Advances in Radiation Oncology (2023) 8, 101365

advances in radiation oncology

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Letter to the Editor

In Reply to Bäcker et al.

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Received 8 July 2023; accepted 13 July 2023

We appreciate the letter by Bäcker et al who suggested strategies for improving the reliability of the database of activation cross-sections. As we pointed out in our discussion,[1] nuclear reaction models in a Monte Carlo (MC) simulation exhibit certain uncertainties.[2] Therefore, the determination of an activation cross-section based on actual measurements is justified, and we consider this important for improving the accuracy of MC simulations. As Bäcker et al state, the kinds of produced radionuclides may be estimated from the database. However, we consider it difficult to respond to the clinical demands of predicting the types of produced radionuclides and their relative abundance ratios because the spread-out Bragg Peak region contains protons of various energies. Furthermore, the gamma-ray spectra obtained from the activated metals contain noise caused by low counts of short-lived radionuclides, and we think that this noise may affect the calculation accuracy of the activation cross-section.

We used pure titanium and gold-silver-palladium alloys, which are common dental materials in Japan, and identified the radionuclides produced by these metals using clinical proton beams. Moreover, we reported a novel observation that the activity of gold-silver-palladium alloys is higher than that of titanium.[1] However, as mentioned previously, these results require careful interpretation because uncertainties of both the MC simulations and measurements. One of our objectives was also to evaluate the usefulness of Particle and Heavy Ion Transport code System as a tool for pre-estimating the types of radionuclides in proton beam therapy. Our results show that the Particle and Heavy Ion Transport code System may indeed be a useful tool, although uncertainties exist.[1] Therefore, MC simulations can be adopted to identify radionuclides in advance in facilities that do not have gamma-ray spectrometers such as high-purity germanium detectors. We believe that pre-estimating radionuclides is useful in clinical practice.

Moreover, Bäcker et al explained that radioactivation had no clinical effects because the activated metals decayed to background levels after a few days. Certainly, in our study, the majority of radionuclides detected had relatively short half-lives, thus the clinical effect is expected to be negligible. However, because patients receiving proton beam therapy are essentially irradiated daily, it is also conceivable that the accumulated dose will increase for the activated metals. In proton beam therapy for head and neck cancer patients, and especially for those with oral cancers, oral mucositis is a severe side effect. Numerous risk factors have been identified for radiation-induced mucositis, including chemotherapy, bad oral hygiene, and smoking.[3] At our hospital, we performed high-dose proton beam therapy combined with intra-arterial infusion chemotherapy,[4,5] which suggested that the radioactivation effect of dental metals cannot be ruled out. However, we have not considered these issues in detail yet and they remain the topic of future continuous investigations.

The radioactivation effects of metals in the human body have not been sufficiently investigated for proton beam therapy; hence, as Bäcker et al pointed out, more investigations are needed. Using continuous radioactivation verification, we expect that the clinical effect of metal

Sources of support: This work had no specific funding.
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https://doi.org/10.1016/j.adro.2023.101365

radioactivation will be clarified, and the accuracy of the activation cross-section will improve.

Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

1. Kato R, Kato T, Narita Y, Sasaki S, Takayama K, Murakami M. Identification of induced radionuclides produced from dental metals in proton beam therapy for head and neck cancer. *Adv Radiat Oncol*. 2023;8: 101153.
2. Boudard A, Cugnon J, David J-C, Leray S, Mancusi D. New potentialities of the Liège intranuclear cascade model for reactions induced by nucleons and light charged particles. *Phys Rev C*. 2013;87: 014606.
3. Maria OM, Eliopoulos N, Muanza T. Radiation-induced oral mucositis. *Front Oncol*. 2017;7:89.
4. Nakamura T, Azami Y, Ono T, et al. Preliminary results of proton beam therapy combined with weekly cisplatin intra-arterial infusion via a superficial temporal artery for treatment of maxillary sinus carcinoma. *Jpn J Clin Oncol*. 2016;46:46-50.
5. Takayama K, Nakamura T, Takada A, et al. Treatment results of alternating chemoradiotherapy followed by proton beam therapy boost combined with intra-arterial infusion chemotherapy for stage III-IVB tongue cancer. *J Cancer Res Clin Oncol*. 2016;142:659-667.