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Treatment planning for the second stereotactic radiosurgery utilizing the previous target reconstructed by image fusion

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Purpose: The intracranial recurrence of brain metastases often manifests in patients treated with stereotactic radiosurgery (SRS) alone. Although such patients would be retreated with SRS for their new lesions, the precise dose distributions of prior irradiation have been difficult to take into account, and often ignored, in the reirradiation planning. We present a methodology for fusing the volumetric images of the previous and current targets into a 3D image, by which the accumulated doses to the normal structures during repeated SRS can be minimized.

Materials and Methods: From October 1997 through February 1999, 13 lesions of recurrent metastatic brain tumors were retreated with SRS. Treatment planning was conducted with the X-Knife 3-D planning system (Radionics) in the following manner: (1) The previous MR and current CT (with stereotactic frame) images were fused; (2) the current MR and current CT images were fused; (3) the bone data were contoured from the current CT images and the internal brain structures were acquired from the current fused images; (4) the previous and current targets were contoured in the respective fused images; (5) the previous targets were transferred into the current fused images; and finally (6) optimum beams were selected by Beam's-eye-View method not to overlap with the previous beams.

Results: By fusing the previous and current targets in a 3D image, it has become feasible to carry out safe treatment planning for the second SRS. For all the 13 lesions, volume doses between the current and the previous targets were 10–15% either of the current or the previous prescribed dose. The number of beams and total arc degrees selected for each new target were 3 to 7 (median 5) and 220–440 degrees (median 305 degrees), respectively. Only an extra 15 minutes was needed for this method.

Conclusion: Accurate reproduction of the previous dose distribution in the current 3D image could facilitate a safe and effective reiiradiation. We hope that this method will be widely used for the SRS retreatment planning.

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'Recumbent position' and Stanford methods of total skin electron irradiation in the treatment of mycosis fungoides: Comparison of long-term side effects

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Purpose: The long-term side effects of a recumbent position for Total Skin Electron Irradiation were compared to those of the Stanford method in the treatment of mycosis fungoides (MF).

Methods: From 1979–97, 69 patients (pts), mean age 66 years (y)(range, 32–84 y), suffering from MF according to the Sanford staging classification: IA-15%; IB-42%; II-26%; III-10%; IV-7%; were treated; 66 pts were available for response. From 1979–92, 45 pts were treated in the recumbent position with 4 MeV electron beams (Philips SL 75/10 Linac), SSD 150 cm; median total dose was 32 Gy (range, 16–44 Gy). Median follow-up was 79 months (m)(range, 4–237 m). From 1992–97, 21 pts were treated by the Stanford method: median total dose was 30 Gy (range, 20–34.5 Gy). Median follow-up was 20 m (range, 4–152 m).

Results: Recumbent position: CR/near CR – 91%. Late cutaneous complications: minimal skin damage – 46%; severe skin damage, including matchline fibrosis and telangiectasis developing within the irradiated volume – 18%. Stanford method: CR/near CR – 89%. Only 2 pts developed severe skin damage.

Conclusion: The Stanford method is preferable because of the fewer late side effects.

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Effectivity of lead blockages of the lung in tangential breast irradiation

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Purpose: Aim of the study is the assessment of dose volume histograms of the lung in breast irradiation with tangential fields to check whether lead blockage is able to reduce the dose delivered to the lung.

Materials and Methods: 3-D planning (TM3 of the firm HELAX) was performed on 110 patients, who underwent radiotherapy with tangential photon beams delivering 56 Gy to the entire breast. All treatment plans were calculated with and without lead blockage of the lung. Both lung doses were analyzed using the dose volume histograms of the radiation plans.

Results: A reduction of the dose delivered to the lung during radiation of the breast was found in 61%. In 38% the usage of a lead blockage wasn't possible. The average dose difference with and without blockage was about 1.37%, which means 0.77 cGy. Even this small dose reduction is only available for 30% of the irradiated lung.

Conclusion: Using lead blockage of the lung reduces the average dose during radiation. Looking at the small volume of the radiated lung affected by this little dose reduction, the usage of this technique seems not to be considerable especially regarding the average risk dose causing lung toxicity.

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Virtual two dimensional (2D) step wedge for film dosimetry calibration for megavoltage photon beams

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Purpose: Photographic film can be used for dose integrating measurements of 2D megavoltage photon beam distributions. Due to the dependence on the photon energy spectrum and film development condition, an optical density to dose conversion curve should be calibrated for the beam, depth and field size when each time films are used. Conventionally, a conversion curve is obtained by exposing several films to different doses. With the Virtual 2D Step Wedge (VSW) proposed in this paper, a conversion curve can be obtained by one film.

Methods: A VSW is formed by asymmetric collimator settings. For a 4 × 4 VSW, a film is exposed 4 times with a different X2 each time then 3 times with a different Y1 each time. These 7 exposures result in 16 subfields with escalated doses. VSW of 2 × 2 or 3 × 3 can be formed by exposing a film 3, or 5 times in a similar way. 3 × 3 and 4 × 4 VSW are suitable for large field sizes, and 2 × 2 VSW is for small field sizes. The dose and film density profiles were measured with RFA300 scanning system to obtain a conversion curve.

Results: VSW was studied for Kodak XV-2 ready-pack film and a 6MV-photon beam. It took 2.5 minutes to move collimators and expose a film 7 times for a 4 × 4 VSW. To minimize the off-axis effect of 3 × 3 or 4 × 4 VSW, the central subfields should be smaller than the peripheral ones. Good coincidence is observed between the conversion curves obtained by VSW with one film and those by the conventional approach with several films.

Conclusion: The proposed VSW offers an efficient method for film calibration and makes it feasible to calibrate film at several depths with one film/phantom setting-up.

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NSCLC: Dose escalation by target splitting with asymmetric collimation

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Purpose: To reduce the radiation doses to normal tissues and to increase the target dose.

Methods and Materials: The target volume is split into a cranial and a caudal part. Both volumes are planned and treated completely independent, using half-collimated fields to prevent over- or underdosage in the junction plane. For comparison with conventional techniques, planning to identical doses is performed for 5 different clinical situations. Dose-volume-histograms (DHVs) for normal lung tissue are presented for both methods.

Results: The irradiated volume of normal tissue of the ipsilateral lung can be lowered at dose levels ≥65 Gy, ≥45 Gy and ≥20 Gy to values of 37% (range 25%–54%), 49% (range 46%–54%) and 86% (range 55%–117%), respectively. Other organs at risk like heart or esophagus can also be spared significantly.

From December 1995 to October 1998, the technique of target splitting has been applied to >70 patients. In this period, 35 patients have been treated with doses > 80 Gy (ICRU-specification, mean 85.1 Gy, range 80.1–90.2 Gy).