

# Evidence of Interlinks between Bioelectromagnetics and Biomechanics: from Biophysics to Medical Physics

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## Abstract

A vast literature on electromagnetic and mechanical bioeffects at the bone and soft tissue level, as well as at the cellular level (osteoblasts, osteoclasts, keratinocytes, fibroblasts, chondrocytes, nerve cells, endothelial and muscle cells) has been reviewed and analysed in order to show the evident connections between both types of physical energies. Moreover, an intimate link between the two is suggested by transduction phenomena (electromagnetic-acoustic transduction and its reverse) occurring in living matter, as a sound biophysical literature has demonstrated.

However, electromagnetic and mechanical signals are not always interchangeable, depending on their respective intensity. Calculations are reported in order to show in which cases (read: for which values of electric field in V/m and of mechanical pressure in Pa) a given electromagnetic or mechanical bioeffect is only due to the directly impinging energy or even to the indirect transductional energy.

The relevance of the treated item for the applications of medical physics to regenerative medicine is stressed.

KEYWORDS : Bioelectromagnetics, biomechanics, mechanobiology, energy transduction, tissue regenerative effects, piezoelectric effect, electrokinetic effect.

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# An Investigation of Dose Calculation Accuracy in Intensity-Modulated Radiotherapy of Sites in the Head & Neck

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## Abstract

Knowledge of the accuracy of dose calculations in intensity-modulated radiotherapy of the head and neck is essential for clinical confidence in these highly conformal treatments. High dose gradients are frequently placed very close to critical structures, such as the spinal cord, and good coverage of complex shaped nodal target volumes is important for long term-local control.

A phantom study is presented comparing the performance of standard clinical pencil-beam and collapsed-cone dose algorithms to Monte Carlo calculation and three-dimensional gel dosimetry measurement. Calculations and measurements are individually normalized to the median dose in the primary planning target volume, making this a purely relative study. The phantom simulates tissue, air and bone for a typical neck section and is treated using an inverse-planned 5-field IMRT treatment, similar in character to clinically used class solutions.

Results indicate that the pencil-beam algorithm fails to correctly model the relative dose distribution surrounding the air cavity, leading to an overestimate of the target coverage. The collapsed-cone and Monte Carlo results are very similar, indicating that the clinical collapsed-cone algorithm is perfectly sufficient for routine clinical use. The gel measurement shows generally good agreement with the collapsed-cone and Monte Carlo calculated dose, particularly in the spinal cord dose and nodal target coverage, thus giving greater confidence in the use of this class solution.

KEYWORDS : IMRT dose calculation accuracy, gel dosimetry, Monte Carlo.

# Use of GAFCHROMIC XR Type R Films for Skin-Dose Measurements in Interventional Radiology: Validation of a Dosimetric Procedure on a Sample of Patients Undergone Interventional Cardiology

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## Abstract

The Gafchromic XR type R film is a suitable dosimeter to determine the map of the skin dose in patients undergone complex interventional radiological procedures, such as cardiology ones. The need of preventing or locating possible skin injuries due to high doses administered to patients – as recommended by international organizations – wants the introduction in patient dosimetry of a dosimeter easy to handle, with low dependence of the response on energy in the typical radiological range, and extended measurable dose range. XR type R films fulfil all these requirements and moreover may be quickly analyzed by cheap commercial scanners. In order to determine skin-dose values by XR-R, a film calibration curve is required.

In this work, a validation of the XR-R dosimetry has been performed for the determination of the skin dose: maximum skin-dose values in 14 patients undergone radiofrequency ablation and pacemaker implant procedures have been determined by XR-R calibrated films. A comparison between skin-dose values determined by XR-R films and retrospective ionometric measurements has pointed out some discrepancies in the results, due to difficulties in retrospectively reproducing the real procedure settings, where XR-R film dosimetry is related to the specific patient procedure, even in very complex interventional settings.

KEYWORDS : Gafchromic film, dosimetry, skin injuries.