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Review

A Literature Review on the Uncommon Use of Extraoral Periapical Radiography

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Abstract: Periapical radiography is a regular radiographic procedure performed by dentists. However, at times, it may not be possible to position the image receptor into a patient's mouth in an optimized or practical way. For these cases, some dentists advocated the use of extraoral periapical radiography (EOPA). This literature review aimed to review the dental literature on the use of EOPA. In October 2023, PubMed, Web of Science, and Scopus were searched to identify papers that reported on the use of EOPA, supplemented by manual reference tracing and Google Scholar searches. After screening, 18 papers published between 2003 and 2022 were identified, including 14 original articles and 4 reviews. From very limited and conflicting evidence, it was found that root length/working length measurements between EOPA and IOPA did not significantly differ or EOPA showed inferiority. No data were available to compare EOPA with other extraoral modalities such as panoramic radiography. The technique used in EOPA to visualize posterior teeth in the maxilla and mandible varied across studies, such as the vertical angulation of the primary beam, whether mouth should be opened or closed, and whether a holder should be used or not. At the current time, EOPA probably should not be advocated for regular use.

Keywords: dental medicine; diagnostic value; endodontics; periapical radiograph; radiology

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1. Introduction

Intraoral periapical radiography (IOPA) is an everyday tool used by dentists, from diagnosis to treatment evaluation. It enables dentists to assess conditions that are invisible to direct visual examination, such as the depth of caries, extent of periodontal bone loss, presence of developmental or structural anomalies of teeth, presence of supernumerary or impacted teeth, and dentoalveolar trauma [1]. For instance, it was reported that over half of respondents from UK and Irish dental teaching hospitals used selected IOPAs together with panoramic radiograph to assess patients with severe periodontal disease, and another one-fourth of respondents used full mouth IOPA for this purpose [2]. Meanwhile, the American Association of Endodontists and American Academy of Oral and Maxillofacial Radiology also recommend that IOPA be the first imaging choice for the evaluation of patients going for endodontic treatment, immediate postoperative evaluation, and evaluation of healing following endodontic treatment [3]. Moreover, IOPA is invaluable for detecting periapical abscesses and cysts, which are sometimes asymptomatic and difficult to diagnose without imaging [4]. Orthodontists are also recommended to utilize IOPA as an additional tool to evaluate the shape and size of the roots if the existing radiographs provide inadequate information [5]. Furthermore, IOPA plays a role in the assessment of dental implant sites before surgery and in the postoperative monitoring of implant osseointegration [6]. In cases of trauma, IOPA can reveal root fractures, tooth dislocations, and alveolar bone fractures that are not visible through clinical examination alone [7]. In restorative dentistry and prosthodontics, IOPA is often used to assist in determining the fit and position of crowns and bridges to ensure that they do not interfere with the periodontal health of adjacent teeth, though some researchers argued that bitewings may actual perform better [8]. IOPA also helps in the detection of secondary caries beneath existing restorations, which can be challenging to diagnose otherwise [9]. The versatility and high resolution of IOPA make it an indispensable tool across various dental specialties, contributing significantly to comprehensive care of dental patients.

However, IOPA requires a dentist to place an image receptor directly into the oral cavity of a patient, which a patient may not tolerate well. For instance, a recent study suggested that the Asian population may not tolerate an image receptor of a standard size because of anatomical constraints or a lack of space in the oral cavity [10]. It was found that patients generally felt that the lower posterior regions were most uncomfortable during IOPA [11], and the retake risk of IOPA of the lower third molar was significantly higher if patients felt very uncomfortable during the first take [12]. Moreover, pediatric patients often find it challenging to tolerate the placement of image receptors due to their smaller oral cavities and heightened gag reflexes. This can lead to increased anxiety and discomfort [13], which may necessitate the use of alternative imaging techniques or sedation in some cases. Similarly, patients with special needs or those suffering from temporomandibular joint disorders may experience significant discomfort or pain when opening their mouths wide enough to accommodate the image receptor.

Several material types of image receptors are available for IOPA. In terms of digital imaging, a phosphor plate closely resembles the traditional analogue film in terms of its physical dimensions, whereas an intraoral sensor made of a charge-coupled device (CCD) or complementary metal-oxide semiconductor (CMOS) is usually much thicker than a traditional film. A previous study has shown that a phosphor plate is a more comfortable image receptor compared to CCD or CMOS intraoral sensors among adults [11]. However, another study reported that the use of intraoral sensors was more comfortable than the use of a phosphor plate or traditional film among adults [12]. Moreover, another study reported no significant difference in adult patient comfort level between the use of intraoral sensors and phosphor plates [14]. In pediatric patients, it was reported that the use of phosphor plate and traditional film was much more comfortable than the use of intraoral sensors [15]. This was reasonable as the mouth of a child is much smaller than that of an adult, and hence intraoral sensors children may complain that they are "too thick" very easily. For cases that are unlikely to obtain images with acceptable diagnostic value by IOPA, extraoral modalities such as extraoral periapical radiography (EOPA) may be more suitable. EOPA is thought to be applicable to numerous clinical situations, such as patients with mental disorders, dental phobia, severe gag reflex, large tongue, or trismus [16].

EOPA was not a mainstream concept and hence seldom mentioned in oral and maxillofacial radiology textbooks. It is believed that Newman and Friedman first introduced the concept of EOPA in 2003 [17] by reporting two cases: one endodontic case with intraoperative and post-operative imaging, and another case with a lower third molar assessment. Basically, EOPA places the image receptor on the face of the patient, buccal to the tooth to be imaged. It can be used without a receptor holder, as the patient can hold the image receptor against their face with their fingers. Before that, Fisher reported the visualization of the third molar region by placing an occlusal film (size 4) extraorally [18]. That was not a periapical radiograph, as Fisher indeed took an IOPA for the patient, but decided to take that additional extraoral image in order to visualize the impacted upper third molar and the associated radiolucency high above the second molar. Another related work was published by Sano et al., who reported the extraoral placement of an occlusal film in the parasagittal plane to visualize the anterior jaw region and obtain diagnostic information from the bucco-lingual dimension [19]. The advantages of EOPA over IOPA are a superior comfort level and applicability. Since no image receptor is placed inside the patient's mouth, EOPA must be more comfortable than IOPA. Moreover, patients with special needs, a sensitive mouth, or trismus can use EOPA when IOPA is not applicable.

One alternative to EOPA is panoramic radiography, but EOPA might be more useful to communities with limited access to panoramic radiography. EOPA can be taken with standard dental radiological armamentarium with little modifications (Figure 1). Basically, the simplest way to perform EOPA is to instruct the patient to place the image receptor on the side of their face ipsilateral to the tooth under investigation. Then, the X-ray tubehead should be positioned such that the primary X-ray beam can penetrate the tooth under investigation and reach the image receptor without passing through the dentition of the contralateral side. Another way to perform EOPA is to reassemble the standard parts of IOPA receptor holders, so that there will be a ring to aim the X-ray tubehead, a plastic block to hold the image receptor close to the face, and a long metal arm that connects the ring and the plastic block. Besides the relatively simple set-up method, periapical radiography also allows for a much clearer assessment of the periapical status of the teeth compared to panoramic radiography [20], such allowing for the ability to detect root dilacerations and other abnormal shapes [21], and apical periodontitis [22]. Due to the complex image acquisition mechanism of panoramic radiography, vertical measurements made on panoramic images are particularly less reliable than horizontal measurements [23]. There are few opinion/perspective papers on promoting the use of EOPA, but there was one recent literature review that focused on the use of EOPA in determining working length during endodontics. Hence, this narrative review aimed to review the dental literature on the use of EOPA, irrespective of a particular dental specialty, to reveal the results of comparisons between EOPA and any other dental imaging modalities.

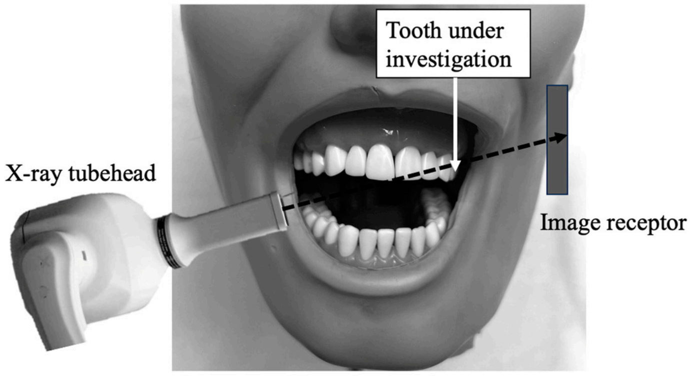

Figure 1. Set-up for extraoral periapical radiography (EOPA).

2. Materials and Methods

Although this is a narrative review, the existing literature was still collected and reviewed in a more systematic manner. The review question was what has been published in the literature regarding EOPA that could be a demonstration of its successful usage or a comparison with IOPA? In terms of PICO, the patient type (P) could be any patient or skull/phantom head; the intervention (I) should be using EOPA; a comparison (C) between EOPA and other imaging modalities should be recorded; and the outcome (O) could be any outcome.

In October 2023, PubMed, Web of Science, and Scopus were searched to identify papers that reported on the use of EOPA. For PubMed, the search strategy was as follows: ALL = ("extra-oral radiographic technique*" OR "extra-oral periapical*" OR "extraoral radiographic technique*" OR "extraoral periapical*"). For Web of Science, the search strategy was as follows: "extra$oral radiographic technique*" OR "extra$oral periapical*" (Topic). For Scopus, the search strategy was as follows: TITLE-ABS-KEY ("extra*oral radiographic technique*" OR "extra*oral periapical*"). The search strings were slightly different between the databases due to the different wildcards available. Only papers written in English were considered. No filter was placed to limit the publication time frame, meaning that all papers indexed by the databases until October 2023 were considered. Manual reference tracing was performed to identify studies that were potentially missed. Google Scholar searches using each of the above search strings (i.e., extra-oral radiographic technique, extra-oral periapical, extraoral radiographic technique, or extraoral periapical) were also performed, and the first 5 pages resulting from each search were checked to identify any omitted papers.

A total of 70 papers were initially identified from PubMed, Web of Science, and Scopus. After manually removing duplicates by checking the paper title and authorship, 49 papers remained. The inclusion criteria were papers written in English that reported or reviewed the use of EOPA. Otherwise, they would be deemed irrelevant and excluded. As a result, 12 papers remained. Reference tracing identified 3 additional papers and the Google Scholar searches identified another 3. Hence, a total of 18 papers that reported or reviewed the use of EOPA were included (Figure 2).

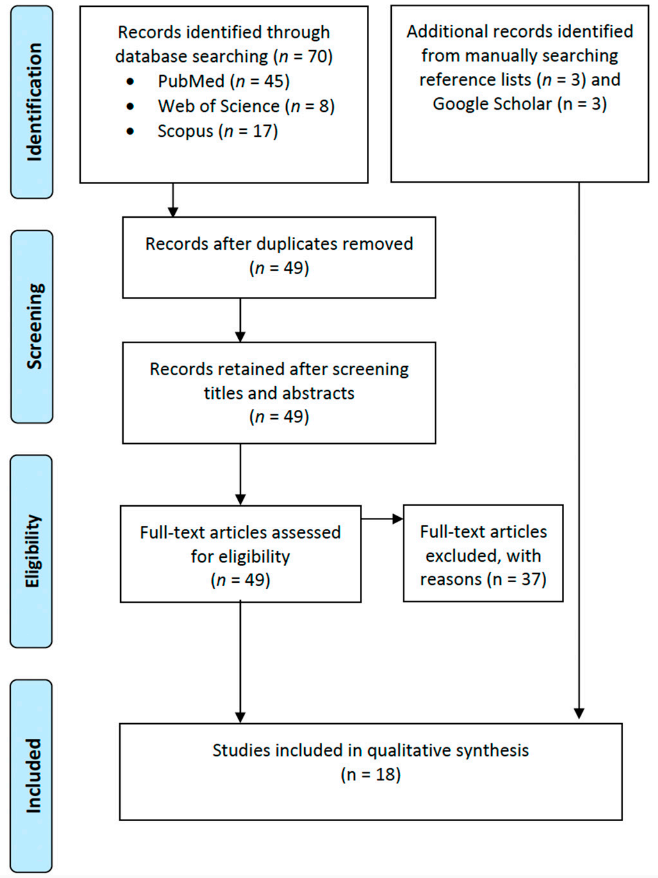

Figure 2. Flowchart of the screening process.

For each included paper, the following metrics were recorded: citation count from Scopus (retrieved from a cited reference search if the paper was not indexed by Scopus directly), journal impact factor and quartile (in the respective publication year), country of the affiliation of the first author, and document type (article or review/commentary). For articles, the study design was recorded (clinical study, case report/series/demonstration, or non-clinical study). The number of radiographic images taken and the type of teeth under investigation were noted. Then, comparisons with IOPA and any other imaging modalities were recorded. The following imaging parameters were noted: the horizontal angulation of the X-ray beam; any anatomical plane that needed to be maintained horizontally; whether the mouth should be opened or closed; whether a film/receptor holder was used; the kV, mA, and exposure time applied; and the receptor type: film, intraoral (IO) sensor, or phosphor plate. For clinical studies and case reports/series/demonstrations, the reasons for radiographic examination and the number and age of patients were recorded. A risk of bias assessment or quality assessment [24–26] of the reviewed literature is presented in Figure 3. The majority of the diagnostic studies had a relatively low risk of bias or high quality content compared to the narrative reviews and case series.

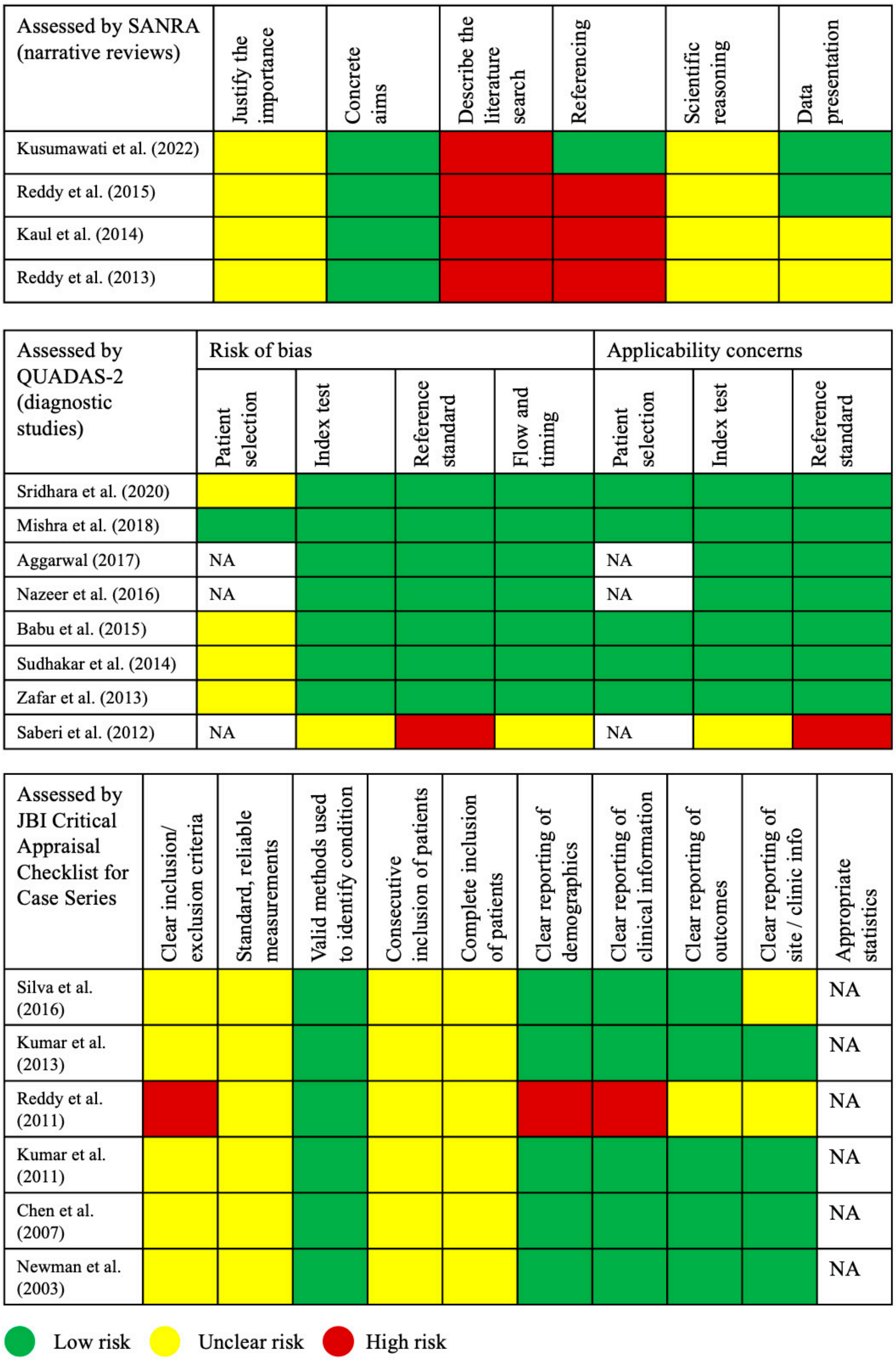

Figure 3. Risk of bias assessment or quality assessment of the reviewed literature. NA, not applicable. Kusumawati et al. (2022), [16]. Sridhara et al. (2020), [27]. Mishra et al. (2018), [28]. Aggarwal et al. (2017), [29]. Nazeer et al. (2016), [30]. Silva et al. (2016), [31]. Babu et al. (2015), [32]. Reddy et al. (2015), [33]. Kaul et al. (2014), [34]. Sudhakar et al. (2014), [35]. Kumar et al. (2013), [36]. Zafar et al. (2013), [37]. Reddy et al. (2013), [38]. Saberi et al. (2012), [39]. Reddy et al. (2011), [40]. Kumar et al. (2011), [41]. Chen et al. (2007), [42]. Newman et al. (2003), [17].

3. Results and Discussion

The 18 included papers were published between 2003 and 2022, with 14 of them being original articles and 4 being reviews. Most papers were from India (n = 11). The two earliest papers were published in Journal of Endodontics and subsequent papers were published in a variety of journals without an impact factor (Table 1). The geographic and chronological distributions highlight the growing interest in EOPA in mainly Southeast Asian countries but a lack of interest from countries with a well-developed oral and maxillofacial radiology community such as the United States, Japan, and European and Scandinavian countries. It potentially indicates a regional preference or necessity for this technique due to the financial or infrastructural constraints encountered by dental clinics.

Table 1. Overview of the 17 papers on EOPA.

Ref.	First Author	Year	Journal	Citation Count	Impact Factor	Journal Quartile	Country/Region
[16]	Kusumawati	2022	*JRDI*	0 *	NA	NA	Indonesia
[27]	Sridhara	2020	*Int J Clin Pediatr Dent*	1	NA	NA	India
[28]	Mishra	2018	*Contemp Clin Dent*	2	NA	NA	India
[29]	Aggarwal	2017	*J Pharm Biomed Sci*	0	NA	NA	India
[30]	Nazeer	2016	*Eur J Dent*	2	NA	NA	Pakistan
[31]	Silva	2016	*Case Rep Dent*	0	NA	NA	Brazil
[32]	Babu	2015	*Int J Sci Study*	1	NA	NA	India
[33]	Reddy	2015	*J Res Adv Dent*	1 *	NA	NA	India
[34]	Kaul	2014	*Adv Hum Biol*	0 *	NA	NA	India
[35]	Sudhakar	2014	*J Clin Diagn Res*	3	NA	NA	India
[36]	Kumar	2013	*Indian J Dent Res*	2	NA	NA	India
[37]	Zafar	2013	*Eur Sci J*	8	NA	NA	Saudi Arabia
[38]	Reddy	2013	*Dent Hypotheses*	1 *	NA	NA	India
[39]	Saberi	2012	*Iran Endod J*	3	NA	NA	Iran
[40]	Reddy	2011	*J Indian Acad Oral Med Radiol*	2	NA	NA	India
[41]	Kumar	2011	*Imaging Sci Dent*	19	NA	NA	India
[42]	Chen	2007	*J Endod*	9	3.369	Q1	Taiwan (China)
[17]	Newman	2003	*J Endod*	13	1.056	Q2	USA

The 4 papers with asterisks (*) are reviews. NA, not applicable.

Among the 14 original articles, 5 papers reported a comparison between EOPA and IOPA (Table 2). Among these five papers, a consistent finding was that root length/working length measurements between EOPA and IOPA did not significantly differ. This suggests that EOPA could be a viable alternative to IOPA for specific diagnostic purposes. However, EOPA also showed inferiority in other aspects, such as sharpness, magnification, distortion, anatomical accuracy, and structural overlapping. These findings underlined the limitations of EOPA in providing accurate, high-resolution images that are necessary for comprehensive diagnostic evaluations. For IOPA, two of these five papers used the bisecting angle technique, one used the paralleling technique, and two did not specify which technique was used. Apart from these, none of the 14 papers compared EOPA with other imaging modalities, such as panoramic radiography or cone-beam computed tomography (CBCT), thereby it is less likely that dental practitioners can be convinced to apply EOPA over other well-established extraoral imaging modalities.

Table 2. General study design of the 14 original articles on EOPA.

Ref.	First Author	Year	Reason for Taking Radiographs	No. of Patients	Age of Patients (y)	No. of Images	Type of Teeth	Comparison with IOPA
[27]	Sridhara	2020	Research	?	13–25	60 IOPA (paralleling) and 60 EOPA of same teeth	34, 44	WL: EOPA < IOPA by 0.25 mm (n.s.)
[28]	Mishra	2018	All indications	45	18–70	45 IOPA (bisecting angle) and 45 EOPA of same teeth	Posteriors	Density and contrast: EOPA = IOPA (n.s.); sharpness, magnification, distortion, anatomical accuracy, and radiographic coverage: EOPA < IOPA ($p < 0.05$)
[29]	Aggarwal	2017	Check tooth length	NA	NA	16 IOPA (?) and 16 EOPA of same teeth	Posteriors	Tooth length: EOPA = IOPA (n.s.)
[30]	Nazeer	2016	Check root length	NA	NA	16 IOPA (?) and 8 EOPA of same teeth	Posteriors	Root length: EOPA = IOPA (n.s.)
[31]	Silva	2016	Check WL	2	28	4 EOPA	16, 36	NA (check WL)
[32]	Babu	2015	Unspecified	30	3–8	30 IOPA (bisecting angle) and 30 EOPA of same teeth	Posteriors	Blurring and overlapping of structures: EOPA > IOPA by 60% and 37%, respectively (no statistical test)
[35]	Sudhakar	2014	Research	20	10–35	20 EOPA	Posteriors	NA (checked entire teeth visualization)
[36]	Kumar	2013	All indications	40	Children and adults	40 EOPA	Posteriors	NA
[37]	Zafar	2013	Research	80	Adults	80 EOPA	Mandibular premolars	NA (check WL)
[39]	Saberi	2012	Optimize technique	NA	NA	?	Posteriors	NA
[40]	Reddy	2011	Research	?	?	?	Posteriors	NA
[41]	Kumar	2011	All indications	3	7–35	3 EOPA	Posteriors	NA
[42]	Chen	2007	Research	12	26–65	12 EOPA	Posteriors	NA
[17]	Newman	2003	Check WL	2	8–16	2 EOPA	Posteriors	NA

WL, working length. ?, not specified. NA, not applicable. n.s., not significant.

The technique used in EOPA to visualize posterior teeth in the maxilla and mandible varied across the studies (Figure 4). For maxillary EOPA, the vertical angulation ranged from $-55°$ to $-20°$, meaning that the primary beam always pointed upward. All the papers recommended mouth opening during maxillary EOPA. Few papers recommended horizontal positioning of the Frankfort plane, indicating a lack of consensus on the optimal patient head posture. For mandibular EOPA, the technique was much more diverse. The vertical angulation ranged from $-35°$ to $+35°$, implying significant variation in clinical practice and therefore creating huge difficulties for dental practitioners to use EOPA. Five papers recommended mouth closing during mandibular EOPA [17,31,35,41,42] whereas others recommended mouth opening (one paper did not specify). This inconsistency in patient positioning could impact the reproducibility of EOPA. Few papers recommended horizontal positioning of either the Frankfort or occlusal plane, further highlighting the lack of standardization. Overall, 5 papers used a holder whereas 9 papers recommended manual positioning and holding of the image receptor. Theoretically, the use of holder should make the radiographic procedure more reproducible. However, the holder for EOPA does not contain any intraoral component for the patient to bite on to for stability, so it solely relies on the patient's hand to hold it steadily in the correct position during the entire radiographic procedure. Hence, it may be difficult for some patients to keep the holder in the correct position over a prolonged period of time.

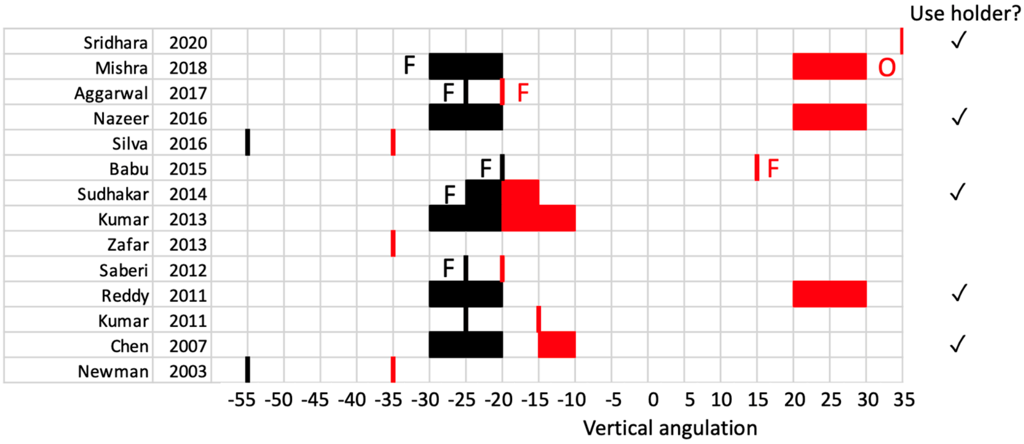

Figure 4. Technique used in EOPA in 14 papers. Angulations indicated for maxillary (black) and mandibular (red) EOPA are indicated. Some papers recommended horizontal positioning of the patient's Frankfort plane (F) or occlusal plane (O). Sridhara et al. (2020), [27]. Mishra et al. (2018), [28]. Aggarwal et al. (2017), [29]. Nazeer et al. (2016), [30]. Silva et al. (2016), [31]. Babu et al. (2015), [32]. Sudhakar et al. (2014), [35]. Kumar et al. (2013), [36]. Zafar et al. (2013), [37]. Saberi et al. (2012), [39]. Reddy et al. (2011), [40]. Kumar et al. (2011), [41]. Chen et al. (2007), [42]. Newman et al. (2003), [17].

Finally, it was found that the exposure factors (kV, mA, s) reported in the papers were diverse (Table 3). Digital imaging with an intraoral sensor (IO sensor) was more frequently involved than traditional film, whereas no paper used a phosphor plate.

Table 3. Exposure factors used by the 14 original articles on EOPA.

Ref.	First Author	Year	kV	mA	s	Image Receptor
[27]	Sridhara	2020	70	7	0.18	IO sensor
[28]	Mishra	2018	65	6	0.9	Film
[29]	Aggarwal	2017	?	?	?	IO sensor and film
[30]	Nazeer	2016	70	15	0.8	IO sensor
[31]	Silva	2016	70	8	0.5 (mandible) and 1.5 (maxilla)	IO sensor and film
[32]	Babu	2015	70	8	0.7	Film
[35]	Sudhakar	2014	70	7	0.5 (mandible) and 1.0 (maxilla)	IO sensor
[36]	Kumar	2013	65	10	0.45–0.55	IO sensor
[37]	Zafar	2013	65	10	0.50–0.55	Film
[39]	Saberi	2012	66	8	0.7	?
[40]	Reddy	2011	70	8	0.1 (IO sensor) and 0.6 (film)	IO sensor and film
[41]	Kumar	2011	65	10	0.45–0.55	IO sensor
[42]	Chen	2007	60	7	0.5	IO sensor
[17]	Newman	2003	?	?	?	IO sensor

IO, intraoral. ?, not specified.

The papers reviewed in this report clearly showed diverse settings in terms of both patient positioning and radiographic equipment settings. This heterogeneity poses challenges for standardization and comparisons across studies, highlighting the need for more uniform protocols.

One strength of this review was that it searched multiple major literature databases and manually searched the reference lists, similar to a recent review on a related topic on the comparison between paralleling and bisecting angle techniques [43]. Unfortunately, very few studies actually compared EOPA with IOPA. Many papers merely demonstrated the usefulness of EOPA. Without ample data to compare between the two, it would be a very bold statement to claim that EOPA was not inferior to IOPA. A particular concern was that the technique used across the studies was highly variable, especially with regard to whether a holder was used, the vertical angulation of the primary beam, and whether the mouth should be opened or closed during mandibular EOPA. This variability can lead to inconsistencies in the outcomes and make it challenging to draw definitive conclusions. It is recommended that future studies should be consistent in the technique used, so that consistent evidence/data can be accumulated for further evaluation. Standardization is critical to ensure that results are reproducible and comparable across different study sites. It would be beneficial for future studies to include larger sample sizes and diverse patient populations to ensure that findings are as generalizable as possible. Comparative studies that directly evaluate the diagnostic efficacy, patient comfort, and clinical outcomes of EOPA versus IOPA are particularly needed. These studies should also consider various clinical scenarios, such as assessing different types of dental pathologies besides merely checking the working length or tooth length, to provide a comprehensive evaluation of the two techniques. Without a certain degree of standardization, the term EOPA can only represent a broad concept that is not reproducible across study sites and cannot be readily followed by general dentists.

The lack of interest from the general audience was similarly reflected by the low citation count of the papers reviewed in this work. None of them were cited 20 times or more, whereas four were cited 1 time and another four were cited 0 times. If the researchers think that EOPA should be further promoted, the publication of meta-analyses, guidelines, and multicenter studies should be considered because these article types have the highest citation counts in radiology journals [44]. Another way to raise the awareness of the professional or general audience towards EOPA is to produce social media videos that demonstrate its procedures and image outcomes. There are already numerous educational videos related to dentistry, including dental radiology, on YouTube [45]. These videos included procedural demonstrations of IOPA and panoramic radiography [46,47]. The merit of EOPA being more comfortable than IOPA, due to the absence of an image receptor within the mouth, can also be explained to the audience as many of them may be afraid of pain induced during a dental visit [48]. Many of these videos have attracted tens of thousands of views. To further enhance the reach and impact of EOPA, collaborations with popular dental influencers and professional organizations to produce relevant social media content could be explored. These influencers often have large followings and can help disseminate information more effectively. Webinars and online workshops hosted by radiology experts in the dental field can provide a platform for in-depth discussions and live demonstrations, making the technology more understandable to a broader audience. Another method of promotion is to engage with dental schools and continuing education programs to introduce or revise the concept and procedures of EOPA. Incorporating EOPA into the curriculum of dental students and offering continuing education credits for practicing dentists can ensure that the next generation of dental professionals is well-aware of this imaging technique, especially with hands-on training and representative case studies to solidify their understanding and application of EOPA in clinical practice. Lastly, leveraging other social media platforms such as Instagram, Facebook, and TikTok can help reach a wider audience. Short, engaging videos and infographics that highlight the key benefits of EOPA, such as reduced discomfort and adequate diagnostic capabilities, can capture the attention of dental practitioners and patients who do not actively seek the latest dental information. By employing a multifaceted approach that includes journal publications, social media engagement, professional education, and public outreach, the awareness and acceptance of EOPA could be improved.

The use of EOPA is applicable to various clinical scenarios, but other extraoral modalities such as panoramic radiography may be readily available in regular dental clinics in the more developed countries and regions, rendering EOPA less useful. During the COVID-19 pandemic, experts in oral and maxillofacial radiology in Europe and North America recommended the use of panoramic machines to take sectional panoramic images or even extraoral bitewings to replace the traditional intraoral bitewings to reduce the risk of aerosol generation [49–51]. It was stated that the "extraoral bitewing" mode of panoramic machines, or even the ordinary mode of the latest panoramic machines, is able to produce high quality images that visualized the entirety of the teeth under investigation. Because of that, dental clinics should probably use a panoramic machine to produce a sectional image that focuses on the tooth under investigation instead of taking an EOPA, in the cases where an IOPA is not possible due to pain, limited mouth opening, and other constraints. An alternative for obtaining better imaging details, such as for periodontal and endodontic purposes, would be another extraoral yet 3D technique, CBCT imaging [52]. CBCT imaging provides detailed, three-dimensional views of the teeth and surrounding structures, making it useful for complex diagnostic and treatment planning scenarios. Upcoming techniques such as ultrasound and magnetic resonance imaging (MRI) can also be applied extraorally and with an additional merit of producing images without ionizing radiation [53]. Ultrasound imaging, although traditionally used in soft tissue evaluation, is being researched for its potential applications in dental imaging, such as the evaluation of the periodontal status of teeth with furcation involvement [54]. MRI, on the other hand, offers superior soft tissue contrast and is increasingly being explored for its applications in diagnosing conditions such as periodontal and periapical diseases [55].

In summary, the diversity in techniques and settings reported in the literature highlights the complexity and challenges associated with EOPA. While it shows promise as an alternative to IOPA for specific applications, the variability in protocols, lack of standardization, and limited comparative data significantly hinder its broader adoption in clinical practice. Future research should aim to establish standardized protocols and conduct comprehensive comparative studies to better understand the advantages and limitations of EOPA relative to other imaging modalities. Otherwise, EOPA could only be perceived as a possible, but unproven, alternative to existing extraoral imaging modalities that is more likely to be applied in dental clinics with a less resourceful setting.

4. Conclusions

There are few papers on the use of EOPA. Apart from the first two papers published in Journal of Endodontics, subsequent papers were published in journals without an impact factor and they generally had a low citation count. While there is some interest in EOPA, it has not yet gained widespread recognition or acceptance in the broader dental research community. From the very limited yet conflicting evidence, it was found that root length/working length measurements from EOPA and IOPA did not significantly differ. The review also highlighted several limitations of EOPA, including issues related to image sharpness, magnification, distortion, anatomical accuracy, and structural overlapping. These factors can significantly impact the diagnostic value of EOPA, rendering it less reliable than IOPA for diagnosis and treatment evaluations. Additionally, the lack of standardization in EOPA techniques, such as variations in vertical angulation, patient positioning, mouth opening, and the use of image holders, further complicates its application in clinical practice. As panoramic and CBCT imaging readily offer high-quality, detailed images, EOPA will likely remain a niche technique with limited adoption in mainstream dental practice.

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