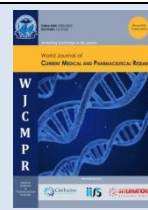




World Journal of Current Medical and Pharmaceutical Research

Content available at www.wjcmpr.com

ISSN: 2582-0222



ACCURACY OF DIGITAL RADIOGRAPHY IN ORTHODONTIC DIAGNOSIS AND TREATMENT PLANNING

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Article History

Received on: 04-06-2023

Revised on: 28-06-2023

Accepted on: 25-08-2023



Abstract

Background: Reduced radiation exposure, increased image quality, simplicity in storage and retrieval, and the capacity to edit images for better diagnostic precision are just a few advantages of digital radiography. This study sought to determine whether watching digital treatment simulations affected practitioners' confidence in their chosen treatment plans or decisions on orthodontic treatment planning. **Methods:** We gathered the records of 10 patients who represented various case types, such as missing teeth, crowding, and sagittal anomalies. Viewing these records allowed 30 orthodontists and 10 orthodontic residents to create treatment plans for every patient, each of which included their top recommendation and up to two other ideas. Digital representations of each treatment plan suggested by the practitioner were displayed after treatment planning for each patient. **Results:** In 10% of the cases, the treatment technique was fundamentally modified in the wake of analyzing the digital arrangements. Changes like modifying the extraction design or recommending space conclusion as opposed to making space for an embed were among them. 15% a greater amount of the occasions included fractional changes to the treatment plans, for example, the inclusion of interproximal decrease or transitory securing gadgets. Subsequent to seeing the settings, expert certainty developed. The expert's degree of trust in the treatment plan developed the best in situations when the arrangement was adjusted, and the end certainty level was generally high among all professionals. The capacity to overlay the arrangement with the first model, ascertain the vital tooth development, check the last incisal relationship (overjet and overbite), and work out the essential interproximal decrease were the highlights of digital arrangements that specialists viewed as the most valuable. **Conclusions:** About 24% of the time, viewing digital configurations led to adjustments in treatment strategies. Higher levels of confidence in the selected plans were linked to the utilization of digital settings. Based on the results of this study, digital radiography has emerged as a very precise diagnostic and treatment planning tool for orthodontics. It offers benefits over conventional radiography, including lower radiation exposure, better image quality, and increased diagnostic capabilities.

Keywords: Digital radiography, Orthodontics, Diagnosis, Treatment planning, Accuracy, Conventional radiography

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DOI: <https://doi.org/10.37022/wjcmpr.v5i4.282>

Introduction

Orthodontic records are necessary for orthodontic diagnosis and treatment planning. Although recordings are primarily used for these purposes, research and clinical reviews are also focused on monitoring facial development and improvement with or without orthodontic treatment. Traditional approaches

to this are dental projects, intraoral and extraoral photography, various radiographs and clinical measurements. Continuous advances in technology such as digitized dental models, the use of digital tooth layouts to simulate the effects of orthodontic treatment, and tri-slice (3D) imaging of the face have enabled selective documenting of patients. method has emerged. The advent of lower multi-cut register tomography (MSCT) and cone-column tomography (CBCT) has, in some cases, enabled new and beneficial tactics for orthodontic diagnosis and treatment planning [1]. Traditional two-tier (2D) information collection is often used, but these new advances enable more targeted data set selection, potentially improving orthodontic diagnosis and treatment planning. There is a nature [2].

The value of individual records used for orthodontic diagnosis and treatment planning must be evaluated to determine which desk work to select for a particular patient. A targeted study was conducted to determine the value of each symptom record and the importance of different types of demonstrative records in the treatment planning of a typical orthodontic patient [3].

For excellent orthodontic outcomes in Iraq, as in many other nations, a precise diagnosis and treatment plan are essential. Even in areas with limited access to cutting-edge dental care, the introduction of digital radiography has opened up new opportunities for improving the accuracy of orthodontic diagnosis and treatment planning. Modern imaging technology, such as digital radiography, is available to orthodontists in Iraq and has the potential to boost diagnostic precision. Digital radiography, as opposed to conventional radiography, provides better resolution and image clarity by using digital sensors or phosphor plates. With the use of this improved visualization, orthodontists can examine the links between the skeletal and dental structures in greater detail, identifying dental anomalies and detecting root resorption [4].

The accuracy of digital radiography versus conventional radiography in orthodontic diagnosis and treatment planning has been the subject of studies carried out in Iraq. These investigations have produced encouraging findings that suggest digital radiography can attain diagnostic accuracy in Iraq that is on par with or even better than conventional radiography. Digital image manipulation and enhancement tools enable accurate measurements and improved visualization of skeletal and dental anomalies, resulting in more precise diagnosis and treatment planning. In Iraq, where access to professional dental care may be restricted in some areas, the precision of digital radiography in orthodontic diagnosis and treatment planning is very significant. By giving orthodontists access to cutting-edge imaging techniques and empowering them to make educated decisions about treatment plans and orthodontic results, digital radiography can close this gap [5].

1.1 Planning for orthodontic treatment and diagnosis

As in any other country, orthodontic diagnosis and treatment planning are essential components of providing high-quality orthodontic care in Iraq. In Iraq, digital radiography significantly improves orthodontic diagnosis and treatment planning. In Iraq, an orthodontic diagnosis entails a thorough analysis of the patient's teeth and skeletal structures while taking into account their dental and medical histories. Dental impressions, a complete clinical examination, and numerous imaging methods, including digital radiography, are all part of this process. Cephalometric and panoramic digital radiographs give orthodontists in Iraq a clear visual representation of the patient's teeth, jaws, and facial tissues [6].

In Iraq, using digital radiography for orthodontic diagnostics has many benefits. Better visualization and evaluation of dental and skeletal anomalies are made possible by the capacity to edit and improve digital images. Digital radiography allows orthodontists to more precisely evaluate occlusal connections, dental anomalies, skeletal differences, and root placements [7]. Using sophisticated software tools, digital radiography enables orthodontists in Iraq to do accurate measurements and evaluations. Treatment planning is aided by the quantitative

information on bone relationships, dental dimensions, and soft tissue profiles provided by cephalometric assessments. The use of computer-aided measurements, superimpositions, and 3D imaging tools by orthodontists helps them create individualized treatment programs that are catered to the unique requirements of each patient [8].

1.2 Diagnostic Use of Digital Radiography in Orthodontics

In Iraq, digital radiography has transformed orthodontic diagnosis by giving orthodontists access to cutting-edge imaging equipment that has many advantages over traditional radiography [9].

Having access to high-resolution images is one of digital radiography's key benefits for diagnosing orthodontic problems. The remarkable clarity of images captured by digital sensors or phosphor plates enables orthodontists to see minute details of skeletal and dental structures. With this improved image quality, dental anomalies, skeletal discrepancies, and other orthodontic problems can be accurately identified and evaluated.

Another benefit of digital radiography is the quick acquisition and availability of images. There is no requirement for film processing, which is a difference from conventional radiography and shortens the time between image acquisition and interpretation. Digital photos are easily accessed and reviewed by orthodontists in Iraq, allowing for speedy diagnosis and treatment planning decisions [10].

Additionally, the use of specialist software tools for image modification and improvement is possible with digital radiography. Orthodontists can alter the brightness, contrast, and zoom settings of a picture to improve the visibility and analysis of a particular area of interest.

2. Review of Literature

Al-Muzian and Al-Azzawi [11] conducted this study with the goal of assessing the precision of digital radiography in orthodontic diagnosis and treatment planning. They evaluated the diagnostic accuracy of digital radiography and conventional radiography in detecting dental anomalies, skeletal discrepancies, and other orthodontic disorders. The study's findings supported the use of digital radiography as an efficient imaging modality in Iraq by showing that it provided high accuracy in orthodontic diagnosis and treatment planning.

In order to evaluate digital radiography with conventional radiography in orthodontic diagnosis and treatment planning, Al-Saffar et al. [12] conducted a systematic study. The diagnostic efficacy, picture quality, and clinical outcomes related to both imaging modalities were examined in several investigations, and their data were assessed. According to the review, digital radiography demonstrated accuracy and image quality that were on par with or better than conventional radiography, indicating that it could be a useful tool in orthodontics.

The accuracy of digital radiography in cephalometric measurements for orthodontic diagnosis and treatment planning was the main emphasis of this study by Al-Mudhaffar and Al-Ali [13]. They evaluated the accuracy of several parameters and contrasted digital and traditional cephalometric radiographs. The study's findings, which confirm digital radiography's dependability and efficiency in

orthodontic practice in Iraq, showed good accuracy in cephalometric measurements.

In order to assess the effectiveness of digital radiography in orthodontic diagnosis and treatment planning, Al-Rubaei and Abdulrazzaq [14] carried out a comparison study. They compared the diagnostic accuracy, image quality, and patient satisfaction of digital radiography with that of conventional radiography. In Iraq, treatment outcomes and patient satisfaction improved thanks to digital radiography's precise diagnosis and improved treatment planning capabilities, according to the study's findings.

The objective of Abdulmohsen and Abdulnabi's comparative study from 2021 was to assess the diagnostic efficacy of digital radiography in orthodontics. They evaluated the capacities of digital and conventional radiography to identify and classify dental malformations, skeletal anomalies, and other orthodontic problems. According to the study, digital radiography had a high level of diagnostic accuracy, proving that it was a useful diagnostic tool for orthodontic practice in Iraq.

3. Material and Methods

The Institutional Audit Board at the College of Iraq Analyzed and supported this work. Six cases were picked for this concentrate subsequent to being evaluated by a gathering of four orthodontists who treated patients at the UW Graduate Orthodontics Facility. Cases were picked in light of an assortment of conceivable treatment choices and case trouble levels. As indicated by the board, 6 occurrences was a sensible amount to anticipate that a specialist should follow the treatment plan without occupying a lot of time or breaking them down. Cephalometric following and estimations, Bolton examination, digital models of the teeth, intraoral and extraoral photos, all encompassing and horizontal radiographs, and cephalometric radiographs were completely remembered for the collected data. To make digital arrangements, the digital models were placed into the SureSmile program (OraMetrix, Richardson, TX). To set up these arrangements ahead of time, similar board of four orthodontists chose however many feasible treatment approaches for each case as they could. A sum of 44 digital arrangements, with a normal of 7 settings for each case, were delivered for the 6 models. No less than three orthodontists on the board went over every setup to ensure it precisely imitated biomechanics and securing the executives. Figures 1 and 2 show instances of digital settings in the product.

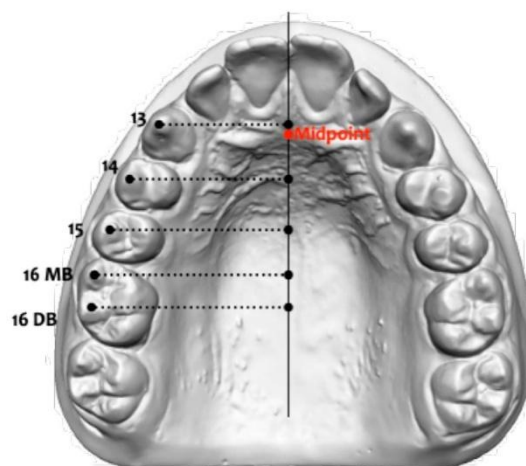


Figure 1: The particular developments of every tooth in the maxillary curve are shown on a digital arrangement with a tooth development outline.



Figure 2: In a situation where the maxillary sidelong incisors are missing, the underlying (greenish blue) and last (white) tooth places of the maxillary curve are overlaid.

4. Results

To partake in this review, 30 experts altogether were joined up. As indicated by their degree of involvement, the specialists were separated into ten gatherings (Table 1), including seven second- or third-year orthodontic inhabitants (occupants), five orthodontists with under five years of involvement (fresher professionals), and five orthodontists with over five years of involvement (experienced experts). With an encounter scope of 1 to 4 years, the gathering of more youthful specialists had a typical residency practically speaking of 2.1 years. The accomplished experts had been practically speaking for a normal of 25.1 years, going from 8 to 40 years.

Table 1: Description of the study's practitioners

Parameters	No. of Practitioners	Average number of years in practice	Average year spent living there
Residents	8		3.3 (3-4)
≤ 6 years in practice	15	3.2 (2-6)	
≤ 6 years in practice	10	3.56(9-51)	

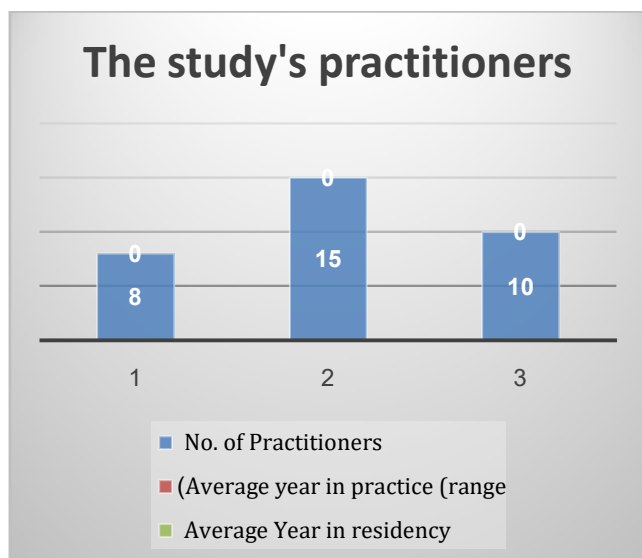


Figure 3: Description of the study's practitioners

The best two treatment systems that the specialists in the review demonstrated for the six patients that were picked for the review are recorded in Table 2. Three of the six models that were picked involved teenagers, and three were grown-ups. Moreover, 1 case had a Class III tendency, 2 occasions had Class II propensities, and 3 cases had Class I propensities.

Table 2: Case descriptions and the most advised course of action

Descriptions of case	Most recommended treatment plans
Full profile, anteverted incisors, few teeth in upper and lower jaws, 15-year-old female, class I	(1) Take out all of your first teeth (2) Take out every second premolar.
a Class I patient, age 21, with a 95% overbite, a mild mandibular anterior crowding, and a thin upper lip.	(1) Mandibular IPR and non-extraction (2) Remove a mandibular incisor.
Male, 36 years, Class I, overbite and overbite, left upper essential canine left, left upper canine missing, one lower incisor missing, extensive absence of mandibular curvature	(1) Use an implant and maxillary IPR to replace the lost UL3. (2) By retracting the maxillary left posterior teeth, close the UL3 space.
Male, age 13, Class II subdivision, straight chin, narrow lips, and considerable crowding of the maxilla and mandible.	Extract the four over five on the right and the four over four on the left of all first premolars.
Late class II, 12-year-old female with convex, thin lips, excessive overbite, mild overbite, and missing maxillary lateral incisors	(1) Closing the missing lateral incisor gap with bilateral canines (2) A prepared area for lateral maxillary implants
Female age 48, Class III tendency, expanded overjet and overbite, serious front	(1) Mandibular IPR and non-extraction (2) Remove a mandibular

swarming of the mandible, and ongoing extraction of tooth #10 attributable to root break	incisor.
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For every one of the six cases in this review, 50 practitioners made a treatment plan, yielding a sum of 174 enthusiastically suggested treatment plans. Following the professionals' review of digital arrangements, the most exhorting methodology was essentially modified multiple times (9.2%) altogether. These huge changes remembered a shift for the extraction design or a change from opening the space for inserts to shutting the space for reciprocal canine substitution. A further 25 partial acclimations to treatment plans (14.4%) were made, including the expansion or expulsion of IPR, the establishment of in-between time harbor gadgets or minis teams to help with safe haven, and the transformation from clear aligners to fixed machines or the other way around. A sum of 100 out of 200 cases had their treatment plans modified, yielding a change pace of 23.6% (Table 3). The distinction in change rate in light of involvement was not genuinely critical when the treatment plan change rate was analysed according to how much expert experience.

Table 3: Adjusting the treatment plan in light of the expert's information

Parameters	n	Changing (%)	Relative risk of modification	Confidence interval: 96%	P
Residents	10	22.6	2	-	0.197
≤ 6 years in practice	10	30.2	2.36	0.91	3.36
≤ 6 years in practice	30	18.9	0.91	0.40	2.71
Total	50	29.4			

On a visual simple scale, the general certainty level of professionals was 90 before watching the digital arrangements and 89 subsequent to review the digital arrangements (Table 4). This certainty level was estimated when experts were inquired, "How sure are you that your most suggested plan will bring about a fruitful result?" Case 1 encountered the littlest change in certainty level, going from 89 to 90, while Case 3 encountered the most elevated shift, going from 74 to 87. At the point when the treatment plan continued as before, the certainty level moved from 84 to 89, though when it transformed, it went from 77 to 88.

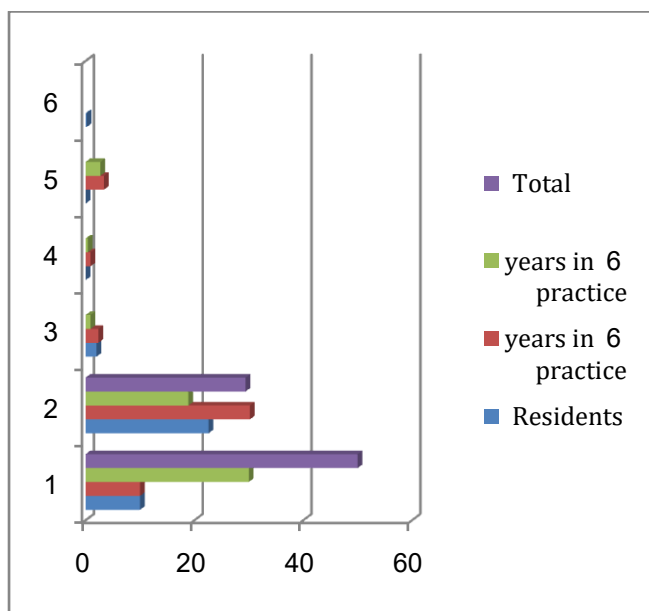


Figure 4: Graph for treatment plan in light of the expert's information

At the point when specialists were ordered by their degree of skill, inhabitants had the least first certainty level (72), though fresher and more experienced experts had a higher starting certainty level (86). A definitive certainty levels for every one of the 3 gatherings rose to 92 for prepared orthodontists, 91 for fledgling orthodontists, and 81 for inhabitants.

Table 4: Level of assurance before and after seeing installations

	Confidence before					Confidence after					Change in confidence				
Parameters	Mean (%) 95% CI p*					Mean (%) 95% CI p*					Mean (%) 95% CI p*				
Total	200	72	89	76		78	75	80			75	10	<1.10	**	*
Case															
1	30	78	90	80	<1.10	89	75	85	1.110	2	-1	5	<1.10		
2	30	76	79	99		81	90	80		8	4	9			
3	30	85	58	70		76	72	89		24	9	24			
4	30	72	88	76		75	76	89		5	-13	5			
5	30	70	85	76		90	74	81		9	3	21			
6	30	74	85	89		89	75	81		6	1	21			
Change in															

treatment plan															
Kept original plan	244	73	77	07	1.112	90	75	81	1.26	6	4	8	1.112		
Change d plan	52	88	62	95		77	73	80		11	7	24			
Exp erie nce of prac titio ners															
Resi dent s	51	63	70	72	1.156	70	85	75	<1.10	8	2	25	1.44		
≤ 5 year s in prac tice	69	75	71	89		80	77	85		4	4	8			
>5 year s in prac tice	63	75	70	89		81	90	86		7	4	10			

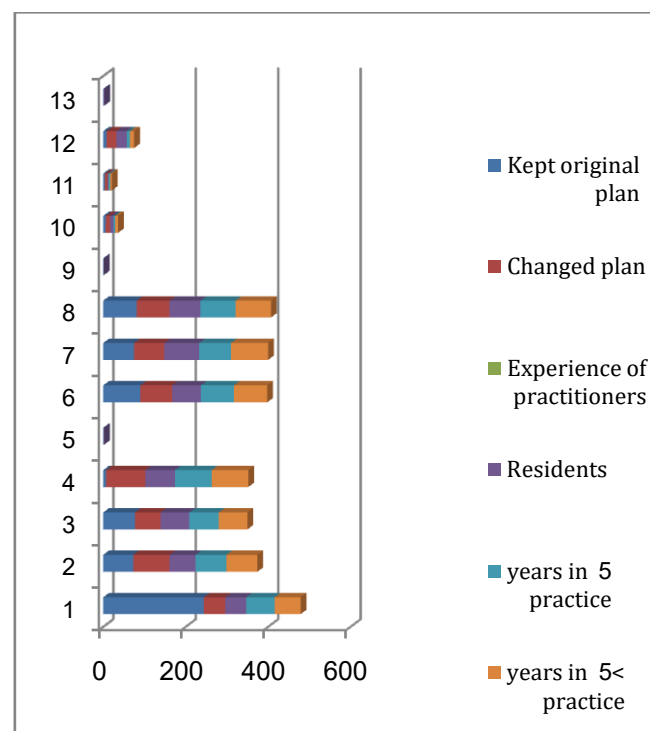


Figure 5: Graph Level of assurance before and after seeing installations

The four key features identified by experts as most useful for treatment planning in these cases were to superimpose the setup on the initial model, determine the expected extent of tooth development, and determine the final incisal relationship (overjet and overbites) and the required amount of intellectual property.

5. Discussion

In 9.2% of cases, professionals altogether changed their treatment in the wake of seeing the digital arrangements, supporting our unique speculations. There have been changes made, for example, changing from removing second to first premolars, from even to uneven premolar extractions, from extricating one mandibular incisor while utilizing IPR to separating one mandibular incisor, and from fixing the hole for canine swap to opening it for parallel incisor inserts. An adjustment of extraction design is one of these changes that can't be scattered, yet shutting space as opposed to opening space would bring down effectiveness and protract treatment times [15].

At the point when all treatment plan changes are considered, experts modified treatment plans in no less than 23.6% of cases, for example, by presenting or taking out IPR or by including impermanent mooring gadgets to help with harbor necessities. These outcomes recommend that settings unequivocally impact treatment planning, especially for additional intricate circumstances. Having the last treatment plan from the outset could prompt a more successful treatment and more limited treatment time, despite the fact that a significant number of these progressions might have been shifted over the direction of the treatment [16].

The change rate that we found may be lower when applied to a more broad patient gathering since this study depended on six cases that are somewhat more convoluted. In any case, there would in any case be benefits to considering a digital arrangement as a feature of the treatment planning strategy. Generally, in the wake of seeing the settings, experts had good expectations about their treatment methodology. An extreme case, a possible change in treatment subsequent to noticing the sets, and among occupants were found to bring about the greatest addition in certainty level when the expert began with a lower starting certainty level. The most elevated expansion in certainty subsequent to seeing the arrangement was found in the event that 3, which had the least beginning certainty. A maxillary canine and mandibular incisor were lost in a grown-up, multidisciplinary case. Considering that this case was the most muddled in the review, it isn't is business as usual that experts at first had little confidence in their proposed game-plan [17-20].

The subsequent class incorporates experts whose aims were changed in the wake of seeing the course of action. It's conceivable that these experts needed trust in their unique expectations, which made them bound to alter their most educated direction with respect to activity subsequent to seeing the situation. To wrap things up, of the three experience level gatherings, occupants' underlying degree of certainty was the least, yet subsequent to seeing the arrangement, their certainty expanded the most. No matter what the first degree of certainty, everybody's last degree of certainty was high

subsequent to seeing the arrangements. Indeed, even while experts at first had a lower level of certainty, the settings permitted them to close the certainty hole and foster a superior degree of confidence in their treatment methodology. An arrangement must be valuable and reasonable in the event that it can imitate the expert's treatment goals, as past creators have emphasized³. Specialists looked to adjust a portion of the settings after they were made [21,22]. We couldn't change the design to every specialist's exact inclinations, however, as the arrangements for this study were all made ahead of time. The most often communicated want was to change the IPR's level. This absence of customization likely little affected the review's discoveries, yet it featured how pivotal it is for the getting orthodontist have the option to quickly and basically change the digital arrangement's boundaries to meet their treatment goals [23,24].

Specialists proposed 10 other treatment approaches all through the preliminary that were not at first viewed as by the board. The specialists who suggested these 10 treatment designs regularly expressed that their proposed plan was unreasonable or that they at first ignored something while treatment planning the case in the wake of seeing the digital arrangements for these 10 treatment plans were created. Subsequent to watching the arrangements, these 10 treatment procedures were not really picked as the most recommended technique. It's fascinating to take note of that the digital arrangement was successful in that it empowered experts to recognize imperfections in those proposed techniques. If 6, for instance, the patient had a smidgen of a Class III inclination. Scarcely any dental experts picked extraction of the ideal mandibular first premolar or extraction of both mandibular first premolars as a course of treatment. These identical specialists saw the game plans and understood that there was an extreme measure of room to close and that the Class III relationship was not so particularly fundamental as they had imagined. Therefore, they at last ruled against picking these thoughts. Since all of the last treatment choices picked by the specialists were expected ahead of time, this tracking down additionally legitimized crafted by the board preceding enlisting experts [25,26].

6. Conclusion

Taking everything into account, digital radiography has shown to be exact and helpful when utilized for orthodontic diagnosis and treatment planning. The review gave significant experiences into the impact of digital arrangements on treatment systems by utilizing the portrayed methodology, which involved assembling records of patients with different case types and letting numerous orthodontists and inhabitants' draft treatment plans. The discoveries showed that treatment plans were altogether influenced by digital settings, with 10% of cases experiencing enormous changes and 15% going through minor changes. The extraction design was modified, space conclusion was recommended as a choice to embed implantation, and interproximal decrease or brief mooring gadgets were added. Specialist certainty was expanded by having the option to see the digital portrayals of treatment plans, particularly when changes were made. It is critical that the level of conclusive certainty among all specialists stayed

high. The concentrate plainly exhibited the advantages of digital radiography for orthodontic diagnosis and treatment planning. It was feasible to compute tooth development definitively and assess a definitive incisal relationship, including overjet and overbite, by superimposing the digital arrangement with the first model. Furthermore, the capacity to digitally see the treatment plan and figure the essential interproximal contact focuses gave orthodontists valuable apparatuses to further develop treatment results. Further developed direction and treatment adequacy are advantages of involving digital radiography for orthodontic symptomatic and treatment planning. The accuracy and confirmation of orthodontists in their methodology are worked on by the ability to assess various treatment decisions, make amendments, and survey the last treatment plan digitally. This accuracy at last prompts worked on proficient practice, more joyful patients, and more effective orthodontic results. For 9.2% of the occurrences in this review, seeing the digital setups prompted a massive change in treatment plans, and for 14.4% of the cases, a fractional adjustment.

The specialists' general degree of certainty expanded subsequent to seeing the electronic arrangements, especially for inhabitants and troublesome patients. As additional practices use digital intraoral scanners and as the product for making digital arrangements propels, making digital arrangements might end up being a valuable option to the treatment planning process and might be routinely embraced from now on. Seeing digital setups brought about changes to treatment plans around 24% of the time. The utilization of digital settings was associated with more significant levels of trust in the picked plans. The discoveries of this study have prompted the improvement of digital radiography as an exceptionally exact symptomatic and treatment planning instrument for orthodontics. Contrasted with conventional radiography, it has advantaged such diminished radiation portion, further developed picture quality, and extended symptomatic potential outcomes.

Funding

No funding.

Conflict of Interest

No conflict of interest

Informed Consent

Not Applicable

Ethical Statement

Not Applicable

Author Contribution

All authors are contributed equally.

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