Exploring hand-held dental X-ray devices and their impact on digital dentistry: rationale and best practices

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ABSTRACT

Dental radiographs are essential in oral healthcare, facilitating accurate diagnosis and treatment planning. In various situations, such as in rural communities, senior homes, military settings or in patients with limited mobility, traditional wall-mounted X-ray machines may not be suitable. Hand-held dental X-ray devices have emerged as a valuable solution for these special circumstances. However, Canadian regulatory bodies have only recently adopted these portable devices, leading to limited available information. This short communication consolidates relevant information on regulations, safety, and best practices to assist Canadian oral healthcare providers adopt this technology effectively and safely. Additionally, it shares insights gained from using hand-held X-ray devices in a dental initiative that delivers care to underserved Canadians through mobile clinics.

Keywords (Mesh terms): dental equipment; dental radiography; diagnosis; portable X-ray, X-rays

CDHA Research Agenda category: access to care and unmet needs

PRACTICAL IMPLICATIONS

- Enhanced Access to Care: Portable X-ray devices offer Canadian oral healthcare practitioners a safe and efficient imaging solution, particularly for patients in remote areas, those with mobility limitations, or during a national crisis, ensuring consistent access to oral healthcare

- Increased Efficiency: These portable and reliable devices are an effective alternative to wall-mounted X-ray systems, enabling the oral healthcare team to maintain a high standard of care, even in challenging circumstances

INTRODUCTION

Radiographic imaging is fundamental to a dental professional's daily clinical practice.[1] It is essential to providing quality diagnosis and to support treatment planning and shared decision-making. [2] As modern dentistry emerges, novel technologies emerge, improving the ability of oral health care providers to deliver optimal care and expanding access to oral health care. Portable X-ray devices are just one example that has emerged and is being recently used in the dentistry. [1,3,4]

Hand-held devices were first introduced to optimize dental radiographs in special circumstances [5] such as military settings, [3,4,6,7] and in times of disasters. [7,8] Nowadays, this technology has been used in the care of the aging population, where mobility is limited [1,2,4,8,9] remote areas, people under house arrest, [7] forensic dentistry [3,8,10,11] and patients under general anesthesia. [1] The use of portable dental X-rays in specific settings increases efficiency due to their transportability. It reduces costs, decreasing the need for a wall-mounted X-ray device in every clinical operatory. [8,11]

Portable dental X-ray devices are available in various designs. One example is the NOMAD device (DEXIS, United States), recently approved in Canada, [12] as presented in Figure 1. Approved devices must include internal and external shielding to reduce radiation exposure and to protect the operator, allowing the operator to remain in the room with the patient. Essential accessories include a rectangular collimator for a restricted exposure area and a remote exposure handset to be

used with an adjustable stand, see Figure 2. [13] As per the technique, the operator holds the device during the exposure with the backscatter shield parallel to the floor and the unit as close to the patient as possible. The patient's head should be adjusted to retain the X-ray beam in the horizontal plane (Figure 2).[14,15]

The standard regulation for portable X-ray devices in Canada was released in 2022. [5] The Safety Code 30, released by Health Canada, mentions a limited set of guidelines centered around the use of these devices.[5] Canada is known to have many remote areas and rural communities that need dental care, and often dental clinics are limited or nonexistent. The Canadian demographic is also shifting toward an aging population where bed-ridden and immobile patients continue to increase, requiring the need to find new ways and tools to optimize dental care.[16] Access to and knowledge about portable devices could improve oral diagnosis and the quality of care provided to these communities.

Around the world, the use of hand-held X-ray devices continues to increase, and while studies, guidelines and discussions are already taking place in different countries,[4] Canada has not fully embraced this technology yet. Therefore, this short communication aims to guide Canadian oral healthcare providers regarding best practices on portable X-ray devices and raise awareness about this technology as a valuable resource for enhancing access to oral healthcare.

CASE DESCRIPTION

At the Mike Petryk School of Dentistry, University of Alberta, the NOMAD Pro 2 portable dental X-ray device has been implemented as part of the Access for All Dentistry initiative

(https://a4ad.ca/). This student-led, student-funded initiative works alongside the Metis Nation of Alberta and provides free dental care to underserved Canadians across Alberta. Under the supervision of instructors, dental and dental hygiene students provide essential oral care to remote communities across various regions of Alberta. These mobile clinics offer a vital opportunity for students to gain hands-on experience while addressing the oral health needs of underserved populations that may otherwise lack access to dental care.

Given the lack of dental facilities in these areas with wall-mounted dental X-ray equipment, portable X-ray devices have become essential to the Access for All Dentistry initiative as they assist in formulating their diagnosis and maintaining the standard of care. As per the student lead, *"The portable dental X-ray device is integral to the trip, the treatment provided in that remote area cannot happen without this device."* As a note, students and instructors participating in the program receive a one-hour training session conducted by the oral radiology team. This training focuses on properly using the device, retaking documentation, and radiation protection measures to ensure safety while providing care to the communities.

DISCUSSION

Is it safe for the operator?

Ionizing radiation exposure levels using portable X-ray devices remain below the limits set by regulatory bodies. [1,2,17] While wall-mounted X-ray devices in dentistry typically provide variable exposure levels and adjustable voltage options, [2–4] hand-held devices generally have fixed voltage and current settings, with only adjustable exposure times. [3] To achieve comparable image quality

to wall-mounted devices, exposure times on hand-held devices often need to be increased. This longer exposure duration may increase the risk of motion-related errors. [4]

It should also be considered that the position of the portable X-ray device relative to the position of the operator can impact radiation exposure, reinforcing the need for proper training and adherence to best practices. [1] Research has shown that with proper position, the measured dose with NOMAD for both patient and operator are well below recommended levels. [14] According to the NOMAD specifications, the average annual dose absorbed by the operator is up to 0.65 mSv and 0.13 mSv with film and digital sensor, respectively. In addition, tests conducted with NOMAD in 715 digital and/or film radiographs demonstrated an average whole body operator dose of 0.04 mSv. [18]

Maximum protection from backscatter radiation exists when the unit is positioned near the patient, is perpendicular to the operator and the backscatter shield is fully extended towards the patient. [1]

Is it safe for the patient?

Portable X-ray devices can be considered safe for patients when used responsibly and according to established standards. The low exposure settings, digital sensors, and shielding incorporated into the devices, combined with proper operator training and adherence to safety guidelines, minimize radiation risk to patients. [5] As with any X-ray procedure, the benefits of the diagnostic information gained should always outweigh the small potential risks associated with radiation exposure. [4]

Health Canada – Radiation Safety Code 30 guidance [5]

- Hand-held X-ray devices should be supported by a stand and operated remotely with an irradiation switch. Manual handling should only occur if a stand cannot achieve a diagnostically acceptable image
- When a portable X-ray device is used, all persons, excluding the operator and patient, should be at least 2 meters away from the device
- Each operator using the device should wear a dosimeter for at least the first year of use.
- The device should be stored in a locked area when it is not in use to prevent any damage or unauthorized use

A critical point is ensuring that the portable equipment used is registered and cleared by Health Canada. The availability of affordable but unregulated alternatives offered online poses a significant risk. These unregistered devices may not meet established safety standards, potentially exposing both operators and patients to unnecessary radiation. Healthcare providers must recognize and avoid noncompliant devices, while cost may be a factor, compromising on safety due to unregulated equipment is unacceptable

Oral health care equity and future directions

The underserved rural and remote population, [19] as well as the aging population, are growing concerns that need to be addressed. [16] Improving oral health access and reducing inequities in Canada is the main goal of the recently announced National Oral Health Research Strategy, which is aligned with Health Canada priorities. [20] In this context, the portable X-ray device should be explored as a valuable tool to help Canadian oral health care providers better serve those demographics.

Future studies should explore the challenges in using and implementing portable dental X-ray devices in Canada. This includes examining issues related to image quality and identifying the types of errors that may arise from using these devices and educational needs.

Clinical relevance

In this era of modern dentistry, we should actively be innovative and find ways to increase our efficiency by delivering optimal care, providing everyone with access to oral healthcare and serving our patients with the best of standards. The portable X-ray device has opened the door as a safe alternative [5]. Whether patients live in remote areas, have disabilities, restrictions that prevent them from accessing a dental clinic, or a nationwide crisis has occurred, this device has been invaluable to oral healthcare professionals. [1–3,7,9–11]

The benefits of these devices as a tool to help provide dental care to specific communities should also be explored. With proper training and use, portable dental X-rays can be a valuable resource for mobile clinics, oral health programs in community health centers, shelters, long-term care facilities, and alternative delivery models, helping to improve access to oral health care.

Recommendations based on the literature and recent Canadian regulation

1. *Training*: Operating personnel in the dental clinic should receive training from the manufacturer or reseller of the portable X-ray device to establish protocols that minimize radiation exposure risks [1,2,8]
2. *Use of Lead Aprons*: Patients should wear a lead apron to reduce radiation exposure from the X-ray beam, as per their province regulations [3]

3. *Dosimeter use*: Wearing personal dosimeters to monitor radiation exposure is highly recommended. In some Canadian provinces, dosimeter use is mandatory [21]
4. *Use of Digital sensors*: Digital sensors are preferred over film, as they reduce exposure time and align with the ALARA (As Low As Reasonably Achievable) principle [7]
5. *Body Position and Shielding*: The operator's body should stay parallel to the device and behind the scatter shield. [2] For maxillary anterior radiographs, the patient should tip their head downwards; for maxillary posterior radiographs, the patient is required to tip their head sideways to be able to capture the radiograph horizontally; for mandibular anterior radiographs, they should tip their head upwards. [15] The operator should remain within the device's protective zone. [1] To optimize shielding, the object should be kept close to the device's tube opening, as distance affects the backscatter angle. [8,10]

CONCLUSION

Portable X-ray devices offer a potential solution for providing care in settings where traditional wall-mounted equipment is not feasible. Our review suggests that these hand-held devices can be used safely with proper training and a well-developed quality assurance program to protect oral health care providers and patients. The portability of these devices, in compliance with Canadian regulations, may improve access to oral care which is crucial for a more equitable system.

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CONFLICTS OF INTEREST

The authors have declared no conflicts of interest.

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Figures Legend

Figure 1 - Portable X-ray device mounted with a stand

Figure 2 - Operator holding the portable device