ABSTRACT

When applying superficial hyperthermia (sHT) prior to radiotherapy (RT) the time interval can be reduced to less than 5 min between the two treatments. In order to maintain the elevated temperature after sHT during the transfer to the linac, preheated blankets (PB) and preheated Bolus (PBo) can be applied. A novel very adaptable bolus is presented in this study: preheated bullshit bolus (PBBo) allows a better adaption to surface. Even curved, convex or concave regions can be flawlessly covered. PBBo provides with its cellulose fibers a rather rigid structure to keep inserted temperature probes to control hyperthermia. Therefore we recommend this novel technique specifically in challenging regions e.g. head & neck. A “quasi-simultaneous” HT-RT application should lead to improved local tumor control. This is provided by this very adaptable PBBo, which keeps heat during transfer from superficial hyperthermia to the linac room.

Summary

The importance of time interval between hyperthermia (HT) and radiation (RT) is still discussed controversial, there are data of near simultaneous application could be beneficial. However this approach is not always clinically realizable. When applying superficial hyperthermia (sHT) prior to RT, the time interval can be managed better and distinctly less than 5 min between the two treatments are feasible. In order to maintain the elevated temperature after sHT during the transfer to the radiation machine (linac), preheated blankets (PB) and/or preheated Bolus (PBo) can be applied. A novel very adaptable bolus is presented in this study: preheated bullshit bolus (PBBo) allows a better adaption to surface. Even curved, convex or concave regions can be flawlessly covered. PBBo provides with its cellulose fibers a rather rigid structure to keep on place inserted temperature probes to control hyperthermia. Comparative analysis showed clear benefits of this technique. Unpleasant odor can be managed with sterilizing the novel material and by adding some dominant natural perfumes. Therefore we recommend this novel technique specifically in challenging regions e.g. head & neck. A “quasi-simultaneous” HT-RT application should lead to improved local tumor control. This is provided by this very adaptable PBBo, which keeps heat during transfer from superficial hyperthermia to the linac room.

Introduction

Hyperthermia (HT) combined with radiotherapy (RT) has shown its best efficacy when applied simultaneously, according to published results derived from laboratory tests dating from the early 80’s (1). In clinical application the importance of timing is less evident due to several technical difficulties:

1. Micro- or radiowaves producing heat could interfere with the electronic steering and control of the linear accelerators (Linac) during simultaneous application in the treatment

2. Hyperthermia is given for 45 – 60 min, in addition there is a need of
preparation time and setting the patient, which could block the room for more than 1½ to 2 h.

3. Lack of space must be expected, if a hyperthermia device is installed in addition into the radiation treatment room.

Therefore one has to separate spatially these two treatment modalities causing a certain time interval. Clinical data are discussed controversially (2). Some data are more in favor of rather short time intervals (3, 4), others recommend even time intervals of more than 1 h up to to 3 h (5,6). In the case deep locoregional hyperthermia (dHT) the time interval between HT and RT can hardly be reduced further down to less than 15 – 30 min (2). When applying superficial hyperthermia (sHT) prior to RT, the time interval can be managed differently better and distinctly less than 5 min between the two treatments are feasible (4). In order to maintain the elevated temperature after sHT during the transfer to the linac, preheated blankets (PB) and preheated Bolus (PBo) should be applied (7). Up to now bolus mainly consist of gelatinous silicone or rubber like material, which provides a certain flexibility but still has a limited adaptation to patient anatomy. There is a clear need of a better adaptability.

Methods

Our research lead us to search for natural products in order to avoid costs and expenses. Among different natural products bullshit became a clear favorite due to its easy way of production, collection and usefulness. After sterilization it can be kept dry or maintained wet for direct clinical application. In comparison to conventional bolus material clinical relevant test and measurements were made to get more accurate information of this material. Fig. 1 shows possible clinical application.

Results

Main characteristics are summarized in Tabl. 1. In comparison to conventional PBo (preheated gelatinous material) PBBo turned out to be much better in terms of adaption to convex or concave regions, flawlessly it covers all treated structures. Inserted sensors to control surface temperature were not displaced during transportation.

**Figure 1:** preheated adaptive bolus to maintain elevated surface temperatures after superficial hyperthermia during transfer to the RT-treatment room

**Table 1:** Comparison of gelatinous bolus material (PBo) and novel bullshit material (PBBo) in different clinical situations

<table>
<thead>
<tr>
<th>Bolus-type</th>
<th>Adaptability (convex and concave regions)</th>
<th>Preheating (45°C)</th>
<th>Sensor positioning</th>
<th>Cleaning and reuse</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBo: (gelatinous bolus)</td>
<td>incomplete</td>
<td>temperature constant</td>
<td>displacements occurred</td>
<td>easy*</td>
<td>Usefulness for flat surfaces, reuse recommended</td>
</tr>
<tr>
<td>PBBo (bullshit bolus)</td>
<td>complete</td>
<td>temperature constant</td>
<td>no displacements observed</td>
<td>not possible</td>
<td>very adaptive for convex and concave regions, one way use</td>
</tr>
</tbody>
</table>

*: procedure of cleaning/sterilizing following product information
to the treatment room. This can be explained by its natural consistency and fibrous (cellular) material. Both material could keep temperature equally good. Reuse of “conventional” PBo is possible and even recommended, whereas PBBo is of one way use. In contrast production of PBBo is easy, although in urban regions not always available. There is no waste, because it is completely natural and there are no ecological damages to be expected as well.

Discussion

When hyperthermia is applied prior to radiation a covering material is needed to maintain elevated temperature on the surface. It is important to separate this bolus material from the use of water bolus in microwave superficial hyperthermia. The latter needs a water bolus system with circulating water to cool down the surface during HT-application, in addition a better coupling of the microwave antenna and the patient is achieved (8). Our bolus system is defined to maintain temperature during the transfer of the patient form the hyperthermia unit to the linac. The bolus can then also be used for electron application to cover completely the heated surface. Otherwise the build-up effect of electrons would protect the first layers of the skin depending of the electron beam energy. This technique is common in electron application (9). When hyperthermia is applied prior to radiation the described PBBo is ideal to maintain elevated temperature on the surface. Careful research led us to evaluate PBBo for clinical use. In addition its easy availability and handling is rather convincing too. Physical parameters are even in favor for this application. PBBo provides the requirements formulated by the QA group of ESHO for technical and clinical application (10,11).

Conclusions

A novel very adaptable bolus is presented in this study: PBBo allows a better adaption to surface. Even curved, convex or concave regions can be flawlessly covered. PBBo provides with its cellulose fibers a rather rigid structure to keep inserted temperature probes to control hyperthermia. In addition multivariate analysis showed significant benefits of PPBo’s in comparison to PBo’s or PB’s. Unpleasant odor can be managed with sterilizing the novel material and by adding some dominant natural perfumes. One way use is not a problem due to the natural source and no ecological damage has to be expected. Therefore we recommend this novel technique specifically in challenging regions e.g. head & neck. Transportation from the HT-treatment room to RT-treatment room is possible without important heat loss or displacement of sensors.

References