

Table 2. Mandibular Rehabilitation Options

Augmentation of the remaining bone	Utilization of the remaining bone
Bone grafting	Short implants
Distraction osteogenesis	Nerve repositioning “All-on-4®”

(Courtesy of Spencer KR: Implant based rehabilitation options for the atrophic edentulous jaw. *Austral Dent J* 63:S100-S107, 2018.)

particulate material with membrane coverage, or combinations of these. Complications with this approach include graft resorption and incisional dehiscence and graft exposure, which can lead to loss of the graft. Inlay grafting corrects only vertical defects, and the amount of vertical gain is anatomically limited.

Vertical distraction osteogenesis (VDO) can be used either anteriorly or posteriorly in the mandible. Its advantages include no donor site morbidity and the ability to obtain greater vertical gain in bone height than grafting procedures. In an atrophic edentulous mandible, the remaining bone is seldom sufficient for posterior distraction to be used. VDO is associated with a high rate of reported complications that make it a less desirable choice. Survival rates for implants are similar to those for other methods to augment bone.

Using Remaining Bone

A short implant in the posterior segment distal to the mental foramen avoids the need for more surgical procedures with their associated risks and added cost. Short implants require sufficient width of bone and a residual bone height above the nerve canal that is at least 8 mm (6 mm implant plus 2 mm safety zone).

Mandibular ‘All-on-4’ is done by placing fixtures into the parasymphseal region. Distal implants are tilted to avoid the anterior loop of the inferior alveolar and minimize the distal cantilever. The implants are inserted with a 35Ncm torque or greater, as in maxillary cases, to allow immediate loading. If the ‘All-on-4’ cannot be used and the patient cannot or is unwilling to undergo an adjunctive procedure to permit implantation, a fixed implant-retained prosthesis may not be feasible. Two implants can be placed in the parasymphseal region as the basis for an implant-

retained overdenture in some cases. Retention, stability, and chewing ability can all be improved in this manner, and long-term prosthetic and implant survival rates, as well as patient satisfaction levels, have been excellent.

Nerve repositioning can be available to permit implant placement in the posterior mandible of patients lacking sufficient bone height for conventional implant placement. Success rates with lateralization can be between 93% and 100%. The technique cannot be recommended, however, because of the risk of permanent neurosensory injury.

DISCUSSION

The goal of implant placement is to achieve long-lasting anchorage in the best possible position to create a functional, esthetic prosthetic solution to the patient’s oral challenges. Having atrophic edentulous jaws can introduce a degree of difficulty that requires creative alternatives to the conventional techniques. The clinician must understand the outcomes of the options and critically evaluate which option is best in each situation.

Clinical Significance

In addition to considering the functional and esthetic consequences of an implant approach with challenging bone loss situations, the clinician must remember the patient-driven demand for an immediate, single-stage treatment approach that carries low morbidity. The use of graftless procedures such as ‘All-on-4’ has increased as a result. Longer term data indicate that some of these approaches are valid and useful, especially the use of shorter implants, sinus lifting and onlay grafting.

Spencer KR: Implant based rehabilitation options for the atrophic edentulous jaw. *Austral Dent J* 63:S100-S107, 2018

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IONIZING RADIATION

Radiographs in orthodontics



BACKGROUND

The use of radiographs in orthodontic treatment is guided by basic information about the risks of ionizing radiation to patients along with consideration of the benefits to the patient and the

therapeutic decision-making that can be realized by the information the radiographs provide. The relevant evidence was explored along with general guidelines and specific recommendations regarding ionizing radiation exposure’s risks and benefits in

relation to the age and clinical condition of the orthodontic patient.

GENERAL GUIDELINES FOR RADIOGRAPHS

Radiographic imaging is justified when there is an expectation that the patient will benefit as a result. The American Dental Association (ADA) and Food and Drug Administration (FDA) offer general, broad guidelines for dental radiographic evaluations and recommendations for patient selection; these are not specific to orthodontics. New adolescent and adult patients whose permanent dentition is being evaluated should undergo a customized radiographic examination that includes posterior bitewings with panoramic examination or posterior bitewings and selected periapical images. When the patient has clinical indications of generalized dental disease or a history of extensive dental treatment, a full-mouth intraoral radiographic examination is preferred.

The selection of radiographic studies for orthodontic treatment should be based on the clinician's judgment predicated on patient presentation and the directive to keep radiation dose as low as is reasonable achievable (ALARA). Because most orthodontic patients are children, who are at higher risk for radiation-induced damage, including cancer, the importance of adherence to the ALARA directive is heightened.

The justification for obtaining radiographs should be based on each individual patient's presentation, which includes the chief complaint, the medical and dental history, and the need to diagnose, monitor, and examine the need, status, or outcome of a procedure or treatment. Radiographs should only be prescribed after a clinical examination has been done.

USE FOR INITIAL EVALUATION

Once the patient's health history and clinical examination have been evaluated, radiographs can be considered if they are likely to provide confirming or clarifying information that can have an impact on the diagnosis and treatment of the patient. Case-specific radiographs should be ordered for the patient's benefit. Combining pretreatment panoramic and cephalometric radiographs is generally appropriate and sufficient in most cases to establish an appropriate diagnosis.

The initial panoramic radiograph is easy to obtain, interpret, and explain to the patient. It gives the clinician information about the status of the patient's dental development, offers a broad view of various structures, and is especially helpful when asymmetry is present. Among the limitations of the panoramic radiograph are that it lacks the fine detail needed to diagnose and monitor carious lesions and periodontal status. It cannot clearly depict objects outside the focal trough. In addition, it is not dimensionally accurate and may contain geometric distortion and variations in the magnification of the image. Finally, the patient must be positioned precisely to obtain an accurate panoramic radiograph.

The initial cephalometric radiograph can help in assessing the patient's growth as well as dental and skeletal relationships. It is not, however, always needed when the problem is mild crowding or spacing or when the treatment plan is limited and will not alter the maxillomandibular relationship. The clinician should base the decision to obtain a cephalometric radiograph on whether it will alter treatment decisions and whether the patient will benefit.

Some circumstances will require additional initial imaging, such as intraoral periapical radiographs. Because caries and periodontal disease are diagnosed best based on periapical and bitewing radiographs, the clinician should not rely solely on the panoramic radiograph because incipient interproximal caries or alveolar bone loss may not be visualized on this image. It's prudent to inform the patient or parent that carious lesions and periodontal status are best managed by the general dentist or periodontist, who will take any intraoral radiographs that he or she feels are needed.

In some cases cone beam computed tomography (CBCT) imaging may improve the clinician's ability to diagnose the patient's condition. This approach provides a 3-dimensional view of anomalies in dental positioning, anomalies in the dental structures, dentofacial deformities, airway insufficiencies, TMJ problems, and pathologic conditions. CBCTs also permit better assessment of craniofacial anatomy, alveolar boundary conditions, maxillary transverse dimensions, vertical malocclusion, and obstructive sleep apnea. More advanced applications are also possible. As a result, CBCT imaging can alter treatment planning for patients. However, some authors believe CBCT does not necessarily improve outcomes of orthodontic treatment and is therefore not justified for use in patients. In addition, the effective radiation doses are greater for CBCTs than for 2-dimensional radiographs (Table 1) and may carry a greater health risk for the patient. To address this concern, small-volume or quick-scan protocols with low radiation doses have been introduced, although they are not always included in commercially available CBCT units.

The effective doses of initial radiographs vary across the age and gender of patients. Female patients have a slightly higher

Table 1. Effective Doses of Digital Panoramic Radiography, Cephalometric Radiography, and CBCT Imaging

Imaging modality	Estimated range of effective dose (μ Sv)
Digital panoramic radiography	6-38
Digital cephalometric radiography	2-10
CBCT	20-1025

Significant variations in effective doses for all radiographic imaging techniques are reported in the literature. (Courtesy of Abdelkarim A, Jerrold L: Clinical considerations and potential liability associated with the use of ionizing radiation in orthodontics. *Am J Orthod Dentofacial Orthop* 154:15-25, 2018.)

Table 2. Age-Risk Relationship Based on a Relative Risk of 1 for a 30-Year-Old Adult

Age group (y)	Multiplication factor for risk
< 10	× 3
10–20	× 2
20–30	× 1.5
30–50	× 0.5
50–80	× 0.3
>80	Negligible risk

(Courtesy of Abdelkarim A, Jerrold L: Clinical considerations and potential liability associated with the use of ionizing radiation in orthodontics. *Am J Orthod Dentofacial Orthop* 154:15-25, 2018.)

stochastic health risk than male patients. Children are at a theoretically higher risk than adults, and elderly patients are at the lowest risk (Table 2). If the relative attributable lifetime risk based on a relative risk of 1 is given to a 30-year-old adult, a patient at age 10 to 20 years would have a 2-fold higher risk based on his or her more radiosensitive organs and longer lifespan. Thus the risk of cancer per unit dose of ionizing radiation is generally higher for younger patients than for adults. The effective dose for young orthodontic patients exposed to CBCT is especially problematic because the tissue-weighting factors used to calculate effective doses are averaged across all ages and because several radiosensitive organs receive higher organ and effective doses. All things remaining equal with respect to exposure protocols, small 10-year-old children receive a 30% higher effective dose than adolescents because of the children's smaller size. This clouds the evidence on CBCT use and leads to conflicting opinions about the advantages and risks of using this modality.

The recommendation for clinicians who plan to use CBCT is to follow the clinical practice guidelines promulgated by respected dental organizations such as the ADA. If CBCT imaging would benefit the patient or change the outcome of treatment compared to 2-dimensional radiographs, its acquisition is justified. Taking a large field-of-view CBCT scan just to synthesize a cephalometric image is not indicated. In addition, CBCT images should not be obtained just to replace impressions or digital scans that don't use ionizing radiation or to obtain the status of a high-tech orthodontic practice.

USE TO TRACK PROGRESS

Progress or mid-treatment radiographs can guide or monitor orthodontic care to detect any adverse conditions that may develop. It's generally accepted as worth the risk to consider taking a panoramic radiograph or customized intraoral radiographs about 6 to 9 months after beginning orthodontic treatment, although the decision should be individualized to the patient's needs. If the patient, for example, has preexisting root resorption or the potential for root resorption, progress radiographs are justified to monitor the status of the teeth. For the purpose of evaluating the presence of root resorption, intraoral periapical

radiographs are more reliable than panoramic radiographs. Should root resorption be detected at 6 months, further progress radiographs are clearly justified as being beneficial to the patient. Such an approach would be considered reasonable and prudent to monitor the health of the teeth and periodontium.

Other situations that justify the use of progress radiographs are to monitor root angulations, significant tooth movements, dental pathologic conditions or anomalies, carious lesions that can develop, and the status of alveolar bone. The last is particularly valuable in adults with preexisting radiographic bone loss or clinical attachment loss. A collaboration with the referring dentist with respect to progress radiographs would be of benefit to patients at high risk for caries, those having multiple preexisting restorations, or those who have rapidly developing white spot lesions despite meticulous oral hygiene. Alterations may be required if progress radiographs detect unanticipated iatrogenic factors or if severe periodontal or pulpal injury is present.

Guidelines for progress panoramic radiographs include limiting the field and collimation to include only the dentition. This reduces the radiation dose and limits the field of view to the specific area of interest.

USE IN FINAL EVALUATION

Final radiographs may have value in showing the patient the outcome of treatment. This has both record-keeping and risk management purposes as well. However, often the efficacy of the treatment cannot be assessed comprehensively or reliably by final radiographic evaluations, making their benefit to the patient questionable. They may show the patient if the periodontium or dentition has been harmed, can record the status of third molar development, or document any other unerupted teeth. Patients have the right to be informed of their oral health status and to confirm any expectations associated with orthodontic treatment, making this an ethical and clinical imperative.

Radiographs taken after treatment has concluded can affect clinical decision making in some cases, but should be justified on a case-by-case basis only. Short-term, limited treatment need not be documented with final radiographs.

The guidelines most helpful for final radiographs is to take them a few appointments before debonding and to obtain information helpful with finishing and detailing, such as detecting teeth with inappropriate root angulations. Radiographs taken a few months before debonding make a radiograph taken immediately after appliance removal both unnecessary and of no benefit to the patient.

Whether to obtain a final cephalometric radiograph should also be determined based on each specific patient. A final cephalometric radiograph could be taken at the end of functional appliance treatment to assess mandibular incisor position, at the end of presurgical treatment in orthognathic patients, and just before the end of active fixed appliance treatment to demonstrate the

position of the mandibular incisors. Because of the limited value to patients in many cases, having final radiographs taken will remain a controversial and individually determined choice.

INTERPRETATION OF RADIOGRAPHS

No matter whether the image is a panoramic radiograph, a cephalometric radiograph, a full-mouth survey, or a CBCT scan, the orthodontist cannot interpret just one aspect of the image. The clinician must fully understand the images and recognize what is normal and what is not. The interpretation should systematically consider the teeth, apical tissues, periodontium, and adjacent structures. All findings should be documented in the patient's chart, with notes indicating whether the abnormalities require immediate treatment, referral, or observation. For children, specific notes should be included about the stage of dental development, whereas for adults, the status of the periodontium is of particular concern. Before any progress radiographs are obtained, the clinician should carefully examine and interpret any images already in the patient's record. This helps in detecting additional or different information, which would justify the use of progress radiographs.

The interpretation of CBCT scans can be technically demanding for orthodontists, but it's widely believed that their interpretation is legally the responsibility of the practitioner who ordered them. The orthodontist is not required to perform this interpretation personally but can refer the images to a qualified oral radiologist. Difficulty in interpretation is most often seen for large field-of-view scans, which are subject to misinterpretation, leading to inaccurate and possibly inappropriate treatment decisions. These are most appropriately referred to an oral radiologist, especially if they include regions of the head and neck that most dentists are not trained to assess.

Small field-of-view scans offer the advantages of reducing the effective dose and shortening the interpretation of the scan. Care must be taken to ensure the entire area of interest is included in the smaller field-of-view scan.

Radiographic reports should be concise, precise, written in the present tense, and free of vague or redundant statements or words. They should be written in standard language, follow a structured format, and be consistent in their content. If further

investigations are recommended based on the findings, the rationale for their use should be clearly stated.

Clinical Significance

When obtaining radiographs, it's important to keep in mind the benefit to the patient and whether it outweighs any risk to his or her health. Each orthodontic patient must be evaluated individually to determine the benefits he or she will reap from imaging, although clinicians should be aware that sometimes the benefit is not appreciated until the radiograph is taken and interpreted. The guidelines that orthodontists should follow with respect to prescribing radiographic studies include the following:

1. Perform the clinical examination before prescribing any radiographs.
2. Only prescribe radiographs that are needed and justified.
3. Select the most appropriate radiographic examination.
4. Consider CBCT imaging only when it's likely to benefit to the patient or change the outcome of treatment compared to 2-dimensional radiographs.
5. Be aware that failing to take necessary, appropriate radiographs based on concern over irradiation exposure to the patient can be considered negligence.
6. Fully interpret all radiographic images either personally or with an appropriate referral to an oral radiologist.

Abdelkarim A, Jerrold L: Clinical considerations and potential liability associated with the use of ionizing radiation in orthodontics. *Am J Orthod Dentofacial Orthop* 154:15-25, 2018

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MINIMALLY INVASIVE DENTISTRY

Resin infiltration for proximal enamel lesions



BACKGROUND

Although the numbers of carious lesions in children and young adults are declining, caries remains a significant oral health problem. In particular, the treatment of proximal early caries lesions is complicated by difficulty detecting the lesions early

and the need to destroy significant amounts of tooth structure to achieve conventional restorations. The use of a tissue-preserving approach to arrest and control incipient lesions has been suggested. Resin infiltration treatment has proved able to seal the micro porosities of incipient caries lesions and block the diffusion pathway to cariogenic agents using