with a small risk of periapical diseases.<sup>9</sup> Little is known about NiTi instruments used in reciprocating mode from clinical point of view, although many in vitro reports showed favorable results,<sup>10–13</sup> some other papers pointed out some negative issues.<sup>14</sup>

Particularly, in undergraduate programs, no previous report have been published so far on this topic. The studies dealing with the quality of endodontic treatments performed by dental students reported a percentage of satisfactory root canal treatments ranging between 45.66 and 69.9%. In many of these studies the root canal treatment were performed with manual stainless steel instruments,<sup>15–19</sup> with manual NiTi instruments<sup>20–23</sup> (LETT), only a few were conducted using mechanically driven NiTi files.<sup>24–26</sup> In addition the obturation technique employed was frequently the cold lateral condensation of guttapercha. So far no previous study on the radiographical quality of the root canal treatments performed by dental students using NiTi instruments in reciprocating motion and obturation with pre-heated guttapercha and carrier.

The aim of this study is to evaluate, through X-ray analysis, the quality of endodontic treatments performed by dental students at the University of Milan using a systematic consisting of NiTi single use tapered instruments, used in reciprocating motion, for shaping and obturation technique based on pre-heated guttapercha with a plastic carrier.

**Material and methods****Endodontic teaching and clinical procedures**

During the forth year of the Undergraduate Program at the University of Milan, Department of Health Science, Dental School, Restorative and Endodontics, twenty four students underwent a teaching program in clinical endodontics on simulator dealing with root canal shaping by NiTi reciprocating system files (Wave One, Dentsply Maillefer, Baillegues, SUI) and root canal obturation system by pre-heated guttapercha carrier based (Thermafil, Dentsply Maillefer, Baillegues, SUI).

The course was 20 h of theoretical lessons and 40 h of practical training on simulators, both on plastic endoblocks and extracted teeth. In the same Dental School, the following year (fifth year of the undergraduate program) three students out of twenty four were randomly enrolled for the clinical trial on patients. They had been requested to perform endodontic treatment under supervision of expert endodontic tutors.

**Patients inclusion criteria**

The clinical trial was conducted on patients demanding endodontic therapy and the eligibility criteria to access the study were the followings:

Patients in good health conditions

Teeth without:

- pulpal disease or periapical inflammatory reaction in acute clinical phases;
- periodontal probing greater than 5 mm;
- previous endodontic therapy;
- root canal anatomy judged by the tutors treatable in a single appointment.

**Sample size**

In this preliminar clinical trial were enrolled 18 patients. The sample size of analyzed patients was composed by 6 females and 12 males. The mean age of the sample was 62 years old. We took into account a total of 28 root canals from single-rooted and multi-rooted teeth.

**Root canal therapy**

Routinely clinical assessments of teeth preoperative conditions were performed, including X-ray examination, periodontal probing and pulp vitality tests.

After local anesthesia with Articaine hydrochloride 4% epinephrine 1:100,000 and proper isolation by rubber dam, root canal procedures were performed according to the sequence following reported. The pulp chamber access was performed by a diamond coated bur (Endo Access Bur, Wave One, Dentsply Maillefer, Baillegues, SUI) and rounded off with a tungsten carbide bur (Endo Zekria Bur, Wave One, Dentsply Maillefer, Baillegues, SUI).

The working length was assessed by an electronic apex locator (Propex II, Wave One, Dentsply Maillefer, Baillegues, SUI) and confirmed by an X-ray examination done with parallel rays technique with a film holder. Glide-path and pre-flaring were performed by manual k-files (10, 15 and 20 ISO).<sup>27,28</sup> NiTi files (Wave One, Dentsply-Maillefer, Tulsa, OK 74135, U.S.A.) with reciprocating motors (Wave One Motor, Wave One, Dentsply Maillefer, Baillegues, SUI) were used to shape all the root canals according to the sequence exposed below.

The first NiTi file was chosen analyzing the shape and the anatomy of the tooth, according to the glide path sensations appreciated during this procedures. In fact, at the end of the scouting procedures, whether a 20 ISO K-file reached the apex without any resistance a Primary file (ISO 25 at D1) was chosen. On the contrary, whether some resistances were present a Small file (ISO 20 at D1) was chosen for the initial shaping.

At the end of this phase an evaluation of the apical gauging was made by stainless-steel file, .02 taper. The right ISO size was considered and, whether larger than ISO 20, a Primary file was used in case of 25 ISO apex, the Large was used with 40 ISO apex, a Protaper F3 finishing file, used in reciprocating motion, were used with the ISO 30 gauges.

During instrumentation copious irrigation with 5% NaOCl was utilized during all the root canal treatment and, at the end of the shaping procedure, a final irrigation with 17% EDTA was made.

The obturation was performed with a carrier based thermoplasticized gutta-percha technique (Thermafil, Dentsply Maillefer, Baillegues, SUI) additioned with epoxy resin-based root canal sealer (Top-Seal, Dentsply Maillefer, Baillegues, SUI) according to manufacturer instruction.<sup>29,30</sup>

The whole treatments were performed by a single appointment procedure. At the end of treatment was placed a temporary filling, and performed a post-operative X-ray examination. Time at the beginning of the root canal shaping up to the end of the obturation phase was recorded in minutes. Instrument breakage or fatigue was also considered.

## Outcomes

Different outcome measures were considered. Time of the root canal treatment, instruments breakage or fatigue were recorded for each root canal therapy. Radiographs were collected and two independent evaluators, specialists in Endodontics, unaware of the study, properly calibrated, examined the pre- and the post-operative radiographies.

The quality of the root canal treatment in length, for each root canal, was classified according to 5 ranks:

- (1) Shorter more than 2 mm from radiographic apex.
- (2) Between 2 mm and radiographic apex.
- (3) At the radiographic apex.

(4) At the radiographic apex with sealer extrusion.

(5) Longer than radiographic apex.

The quality of root canal filling was also scored, by a dichotomic variable, for the presence or absence of voids along the root canal preparation. Inter- and Intra - examiner agreement were also evaluated and the worst value was took into account in case of discordance.

## Statistical methods

Inter- and Intra - examiner agreement was measured by Cohen's kappa ( $k$ ) values. The descriptive statistics consisted of simple frequencies.

## Results

Root fillings length was adequate in 26 of the 28 root canals evaluated (92.86%). (Figs. 1–4). Regarding these 26 root canals, 19 (73.08%) presented extrusion of the endodontic sealer. In 4 root canals (15.38%) the filling ended between 2 mm and the apex and 3 root canals (11.54%) the filling ended at radiographic apex.

Only 1 root canal filling (3.57%) was shorter than 2 mm from the radiographic apex and only 1 root canal filling (3.57%) was ranked longer than the radiographic apex.

No voids were appreciated in all the root canals treated and evaluations on that variable were discarded in the final



Figure 1 Lower molar with irreversible pulpitis.



Figure 2 Root canal treatment performed by NiTi reciprocating files.



**Figure 3** Upper molar with chronic irreversible pulpitis.

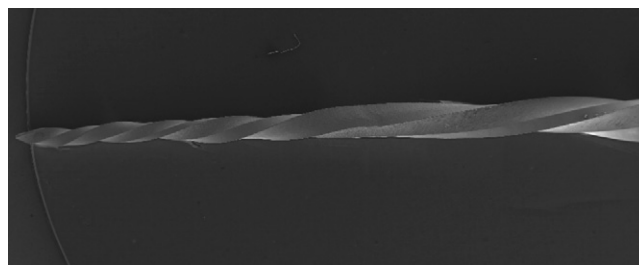


**Figure 4** The final result of the root canal treatment performed.

report. Only one primary file was observed with light structural modifications (Fig. 5), no instrument breakage was reported. The time of instrumentation for multirouted teeth was 75 min in average (15.5 standard deviation), while single rooted teeth were instrumented in average time of 32 min (9.4 standard deviation).

## Discussion

Root canal shaping procedures by NiTi instruments are quite popular among clinicians<sup>31</sup> but are still to be widely adopted in dental schools; on the contrary, a higher and higher level of competence is requested to dental students during their undergraduate course.<sup>1</sup> Some studies reported good clinical<sup>24</sup> and pre-clinical results about root canal shaping in teeth instrumented by dental students using NiTi instruments,<sup>32</sup> but most of them were done with manual NiTi files,



**Figure 5** A SEM imaging of a Primary file stretched ( $\times 200$  magnification).

engine driven rotary NiTi instruments. So far no previous study on this topic have been published to our knowledge.

In clinical studies, different parameters were evaluated: the length of the root canal filling, the extension and the presence or absence of void were considered in radiographical assay of the root canal treatment. Some studies obtained quite good results if each parameter, length, presence or absence of voids and taper were taken into account separately; combining all these elements, a poor result, in terms of treatment quality, was achieved in most of the studies ranging from a discouraging 13% up to 62% of well treated root canals.

The quality of root canal fillings placed by dental undergraduate students in various populations has been reported. As an example, in Jordan,<sup>18</sup> 61% of roots had fillings were acceptable in length but there was only 47% acceptability when length, density and taper were considered together. In Turkey<sup>33</sup> 69% had adequate length, but only 33% demonstrated an overall satisfactory filling. In Greece,<sup>25</sup> 55.2% of root fillings were classified as acceptable in terms of length and voids and more recently in France,<sup>23,34</sup> it was reported that 69% of canals had adequate length but only 30.3% acceptability in terms of length and voids. In Cork, Ireland 63% of single rooted teeth were graded as acceptable length with no voids, perforations or fractured instruments.<sup>21</sup> One study in Cardiff, Wales, however, reported only 13% were satisfactory.<sup>16</sup>

In this preliminary study, taper was not considered in the outcome measures as the instrument itself can give a continuous taper to the root canal owing to its conicity, no voids were recorded, probably due to the type of obturation technique chosen.

The length of the obturation was considered more satisfactory if compared to the other studies but most of them were conducted by lateral condensation technique or, only in a few cases, warm vertical compaction; for these reasons it is difficult to compare the results of this study with all the other. On the contrary, the good overall results obtained might be considered as an interesting starting point for undergraduate endodontic programs.

## Conclusion

Root canal therapies performed by dental students with NiTi reciprocating files and pre-heated guttapercha with carrier might be favorably considered in undergraduate program due to high overall treatment quality obtained and very low incidence of adverse effects.



## Clinical relevance

These experimental conditions pointed out that, from a clinical radiological point of view, undergraduate students might use NiTi instruments in reciprocating motion to perform high quality endodontic treatment without any adverse effect.

## Conflict of interest

The authors decline any conflict of interest.

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