Original Article

Manual root extractor: an attempt to revamp the traditional technique—a randomized clinical trial

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Background: The goal, in today's era, is to expedite the extraction process with little to no harm to the surrounding tissues. This study examines the effectiveness of using a manual root extractor to remove maxillary anterior root fragments without damage to surrounding bone and soft tissues.

Methods: An *in-vivo*, prospective, randomized, clinical study was done to evaluate the efficacy of a manual root extractor in the extraction of maxillary anterior teeth. A total of 52 maxillary anterior teeth were extracted with the manual root extractor. Parameters chosen for this study included operator's difficult, if the extraction was successful, if yes then the time taken for the extraction and patient's comfort. Data was compiled in Microsoft Excel Sheet and was analyzed using IBM SPSS version 21.

Results: Forty-four extractions were successful (84.6%) and 8 were unsuccessful (15.4%). The average time taken for extraction was 0.98–6.70 min. The patients were significantly comfortable with the manual root extractor. However, operators did face few difficulties while extracting the canines.

Conclusions: We can conclude that this device proved highly efficient in atraumatic extraction of maxillary central and lateral incisors only. However, it did not prove efficient in the removal of maxillary canine because of its oval root canal anatomy. This study not only summarizes the advantages of this device but also elaborates on the difficulties faced by the operator during the procedure. This study is distinctive since it explains the benefits and drawbacks of using a manual root extractor in detail, as there haven't been many studies on this device. Preservation of bone helps in effective implant placement and prosthetic rehabilitation. However, the study's limitations prevent us from knowing how effective it is in extracting anterior teeth that have undergone root canal therapy and when compared to other non-traumatic extraction techniques.

Keywords: Maxillary anterior root pieces; manual root extractor; novel technique; atraumatic extraction; prosthetic rehabilitation

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Introduction

The paradigm of extraction technique has changed from a stressful traumatic procedure to a minimally traumatic one with the development of various atraumatic extraction techniques. Conventional dental extraction forceps used for the removal of teeth or root pieces resulted in the weakening of the buccal, lingual or palatal cortices. The most common complication faced during extraction is a fracture of the root. Its removal is necessary to prevent pain and infection (1). The art of a surgeon's hand lies in retrieval of these root pieces with minimal trauma to the adjacent hard and soft tissues (2). Extraction of tooth/ root can be done either by simple technique (closed/forceps technique) or transalveolar technique (surgical/open technique). Transalveolar (Surgical) extractions is one of the most opted techniques for the removal of broken teeth at or below the level of surrounding interdental and inter radicular bone. It includes reflection of the muco-periosteal flap, bone removal, sectioning of the tooth/ root, and retrieval with the help of elevators. However surgical extractions tend to cause more post-operative pain as compared to simple extractions (3).

The aim still lies in achieving quicker extraction with no or minimal trauma to the investing tissues. Various conventional techniques are used for the removal of broken root pieces like the use of conventional periotomes, luxators, apexo elevators, rubber band extractions, the creation of a bony window above the root apex (4), use of syringe needle (5) or by engaging the endodontic 'H' file into canal (6-8). However, each of them has its own set of complications.

An elevator when placed between the root and the bone helps in severing the periodontal ligament and luxates the tooth/root by expanding the alveolar bone (9,10). However, two major complications faced in the use of elevators are the luxation of adjacent tooth and fracture of interdental or inter-radicular bone (11). Complications faced during the removal of broken root pieces with the help of elevators are displacement into the maxillary sinus or lingual pouch, oroantral communication, and damage to adjacent alveolar bone (9). This leads to difficulty in maintaining the socket integrity due to hard tissue damage and thus making future prosthetic replacement difficult (12).

Periotome has shown good results in the preservation of surrounding osseous structures without reflection of the mucoperiosteal flap. However, it is time-consuming (13). Rubber band extraction being an inexpensive technique needs longer visits (12).

Studies show the use of various instruments for removing broken root pieces by introducing them into the root canal viz. endodontic H-file, K-file, reamer, syringe needle, straight bur, and straight probe. Breakage of endodontic H-files and dental burs can occur due to wrong handling, defect in the manufacturing, or rusting of the instrument (11). Other complications like metallic pieces may get displaced into the adjacent spaces leading to infections (14).

Newer techniques like powered periotome, sonosurgery, piezosurgery, implant drilled extraction, powered physics forceps have been formulated for atraumatic extractions. Powered periotomes save more time as compared to conventional periotome but it is quite expensive. Sonosurgery being a quicker technique, it is contraindicated in patients with cardiac pacemakers and infectious teeth as it causes aerosol spread and may aggravate the condition. The use of powered physics forceps is economical but excessive force may cause tooth or root fracture (12).

Extraction of maxillary anterior teeth for esthetic rehabilitation or implant placement becomes a tedious and agonizing task. Atraumatic techniques help in planning immediate implant placement as it preserves the surrounding bone resulting in lesser bone loss. Immediate implant placement in maxillary anterior teeth is widely accepted as it prevents buccal bone resorption, avoids the need for bone augmentation and reduces treatment time (15).

We hereby discuss a novel method of extraction of root pieces using a manual root extractor (Jull-Dent, Jullundur

Highlight box

Key findings

- In this paper, manual root extractor, a special tool for extracting maxillary anterior teeth, is discussed. We have evaluated the efficacy of this device by assessing the time taken for extractions, the operator's difficulty, patient's comfort ad complications if any.

What is known and what is new?

- Number of standard methods like use of endodontic 'H-file', luxators, apexo-elevators, rubber band extractions, etc have been used for removal of broken root pieces. This is a novel study because no previous clinical studies have examined the effectiveness of a manual root extractor. This device has proved to cause no damage to the surrounding structures.

What are the implications and what should change now?

- For the atraumatic extraction of maxillary anterior root fragments, use of a manual root extractor should be highlighted in the upcoming literature and further studies should be done to prove its efficacy in atraumatic extractions.

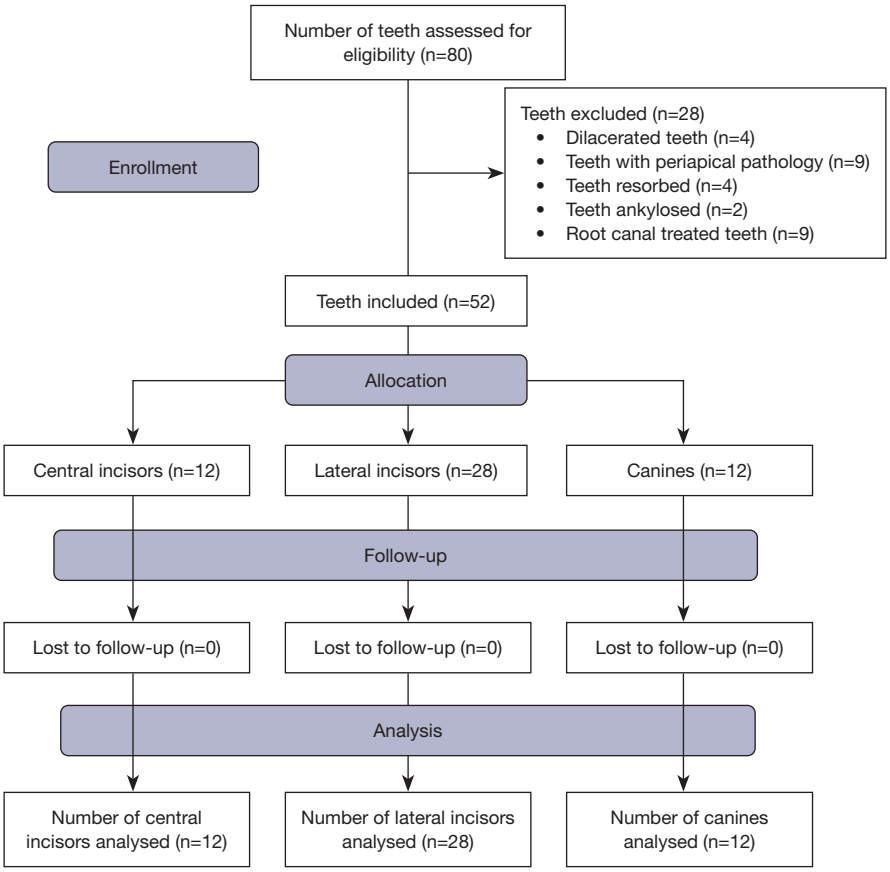

Figure 1 Flow chart indicating the status of teeth and its selection.

surgical works, Malad-W, Mumbai-64) for maxillary anterior root pieces. It is a relatively simple, atraumatic, less time-consuming technique and does not need any extra armamentarium. We present this article in accordance with the CONSORT reporting checklist (available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-52/rc).

Methods

A prospective, *in-vivo*, randomized clinical study was conducted to evaluate the efficacy of the manual root extractor. Fifty-two maxillary anterior root piece extractions (N=52) were performed on 26 patients visiting our institute Dr. D.Y. Patil Vidyapeeth, Pimpri, Pune in the time period of July 2019–2020. The sample size was calculated with the formula – $n=\left(2\frac{a}{2}+2b\right)^2\times 2\times\frac{6^2}{d^2}$, where, a= alpha 95% confidence interval; b= beta 80% power of study and d= error. Fifty-two teeth which were indicated for extraction were randomly selected and were extracted as per the requirements. Before the start of the study, permission was obtained from Institutional Review Board and the Institutional Ethical committee of Dr. D.Y. Patil Vidyapeeth (No. DYPDCH/1EC/123/133/19). After the clearance, detailed case history and valid written informed consent was obtained from the patients. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

The sampling technique used was Convenience sampling with random allocation. The inclusion criteria were participants who were aged 18 years and above, patients indicated for extraction of anterior root piece and patients willing to participate in the study. While patients having dilacerated root anatomy, periapical pathologies (cyst, abscess), resorbed roots (internal and external resorption), ankylosed teeth and root canal treated teeth were excluded (*Figure 1*). No control groups are included

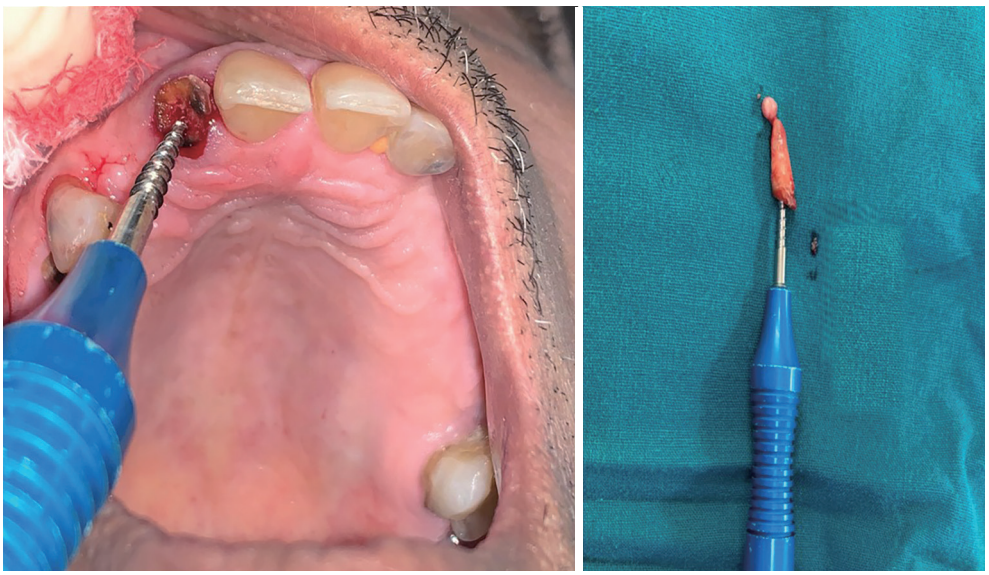

Figure 2 Placement of manual root extractor parallel to the long axis of the root.

because the purpose of this clinical study is to determine the effectiveness of manual root extractors.

The study was carried out in a step-wise chronological sequence where detailed case history & valid written informed consent was obtained from the patient with maxillary anterior root piece extraction. The patients were sequentially intervened in the month of July 2019 and further as and when they appeared. Radiovisiographs (RVG) were obtained for the maxillary root pieces needing extraction. All the extractions were performed under 2% Lignocaine HCl + 1:2,00,000 adrenaline and under complete asepsis. The gingiva around the neck of the root pieces to be extracted was reflected with the help of Moon's probe. The canal orifice was located, manual root extractor was introduced into the canal and slowly turned in a clockwise manner till the operator felt some resistance (*Figure 2*). Extraction is performed with the slow and firm figure of eight movements. The difficulty encountered during extraction, time taken for extraction, patient's comfort and complications encountered if any were noted and subjected to statistical analysis. The operator's difficulty was assessed as per the difficulty index provided to the operator, whether the extraction was successful or unsuccessful and the complications faced by the operator were also noted. Time taken for extraction was noted with the help of a digital timer. While, the patient's comfort was assessed with the scale provided to the patients. Required data was then collected and sent for statistical analysis in August 2020 in our institute.

Statistical analysis

All the readings were recorded and subsequently tabulated as master charts and then sent for statistical analysis. Data was compiled in Microsoft Excel Sheet and was analyzed using IBM SPSS version 21.

Results

This experimental study was conducted from July 2019 to August 2020. In our study, a total of 26 patients aged 18 years and above participated. Before starting the procedure, a detailed case history with the extra oral and intraoral examination was obtained.

Out of 26 patients, 52 maxillary anterior teeth were extracted (central incisors, 12; lateral incisors, 28; canines, 12) (*Figure 1*). RVG or an intra oral periapical radiograph (IOPA) was obtained for radiographic evaluation. Out of total of 52 maxillary anterior extractions, 44 were successful (84.6%) and 8 (2 central incisors and 6 canines) were unsuccessful (15.4%). Two extractions of central incisors failed because of their wide canal causing difficulty in engaging the manual root extractor. Due to inadequate engagement of the manual root extractor with the root canal of the central incisors, the forces could not be transferred from the extractor to the root piece thereby leading to a failed extraction.

Table 1 Various parameters for assessment (N=52)

Parameters	Frequency	Percentage
Extraction outcome		
Successful	44	84.6
Unsuccessful	8	15.4
Patient's discomfort		
Comfortable	34	65.4
Non comfortable	2	3.8
Very comfortable	16	30.8
Operator's difficulty		
Flap needed	2	3.8
None	42	80.8
Tooth splintered	6	11.5
Wide canal	2	3.8

While six canines failed due to the splintering of the roots. This occurred due to the presence of an oval root canal in canines, unlike central and lateral canals with conical canals (*Table 1*). The time taken for the extraction from placement of the manual root extractor into the canal to the removal of the root was measured with the help of a digital timer. The average time taken was 0.98–6.70 (2.3027±1.69359) min. Out of 26 patients, only 2 patients (7.7%) complained of discomfort, while 92.3% of patients were at ease (*Table 1*). In two cases, the central incisor was fractured below the level of the interdental bone. Due to the overgrowth of soft tissue around it, it was difficult to locate the canal orifice. Thus, there was a need for flap reflection. In 3.8% operators felt difficulty in extraction due to the wide canal. While in six canines, roots were splintered into multiple pieces (*Table 1*). The master chart makes it clear which extractions of specific teeth were successful and which were not (*Table 2*). Overall, no difficulty was faced by the operator while using the manual root extractor in all teeth except for canines. However, inter-individual operator difficulty in the use of this device may vary.

Discussion

A manual root extractor is a palm-sized long instrument with a cylindrical handle and has serrations for palm grip. It has a narrow long shank that is parallel to the handle. The working tip of the extractor is conical and pointed for its penetration into the root canal (*Figure 3A*). The tip is strong enough for penetration into the canal but penetration into the cortices or alveolar bone was not possible. It has a triangular-shaped cross-sectional design with a positive rake angle for cutting efficiency. Its working end is conical and tapers at the tip with cutting edge (blades) similar to but stronger than the H-file. Between the blades, grooves are formed which collect the debris when cut through the bone.

It differs from the H-file as it is broader than the H-file and has a long and broad handle which makes the instrument tougher than an H-file. Also due to the broad working end of the root extractor, it prevents its bending or breaking, unlike H-files which are delicate and bend or break easily. Other instruments like a straight probe, reamer, endodontic K-file, syringe needle and straight bur can be used for retrieving broken root pieces. Straight probe, though longer than H-file can cause difficulty in delivering adequate forces and movement for extraction. Since the working tip it has an angle of 90 degrees to the shank, the straight probe tends to lose its bend on movement. While files, reamers and burs are thinner as compared to the manual root extractor thereby causing difficulty in engaging the instrument into the canal. Also, the length of the working tip is shorter than the extractor thus there are high chances of slippage of the instrument due to inadequate anchorage. Nevertheless, the short handle of files, reamers and bur leads to inadequate delivery of the forces to the root pieces.

The conically designed tip helps in engaging the working end into the maxillary anterior root pieces which have conical roots. Moreover, due to its straight handle and parallelism with the long axis of maxillary anterior teeth, the extractor enables an easy entrance into the root canal. Unlike straight probes, the manual root extractor allows uninterrupted and free movement of the extractor. Maxillary posterior root pieces cannot be accessed due to the absence of angulation in the shank. Similarly, it is not designed for mandibular teeth as it is long and cannot be placed parallel to the long axis of the mandibular anterior or posterior teeth. There are two variations in the tip viz., one tip is long and broad with a smaller number of flutes placed 1 mm apart (*Figure 3B*) while the other type has shorter length of tip with a greater number of flutes placed 0.5 mm apart (*Figure 3C*). One of these snugly fit into the root canal of the maxillary anterior root pieces.

It is very important to have anatomical knowledge of the root and canal orifice. Maxillary central incisors have one root and one canal which are ovoid mesio-distally in

Table 2 Master chart

No. of patients	Age (years)	Tooth of concern	Extraction	Time taken	Patient comfort	Operator difficulty
1.	46	11	Successful	1 min 12 s	Very comfortable	None
		12	Successful	1 min 20 s	Comfortable	Flap needed
2	45	12	Successful	59 s	Very comfortable	None
		13	Unsuccessful	5 min	Comfortable	Tooth splintered
3.	32	13	Unsuccessful	4 min 55 s	Comfortable	Tooth splintered
4.	33	22	Successful	1 min 18 s	Very comfortable	None
		11	Successful	1 min 10 s	Comfortable	None
5	45	23	Successful	3 min 54 s	Very comfortable	None
		11	Successful	1 min 12 s	Very comfortable	None
6.	33	11	Successful	1 min 10 s	Very comfortable	None
		12	Successful	1 min	Comfortable	None
		23	Successful	4 min	Very comfortable	None
7.	32	12	Successful	1 min 3 s	Comfortable	None
		22	Successful	2 min 10 s	Very comfortable	None
8.	50	21	Successful	2 min 3 s	Comfortable	None
9.	55	12	Successful	1 min 20 s	Comfortable	Flap needed
10.	60	11	Unsuccessful	5 min 34 s	Comfortable	Wide canal
		22	Successful	2 min 13 s	Comfortable	None
11.	55	12	Successful	2 min 5 s	Very comfortable	None
		11	Successful	1 min 40 s	Very comfortable	None
12.	48	22	Successful	2 min 15 s	Comfortable	None
		12	Successful	2 min 20 s	Very comfortable	None
13.	60	12	Successful	1 min 30 s	Comfortable	None
		22	Successful	2 min 20 s	Comfortable	None
14.	48	13	Unsuccessful	6 min 42 s	Comfortable	Tooth splintered
15.	39	12	Successful	1 min 38 s	Comfortable	None
		23	Unsuccessful	7 min	Not comfortable	Tooth splintered
16.	57	11	Successful	1 min 10 s	Not comfortable	None
		12	Successful	1 min 30 s	Comfortable	None
17.	56	22	Successful	2 min 3 s	Comfortable	None
		23	Successful	2 min 20 s	Comfortable	None
18.	55	23	Successful	2 min 24 s	Comfortable	None
		11	Successful	1 min 10 s	Very comfortable	None
		12	Successful	2 min 20 s	Comfortable	None

Table 2 *(continued)*

Table 2 *(continued)*

No. of patients	Age (years)	Tooth of concern	Extraction	Time taken	Patient comfort	Operator difficulty
19.	59	12	Successful	1 min 6 s	Comfortable	None
		13	Successful	7 min	Comfortable	None
		22	Successful	2 min 2 s	Comfortable	None
20.	60	13	Successful	1 min 55 s	Comfortable	None
		12	Successful	1 min 38 s	Comfortable	None
21.	44	22	Successful	2 min 30 s	Comfortable	None
		21	Successful	2 min 10 s	Comfortable	None
22.	55	12	Successful	1 min 3 s	Comfortable	None
		13	Unsuccessful	6 min	Not comfortable	Tooth splintered
23.	59	22	Successful	2 min 11 s	Comfortable	None
		12	Successful	1 min 5 s	Very comfortable	None
24.	60	23	Unsuccessful	6 min 30 s	Comfortable	Tooth splintered
		12	Successful	1 min 3 s	Comfortable	None
25.	58	11	Successful	1 min 40 s	Very comfortable	None
		12	Successful	60 s	Very comfortable	None
		22	Successful	2 min 30 s	Comfortable	None
26.	57	12	Successful	2 min 20 s	Very comfortable	None
		11	Unsuccessful	5 min	Comfortable	Wide canal

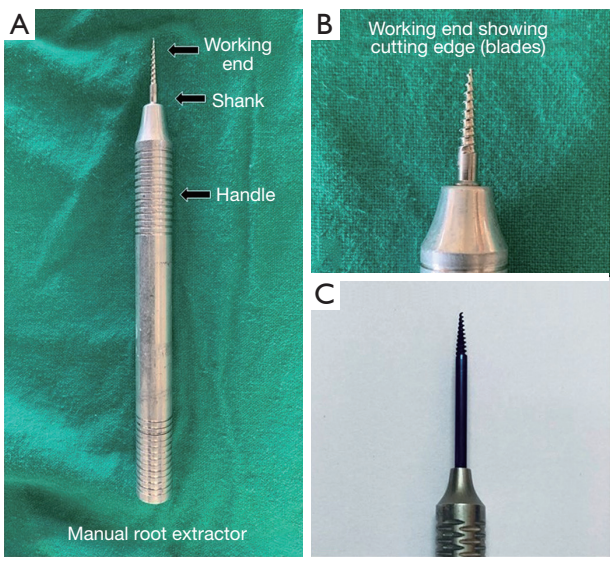

Figure 3 Manual root extractor.

the cervical 3rd to almost round in the middle and apical third. Labial perforations are common iatrogenic errors. Maxillary lateral incisors are similar to central incisors in all aspects but smaller. The canal is ovoid labio-palatally in the cervical 3rd of the root and round in the middle and apical third. Accessory canals are seen more frequently in maxillary lateral incisors than in maxillary central incisors (16,17). Thus, no difficulty was faced during the extraction of central and lateral incisors as the conical head of the device fits snugly into the conical canal. Maxillary canine roots are longer than that of maxillary central and lateral with single root and single canal. It is wider labio-palatally throughout its length which doesn't allow smooth penetration of the conical head of the root extractor. This leads to microfracture when forcefully engaged and finally splintering of the root may occur.

The need of minimal soft tissue reflection in this

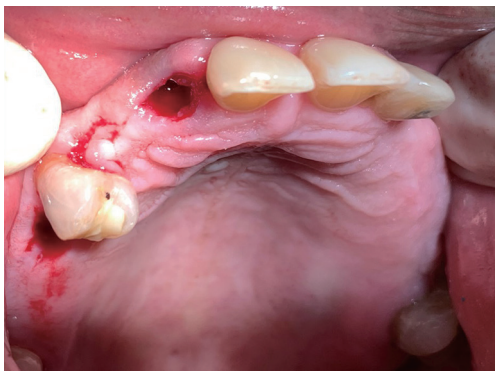

Figure 4 Atraumatic extraction with preservation of the cortices.

technique helps in the preservation of the surrounding soft tissue (*Figure 4*). Deeper reflection of the gingiva, application of forceps over the buccal and palatal cortices and slippage of the beaks of the forceps can cause inadvertent trauma to the surrounding soft tissue and can also cause alveolar bone damage or fracture. According to Joshi *et al.*, there is a risk of damaging the labial plate during the extraction in maxillary anterior (18). This atraumatic extraction technique helps in the preservation of the surrounding hard and soft tissue for prosthetic rehabilitation or implant placement. It avails immediate, early or delayed placement of the implants. Preservation of the osseous structures helps in the reduction of bone loss post-extraction and the long-term success of implants.

This device is not designed to perforate the bone. Hence its action is limited to the root itself. Thus, even when splintered or fractured, it causes no trauma to the cortices or interdental bone. It is a very operator-friendly device as it is light in weight and easy to use. It provides a good tactile sensation. Unlike elevators, it does not take support from adjacent interdental bone. Hence, it does not damage or luxate adjacent teeth or roots. Also, it is less time-consuming as compared to other atraumatic extraction techniques.

It is made of stainless steel, thus serving good strength and is autoclavable. It does not require any extra armamentarium and is cost-effective. However, even if the working end breaks due to a manufacturing defects or instrument fatigue, it breaks into the canal itself. Hence, there is no damage to the surrounding soft tissues and retrieval of the broken piece is easy as it is done along with the root itself.

However, the wrong technique or excessive force may lead to a splintering of the tooth. It can also cause splintering or chipping off of the root in brittle or root canal-treated teeth. It cannot penetrate calcified canals (geriatric patients). It is designed only for conical single-rooted teeth only and cannot be used for mandibular anterior teeth or Blunderbuss canals. This is a novel study and further study on its comparative evaluation with the traditional extraction techniques needs to be performed. Its use in root pieces other than maxillary anterior teeth is not possible because of its conical tip which cannot be engaged in ovoid or slender roots. The study's shortcomings, however, are related to the data specificity because of lack of clinical trial registration. Also, we are unable to compare the manual root extractor with the traditional extraction techniques since there is no comparison with the control group. Therefore, further comparative studies with a larger sample size are required.

Conclusions

This study was conducted to evaluate the efficiency of a novel manual root extractor in maxillary anterior teeth. We can conclude that this device proved highly efficient in the atraumatic extraction of maxillary central and lateral incisors. However, it did not prove much efficient in the removal of maxillary canine because of its oval root canal anatomy.

Further larger sample size studies are required to compare its efficacy with other atraumatic extraction techniques and in root canal-treated teeth.

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Footnote

Reporting Checklist: The authors have completed the CONSORT reporting checklist. Available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-52/rc

Data Sharing Statement: Available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-52/dss

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Conflicts of Interest: All authors have completed the ICMJE

uniform disclosure form (available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-52/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Before the start of the study, permission was obtained from Institutional Review Board and the Institutional Ethical committee of Dr. D.Y. Patil Vidyapeeth (No. DYPDCH/1EC/123/133/19). After the clearance, detailed case history and valid written informed consent was obtained from the patients.

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