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Influence of some prognostic factors on the treatment outcome of apicectomy

J.O Ajayi[1], T.A Esan[2], A.O Oginni[2]
1. Department of Dental and Maxillofacial Surgery University of Abuja Teaching Hospital, Gwagwalada, Abuja, Nigeria.
2. Department of Restorative Dentistry, Faculty of Dentistry, Obafemi Awolowo University, Ile Ife, Osun State, Nigeria
Correspondence: Dr J.O Ajayi
Department of Dental and Maxillofacial Surgery University of Abuja Teaching Hospital, Gwagwalada, Abuja, Nigeria.

Abstract
Aim: The aim of this study was to determine the influence of some prognostic factors such as preoperative size of the lesion, clinical diagnosis, retrograde vs orthograde filling, on the treatment outcome of apicectomy.
Method: A total of 33 patients with 40 apicectomised teeth that met the inclusion criteria were followed up for 12 months. The teeth were randomly allocated to two methods of root end filling (Retrograde and without retrograde) based on the pre-operative lesion size and clinical diagnosis before treatment. The participants were followed up for one year. The outcome of treatment was assessed both radiographically and clinically.
Results: 19 males (57.6%) and 14 females (42.4%), 16-66 years mean age 27.4 years (SD 10.8). Thirty-two teeth were considered successful, 4 doubtful and 4 failed. There was no significant difference between males and females (p>0.5). Similarly, there was no significant difference in the treatment outcome by preoperative radiographic lesson size and diagnosis of the lesion. Binary logistic did not show any influence of age, preoperative radiographic lesson size and diagnosis of the lesion on treatment outcome (P>0.05)
Conclusion: There was no significant influence of age, preoperative size of periapical lesions, presence of preoperative signs and symptoms, diagnosis and method of apicectomy on the treatment outcome.

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I. Introduction

Apicectomy has been widely used as a treatment in situations where endodontic infections has involved the periapical tissues, difficult to reach canals or endodontic failures. Variations have been reported regarding the success and failure rates of this procedure. Some of the variations may be due to methodological issues and the differing criteria for determination of success or failure. Several factors such as age, sex, size the of lesion, location and type of teeth and pre-operative signs snd symptoms have been documented to contribute to the success of apicectomy. However, controversies still exist on the relative contribution of these factors on the treatment outcome especially where some factors such as the type of teeth, quality of the surgeon and the filling materials are controlled for.

Many authors have considered the effects of age and gender on the outcome of apicectomy. While some believe that age has no effects on the outcome of apicectomy[1,2], Harty et al[3] reported more success in over 45-year age group. Others are of the opinion that young patients tend to heal better than the older ones[4, 5]. In respect of gender influence on the outcome of apicectomy, there seems to be a general agreement between authors[1, 2].

Most studies[4, 6] reported that there is no difference in the healing frequency in patient with or without signs and symptoms but in the study of Lustmann et al[1], a higher success rate was observed with lack of preoperative signs and symptoms. It is expected that the teeth with preparative signs and symptoms should show higher level of bacterial inflammation thereby delaying the healing process compared to those without signs and symptoms. Although this assertion is without prejudice to some underlying systemic conditions that may affect healing.

Most apicectomy procedures and most prognostic studies were carried out on the maxillary anterior teeth[,3,4,7,8] and the success rates have been consistently high. Apicectomy is not commonly performed in the posterior teeth[5, 9], this may be related to the difficulty of access, complex root and pulpal canal anatomy, and close proximity to structures such as the inferior dental canal and maxillary sinus[2]. Among the few studies [10,11,12] that reported on the posterior apicectomy, success rates varied between 44% and 70%. Similarly, lower success rates have been documented in literature. Testori et al[2] were of the opinion that the lower success rates were due

to the greater difficulty involved in performing surgery in the mandible. Therefore, because of the difficulties in access to anterior mandibular teeth and the variations in the anatomy of the posterior teeth which can be difficult to control for, this study employed the use of maxillary anterior teeth.

It was documented in several studies,[4, 6, 13] that there is a better chance of obtaining a successful clinical outcome from operating on small periapical lesions than larger lesions; Other authors reported no significant difference in the clinical outcome of apicectomised teeth [1,7]. The reason for this disparity is not clear and could be due to methodological issues such as the type and location of apicectomised teeth and the length of the follow up period.

From the various studies, [6, 12] more lesions that were histopathological classified as radicular cysts healed successfully following apicectomy when compared with those classified as granulomas. Although, there is a trend towards increased incidence of cysts among larger lesions,[14, 15] it is generally accepted that periapical lesions cannot be differentially diagnosed into radicular cyst or granuloma based on radiograph alone[16]. However the clinical diagnosis of radicular cysts made based on the size of the apical lesion and the character of the border produced a value close to the ones obtained in the histologic classifications[6, 17]. Oginni and Olusile[6] therefore suggested that a periapical lesion greater than 10mm on standard periapical radiographs with a clearly defined border is more likely to be a cyst than granuloma. In the study of Rud et al[9], the presence of a cyst or granuloma did not play any significant role on the healing.

To place or not to place root-end filling following apical resection has been controversial. Some authors supported apical resection alone, with no retrofill, as the treatment of choice[18,19] while others[20-23] maintain that the quality of the apical seal is improved with the use of a root end filling material. The advocates of retrofill argue that the solubility of the sealer in periradicular tissue fluids may result in delayed leakage and long-term failure[23]. However, the choice of no root-end filling is justified if the apical resection and complete cleaning and obturation of the canal space eliminate the source of the irritants. This no-retrofill option is particularly attractive in areas where surgical access for retropreparation and retrofill is limited. However, the quality of the obturation of the canals and the absence of unfilled canals or isthmi are considered essential for this option to have a reasonable chance of long-term clinical success[19]

An in-vitro study by Abdal et al[24] evaluated the effectiveness of the apical seal obtained by post resection orthograde filling with gutter percha and found varying degrees of microleakages depending on the materials used. Similarly, Nordenran and Svardstrom[25] reported worse results when root-end filling was included. On the contrary, some authors[26,27] found that failures were more frequent in apicectomies without root-end filling than when supplemented with root-end filling.

Without doubt, the numerous controversies in literature on some factors that influence the successful clinical outcome in apicectomy necessitates further well designed and controlled study. Granted that undertaking such a well-designed study may lead to a fewer sample size, however, a more objective and reasonable conclusions can still be made from such study. Therefore, this study determines the influence of some prognostic factors such as age, preoperative size of the lesion, clinical diagnosis, retrograde vs orthograde filling, on the treatment outcome of apicectomy.

II. Method

This was a cross-sectional intervention study of 33 patients requiring apicectomy of maxillary anterior teeth, who met the inclusion criteria, gave informed consent to participate and completed the follow up period of 12 months. All patients were recruited from the Dental Center Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife. Ethical approval was obtained from the ethics committee of the Hospital.

Relevant sociodemographic history such age and the past dental and medical history was taken to rule out any systemic diseases of importance that would contraindicate surgery. Detailed extra- and intra-oral examination and investigations such as pulp vitality and radiological investigations were carried out. Clinical indications for apicectomy such as radicular cysts, chronic apical infections, failed endodontic treatments and failed retreatment were documented. The age was grouped into three. 16-30 years, 31-50 years .and 51-66 years. Pre-operative radiographs and post-operative periapical x ray were taken at 1 week, 6 months and 12 months using the parallel technique. Pre-operative radiologic size of the lesion was determined by the longest diameter of the lesion using an endodontic ruler.

Before the commencement of the study, 40 teeth from the 33 patients were randomly allocated based on age, pretreatment radiological size of the periapical lesion and preoperative diagnosis of the lesion, to the two treatment methods of root end filling (With or Without retrograde filling). All the patients were treated under local anesthesia using 2% lignocain HCl with 1: 80000 adrenaline vasoconstrictor. Access was made into the canals through coronal access cavity in all cases and conventional canal debridement was done using K-type reamers and files. In cases of failed conventional root canal treatments, old canal obturations were removed and canal cleaning were repeated. During the instrumentation, canals were irrigated with 5.25% sodium hypochloride solution alternate with normal saline solution. After raising full thickness mucoperiosteal flap, the

overlying cortical bone was removed with burs at high speed using brush stroke approach under continuous normal saline irrigation until the apex of the tooth was exposed. All pathologic tissues located around or adjacent to the root were removed. Curettage was accomplished with curved surgical bone curettes which were used to detach the soft tissue from its base. Once loosened, tissue forceps were used to grasp the tissue gently as it was teased from its position with a bone curette. Root-end resection was performed with bur at high speed, with about 2 mm of resection. The resection was done with a bevel angle of about 45 degree facing the buccal surface for canal visibility and access for the root-end filling material.

Following the apical resection, root canals were thoroughly irrigated with normal saline and dried with paper points. Root canal obturations were done with gutta percha and zinc oxide eugenol based sealer using lateral condensation technique. The placement of gutter percha was such that it protruded beyond the resected root apex. Excess filling materials were removed from the apical region using fine diamond bur at high speed. When retrograde filling was required, a small oval root-end cavity preparation was created using diamond bur and root-end filling of Super-EBA was placed in the cavity. A fine diamond bur was used to polish the super-EBA and the apical surface. The coronal access cavities were sealed with amalgam.

After a thorough irrigation of operation site with normal saline and achievement of hemostasis, the reflected tissues were re-approximated to their original position, compressed and stabilized, and sutured with non-absorbable suture (3/0 black silk suture). Antibiotic (caps ampiclox 500mg 6 hourly x 5days) and non-steroidal anti-inflammatory analgesics (tabs ibuprofen 400mg 8hourly x 3days) were routinely prescribed prophylactically and postoperative instructions given in verbal and written forms. Patients were seen the following day for post-operative review examinations and at 1 week for review (clinical signs and symptoms), postoperative radiographs and suture removal. Patients were recalled at 6 and 12 months post operatively and assessed clinically and radiographically for signs and symptoms (pain, tenderness, swelling, sinus and mobility) and radiographically using standardized radiographs taken at similar angulations for comparison with those taken 1 week post operatively and the previous preoperative radiographs for evidence of bone healing. The extent of periapical destruction was defined as the average of 2 greatest diameter of bone cavity measured in millimeters on radiographs taken 1 week after operation[4].

The examinations and treatments of all the patients were done by the author (JO). Also the treatment outcomes were assessed by the author (JO) and an independent observer (AO).

Evaluation of healing results was based on clinical and radiographic observations. Clinical observations included subjective symptoms such as pain, sensitivity to percussion, evidence of fistula, presence of swelling or tooth mobility. Radiographic evaluations were done using Rud`s et al classification[28] as follows:

1. Complete healing (successful): Complete bone regeneration around the apex with or without a recognizable periodontal ligament space.
2. Incomplete healing (scar tissue): A periradicular rarefaction (in comparison with a postoperative or previous follow-up radiograph), either decreased or stationary, the rarefaction is irregular and often has asymmetrical outline and an angular connection to the periodontal ligament.
3. Uncertain healing: A rarefaction located symmetrically around the apex, with a funnel shaped connection to the periodontal ligament space; the size of the rarefaction is less than it appears to be on the postoperative radiograph.
4. Unsatisfactory healing (failure): the same radiographic signs as those of uncertain healing, except that the area of the rarefaction is either enlarged or unchanged in comparison to the immediate postoperative condition.

Overall treatment results were classified as:

Successful- Criteria for successful healing included absence of clinical signs/symptoms and a radiographic classification of complete or incomplete healing.

Doubtful- Criteria for doubtful cases included absence of clinical signs/symptoms and a radiographic classification of uncertain healing.

Unsuccessful\Failure-Criteria for failure included the presence of any clinical signs/symptoms and/or a radiographic classification of unsatisfactory healing.

Data were analyzed using IBM SPSS for Windows version 22.0. Analysis included frequency, cross tabulations and calculation of means. Associations between discrete variables were tested by Chi-Square and Fisher's exact test as appropriate. The outcome of treatment was dichotomized into successful and failed with those with doubtful outcome not included in the final regression equation. Therefore, the influence of age, preoperative size of the lesion, clinical diagnosis, retrograde vs orthograde filling, on the treatment outcome of apicectomy was tested using Binary logistic regression after model fitting. Significant differences was inferred at $p<0.05$.

III. Results

Forty teeth were apicectomised in 33 patients, 19 males (57.6%) and 14 females (42.4%), aged 16-66 years, mean age 27.4 years (SD 10.88), in good general health were included in the study. Retrograde fillings were done in 14 cases while 26 apicectomies were performed without root end fillings.

Of the 40 teeth treated, 25 (62.5%) were in males while 15 (37.5%) were in females. Eighteen teeth (72.0%) were rated as successful in male while 14 (93.3%) were considered successful in females. However, the difference was not statistically significant. P>0.5. (Fisher's exact test = 0.219)

Table 1: Treatment outcome related to operative methods

Method	Successful	Doubtful	Failure	Total
Apicectomy without Retrograde Filling	23(88.5)	2 (7.7)	1(3.9)	26 (100.0)
Apicectomy with Retrograde Filling	9(64.3)	2(14.3)	3(21.4)	14(100.0)
TOTAL	**32(80.0)**	**4(10.0)**	**4(10.0)**	**40(100.0)**

**The column under doubtful outcome was not considered in the analysis* Fishers exact p=0.098

Out of 26 teeth that were operated without root-end fillings 23 (88.5%) were successful, and of 14 teeth operated with retrograde root end fillings, 9 (64.3%) had successful outcome. The influence of the two methods employed in the treatment of the root end on the outcome variables (successful and failed) was compared using Fishers exact test. The treatment methods did not have statistically significant effect on the treatment outcomes (p>0.05).

Table 2: Radiographic size of the lesions and treatment groups.

Size of the Lesion	Type of apicectomy				Total	
	With Retrograde		Without Retrograde			
	No	%	No	%	No	%
Less than 5mm	3	21.4	4	15.4	7	17.5
6 to 10 mm	3	21.4	4	15.4	7	17.5
Above 10 mm	8	57.2	18	69.2	26	65.0
Total	**14**	**100.0**	**26**	**100.00**	**40**	**100.0**

Likelihood-ratio chi-sq. = 0.796 p = 0.672

The allocation of the lesion sizes to different treatment group was corrected for in this study. Table 2 showed no significant variation in the allocation of the lesion size to the treatment groups (p>0.05).

Table 3: Radiographic size of the lesions related to treatment outcome.

Size categories	Successful	Doubtful	Failure	Total
Less than 5mm	5 (71.4)	1(14.3)	1(14.3)	7 (100.0)
6 – 10mm	6 (85.7)	0 (0.0)	1(14.3)	7(100.0)
Above 10mm	21(80.8)	3(11.5)	2(7.7)	26 (100.0)
TOTAL	32 (80.0)	4 (10.0)	4(10.0)	40 (100.0)

Likelihood-ratio chi-sq. = 0.377 p = 0.828

The radiographic size of most of the lesions (26 out of 40) was above 10 mm.. There was no statistically significant difference in treatment outcome between lesions sizes (p>0.05),

Table 4: Odd ratio of the treatment method and outcome of treatment controlling for lesion size

Outcome	Radiographic Size	Retrograde		Without Retrograde	
		No	%	No	%
Successful	Less than 5mm	2	22.2	3	13.0
	6 to 10 mm	2	22.2	4	17.4
	Above 10 mm	5	55.6	16	16.6
	Total	**9**	**100.0**	**23**	**100.0**
Failure	Less than 5mm	1	33.3	0	0.0
	6 to 10 mm	1	33.3	0	0.0
	Above 10 mm	1	33.3	1	100.0
	Total	**3**	**99.9**	**1**	**100.0**

Note. Doubtful outcome group was omitted from the analysis.

The odd of having a successful outcome in the without retrograde filling group is not significantly higher than that of the retrograde group irrespective of the radiographic lesion size (OR=7.67) (Fishers exact 95% CI =0.00-1.99).(Table 4)

Table 5: Preoperative signs and symptoms and treatment outcome.

	Successful	Doubtful	Failure	Total
Absent	3(100.0)	0 (0.0)	0(0.0)	3(100.0)
Present	29 (78.4)	4(10.8)	4(10.8)	37(100.00
Total	32(80.0)	4(10.8)	4(10.8)	40 (100.0)

37 (92.5%) of the teeth were associated with preoperative signs and symptoms but the presence or absence of preoperative signs and symptoms did not have significant effect on the treatment outcome Fisher's exact test = 1.000 (Table 5)

Table 6: Distribution of preoperative signs and symptoms ny treatment menthod.

Pre-operative signs and symptoms	**Type of apicectomy**		**Total**
	Retrograde	**Without Retrograde**	
Absent	1 (7.1)	2 (7.7)	3(7.5)
Present	13 (92.9	24 (92.3)	37 (92.5)
Total	**14 (100.0)**	**26 (100.0)**	**40 (100.0)**

Table 6 shows that there is no significant variation in the distribution of patients with presence or absence of pre-operative signs and symptoms by the method of apicectomy. Fishers exact =1.00.

Table 7: Distribution of patients with signs and symptoms by treatment outcome and method of treatment

Outcome	**Symptoms**	**Type apicectomy**				**Total**	
		Retrograde		**Without Retrograde**			
Successful	Absent	1	11.1	2	8.7	3	9.4
	Present	8	88.9	21	91.3	29	90.6
	Total	**9**	**100.0**	**23**	**100**	**32**	**100.0**
Failure	Absent	0	0.0	0	0.0	0	0.0
	Present	3	100.0	1	100.0	4	100.0
	Total	**3**	**100.0**	**1**	**100.0**	**4**	**100.0**

There is no relationship between the outcome of treatment, presence or absence of pre-operative symptoms and the method of treatment Fishers exact test **= 0.098**

Table 8: Predictors of success or failures of Apicectomy

Variables	B	S.E.	Sig.	95% C.I .for EXP(B)	
				Lower	Upper
Retrograde filling	20.377	8018.513	0.998	.000	.
Less than 5mm	.693	1.871	0.711	.051	78.250
6 -10 mm	.000	1.732	1.000	.034	29.807
Presence of symptoms	-19.728	19223.763	0.999	.000	.
Radicular cyst	19.796	16242.665	0.999	.000	.
Chronic apical periodontitis	62.069	44086.228	0.999	.000	.
Age group 16-30 years	21.203	13397.656	.999	.000	
Age group 31-50 years	.000	16264.138	1.000	.000	
Constant	-40.866	18114.103	0.998		

Binary logistic regression was done to predict the influence of the predictor variables (methods of filing, radiographic size of the lesion and presence or absence of symptoms on the outcome variables (Success or Failure of the treatment). Model fitting was done using Hosmer and Lemeshow Goodness of fit, Chi square=0.809, df =5, p=0.98. The variables under study could not be used to predict outcome of apicectomy. (Table 8).

IV. Discussion

Few studies have demonstrated the prognostic abilities of treatment with or without root end filling, radiographic size of the apical lesion, and pre treatment signs and symptoms with no conclusive results[7,8.29]. Such disparity could be explained by the nature of the studies, the different sample sizes, the period of recall and the criteria used for evaluating clinical and radiographic parameters of healing. Other factors of success that have been reported include patient demographics and systemic condition, tooth involved (type, number and location), amount and location of bone loss, quality of previous root canal treatment or retreatment, coronal restoration, occlusal microleakage, surgical materials and techniques and surgeon skill[3,4,30].

A limitation of this study is the small sample size of 40 teeth from 33 patients compared to previous studies on apical surgery[3,13,31]. However, it is comparable to other studies done in Nigeria[6] and elsewhere [32,33] and we feel the sample is large enough to allow for statistical tests.

The overall success rate of apicectomy in this study was 80.0%. This was in accordance with other sited reports; 25-90% (Gutmann & Harrison)[34] and 58-96% (Hirsh Jan-M et al)[29], Nord P.G[8]). Harty et al[3] found in his study of 1026 cases of apicectomy to be 90% and Oginni & Olusile[6] reported 71,9% success in apicectomy of anterior teeth. In another study by Peterson and Gutmann[35], a success rate of 64% was reported. The difference could possibly be due to case selection and because different criteria were used when evaluating the parameters of healing. In this study, cases were classified as successful after one year in the absence of clinical signs and symptoms and radiographic classification of complete and incomplete healing, as suggested by Grung et al[36] and Molven et al[26].

Most apicectomy procedures and most prognostic studies were carried out on the anterior teeth[3, 4, 7, 8] and the success rates have been consistently high. Apicectomy is not commonly performed in the posterior teeth[5, 9], this may be related to the difficulty of access, complex root and pulpal canal anatomy, and close proximity to structures such as the inferior dental canal and maxillary sinus[2]. These factors increase the difficulty of operation thus affecting the outcome negatively.

This study utilized super EBA, a known root apex sealant with good antibacterial properties, biocompatible and with a good ability to achieve hermetic seal[37-40]. Retrofilled roots showed a much higher failure rate in this study, 21.4% versus 3.9%. Studies have shown that root-end preparation opens more apical dentinal tubules to the apical tissues, shortens the length of the root canal obturation and disturbs the seal of the obturating materials at the apical portion of the canal[41,42]. The result corresponds to the study of Molven, Halse & Grung [26] that showed failure rate of 27% for retrofilled roots as compared with 3.6% in cases filled at surgical appointment without root-end filling. However, results of some other authors showed a higher success rate when apicectomy is done with retrograde root end filling than when done without it and recommend the placement of root end filling especially when an unsuccessful root canal therapy was corrected by an apicectomy rather than by retreatment[29]. Routine placement of root end filling is also recommended in apicectomy when there is no access to the canal due to calcification, post, or broken instruments in the canal.

The size of periapical cyst in relation to the success or otherwise of apicectomy treatment has been investigated without any conclusive report. While some found no significant difference in the success of apicectomy in relation to the size of periapical cyst [1,7,26] others found a significant difference with teeth with larger periapical cyst having higher failure rate [4,6,13]. One would have expected higher success rate with smaller periapical cysts due to early resolution of the disease and bone healing. However, our study did not show any consistent results in the relationship of the size of periapical cysts to the success rate of apicectomy with 80.8%, 85.7%, and 71.4% success for lesions, above 10mm, 6-10mm and 5mm and below respectively. Similarly binary logistic regression also did not show any significant influence of the size of the periapical lesion on the clinical outcome. The poorer results in larger cysts reported by some authors may be due to the involvement of contiguous structures

Studies have shown that clinical diagnosis is not related to treatment outcome[4,6]. On the contrary, in some other studies[6,12], lesions that were histopathological classified as radicular cysts healed successfully following apicectomy when compared with those classified as granulomas. Although it is generally accepted that periapical lesions cannot be classified into radicular cyst or granuloma based on radiograph alone,[43] studies[6,44] have shown that the clinical diagnosis of radicular cysts made based on the size of the apical lesion and the character of the border produced a value close to the ones obtained in the histologic classifications. Oginni and Olusile[6] therefore suggested that a periapical lesion greater than 10mm on standard periapical radiographs with a clearly defined border is more likely to be a cyst than granuloma. The present study showed that treatment failure is commoner in tooth with failed RCT/retreatment than radicular cyst. This could be due to bacteria organisms implicated in retreatment failure. E, faecalis is anaerobic and has been shown to be fastidious and more resilient to cleaning agents. In the study of Rud et al[9], the presence of a cyst or granuloma did not play any significant role in the healing.

Furthermore, it is expected that the presence of pre-operative signs and symptoms which is a reflection of the severity of the condition should have affected the outcome of treatment. However, the present study showed no significant effect of the signs and symptoms on the outcome of treatment although the small sample size may have affected the outcome of the study. Aside our statistical findings, this study found 100% success rate among patients with no pre-operative signs and symptoms. Most studies[4,6] reported that there is no difference in the healing frequency in patient with or without signs and symptoms but in the study of Lustmann et al[1], a higher success rate was observed with lack of preoperative signs and symptoms.

In conclusion, our study did not find any influence of some prognostic factors such as age, periapical size of the lesion, diagnosis, presence of symptoms and method of root end filling on the outcome of treatment of apicectomised maxillary anterior teeth.

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