Can the placement of dental implants in head and neck cancer patients be done before radiation therapy?

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A doctoral thesis at the University of Oslo's Faculty of Dentistry points to the possibility of reconsidering standard treatment routines, aiming to improve the quality of life for people who survive head and neck cancer.

Globally, head and neck cancer accounts for 5% of all cancer types, with a mortality rate of 50%. However, in the Nordic countries, head and neck cancer accounts for only 2.6% of all cancers, with a mortality rate of just 30%.

But more survivors mean that many must live with extensive damage and side effects after cancer and cancer treatment.

"It is the exposed and vulnerable location that makes head and neck cancer one of the most mutilating types of cancer," explains Lisa Printzell.

She works as a specialist in oral prosthetics at the ear, nose, and throat department at Rikshospitalet. Recently, she completed a doctorate at the University of Oslo, where she investigated an alternative rehabilitation pathway for head and neck cancer patients.

Patients often have teeth removed in connection with cancer treatment

"Damage from surgery and radiation therapy can make it difficult for patients to chew, swallow, and speak afterward," says Printzell. In some, their appearance changes significantly, which they may find incompatible with a normal or dignified life.

Printzell also explains that before patients can receive radiation therapy

for head and neck cancer, a number of teeth often need to be removed to prevent infections.

"For most patients, this news comes as a great shock. Some find the news of having to pull teeth almost as brutal as the diagnosis of serious cancer," says the researcher.

Rehabilitation after head and neck cancer is demanding

"Anatomical changes after cancer surgery can create significant functional and aesthetic challenges. However, the side effects of radiation therapy are perhaps what make oral rehabilitation most demanding," Printzell explains.

Patients often have thin, dry, and very fragile oral mucosa after radiation therapy, making it difficult to use ordinary dental prostheses that rest on toothless jaws.

"To achieve satisfactory oral rehabilitation in these patients, dental implants are often used to support and attach prostheses or other dental replacements," Printzell explains. Dental implants are titanium screws that are surgically inserted and integrated into the patient's jawbone. These so-called osseointegrated implants then serve as an attachment for various types of dental replacements.

A major challenge in this context is that irradiated tissue has a reduced ability to heal, leading to reduced and uncertain integration (osseointegration) of dental implants.

"The survival of dental implants placed in irradiated jawbones is significantly lower than those placed in non-irradiated patients," says

Printzell.

She notes that any surgical procedure in previously irradiated jawbone carries an increased risk of infection. Besides the lack of healing ability, it can, in the worst case, result in osteoradionecrosis, where the jawbone dies as a result of the radiation treatment.

Long waiting time

Due to the risks involved, rehabilitation with dental implants for these patients is not considered until at least one year after the completion of radiation therapy. Patients experience this as a long waiting period with significantly reduced quality of life.

"Therefore, we need research on alternative methods. At the very least, methods that can provide a faster oral rehabilitation for the group of these patients who need it the most," explains Printzell.

One possibility for this is to install the implants before radiation therapy starts, in connection with cancer surgery or tooth extraction.

Radiation could reflect onto healthy cells

Printzell explains that so-called primary installation of implants is not unknown. Studies have shown an increased use of this approach in the past decade, always justified by the increased quality of life for patients.

However, despite the undeniable benefits of faster oral rehabilitation, clinicians remain somewhat hesitant and skeptical of this approach.

One reason for this is the concern about the "backscatter effect," which occurs when radiation hits the implants.

"When ionizing radiation is directed at a cancerous tumor and there is a titanium implant in the radiation field, not all the radiation will penetrate the metal. Instead, it will reflect back to the surrounding tissue," Printzell explains. Healthy cells on the implant's surface will then receive a higher radiation dose and may suffer more damage than they would if there were no implant present.

"There is a concern that this will negatively affect the ongoing osseointegration (healing) of the implant, and thereby also the survival of the implant," says Printzell.

Printzell notes that very little is known about how harmful this backscatter effect really is. Therefore, she and her colleagues wanted to investigate this further.

They assessed the effect of backscatter radiation from titanium on two of the most important cell types for bone healing and osseointegration of dental implants. These cell types are called human mesenchymal stem cells and osteoblasts.

Human mesenchymal stem cells have the potential to develop into many different cell types, including osteoblasts, which are the precursors to mature bone cells.

Printzell adds, "In our experiments, these cells were seeded on two different titanium surfaces, as well as a plastic surface. The cells were then exposed to various doses of ionizing gamma radiation, relevant to what is used in cancer treatment. The titanium surfaces generated backscatter radiation to the cells, while the plastic surface represented 'jawbone without an implant present.'"

Small doses over time

In cancer treatment, radiation doses are measured in gray (Gy). Gray is the international unit for measuring absorbed radiation dose. Patients typically receive radiation therapy in small doses (often 2 Gy) 5 days a week until the total dose (50–70 Gy) is achieved after 5–7 weeks.

The purpose of administering many small doses over time is to give healthy cells in the radiation field time to repair minor DNA damage between doses.

"We found that backscatter radiation from titanium generated as much as a 40% increased radiation dose to the cells closest to the titanium surface. However, the lowest doses (2 and 6 Gy) caused minimal effect on the cells," says Printzell.

Higher radiation dose (10 Gy) significantly reduced the number of osteoblasts (bone-producing cells) on titanium surfaces compared to plastic surfaces but increased the surviving cells' ability to develop into mature bone cells.

"We also found that the highest dose of 10 Gy inhibited both cell types' ability to move from one place to another on titanium, while lower doses (2 and 6 Gy) neither caused significant DNA damage nor affected the cells' ability to move.

"The results indicate that backscatter radiation from titanium at doses of 2 Gy does not cause greater cell damage than the same dose does without an implant present," says Printzell.

She says more research is, of course, needed to establish this treatment as the first choice for this patient group.

"Nevertheless, we can conclude that our findings are important for the question of whether backscatter radiation from titanium implants should

be a reason to avoid the so-called primary installation of implants in patients who are to undergo radiation therapy."

Printzell explains that when they started this study, they knew there is an increased risk of placing implants in previously irradiated jawbone. What they did not know was whether it involves greater, lower, or the same risk to insert implants in these patients just before they undergo radiation therapy.

"What we did know, and still know today, is that implant-supported dental replacements significantly increase the quality of life for head and neck cancer patients, and the earlier the patient can be rehabilitated in this way, the shorter the road back to a somewhat normal life," says Printzell.

More information: Doctoral thesis: The impact of radiation backscatter on cells involved in the osseointegration of titanium dental implants.

Provided by University of Oslo