Evaluation of ion chamber dependent correction factors for ionisation chamber dosimetry in proton beams using a Monte Carlo method

H. Palmans and F. Verhaegen
Standard Dosimetry Laboratory, Department of Biomedical Physics
University of Gent, BELGIUM

In the last decade several clinical proton beam therapy facilities have been established. To satisfy the demand for uniformity in clinical (routine) proton beam dosimetry two dosimetry protocols (ECHED and AAPM) have been published. Both protocols neglect the influence of ion chamber dependent parameters on dose determination in proton beams because of the scatter properties of these beams, although the problem has not been studied thoroughly yet. A comparison between water calorimetry and ionisation chamber dosimetry showed a discrepancy of 2.6 % between the former method and ionometry following the ECHED protocol. Possibly, a small part of this difference can be attributed to chamber dependent correction factors. Indications for this possibility are found in ionometry measurements. To allow the simulation of complex geometries with different media necessary for the study of those corrections, an existing proton Monte Carlo code (PTRAN, Berger) has been modified. The original code, that applies Mollière's multiple scattering theory and Vavilov's energy straggling theory, calculates depth dose profiles, energy distributions and radial distributions for pencil beams in water. Comparisons with measurements and calculations reported in the literature are done to test the program's accuracy. Preliminary results of the influence of chamber design and chamber materials on dose to water determination will be presented.

Human calf muscular metabolism study with a home-made ergometer using ^{31}P NMR spectroscopy

J.Peynsaert[1], E.Achten[1], E.Claeys[1], M.Rousseaux[2]
[1] MR Department, Gent University Hospital, Belgium
[2] Department of Sport Medicine, Gent University Hospital, Belgium

I. Introduction and Purpose

^{31}P NMR measurements were performed to examine the variations in the concentration of phosphate metabolites in calf muscle during exercise. Therefore, volunteers, installed in the supine position, were asked to push repetitively on the pedal of a home-made ergometer. The produced work and the changes in phosphorus containing metabolites were measured continuously. Correlations were made between the inorganic phosphate/phosphocreatine ratio and the cumulative work and between the intracellular pH and the cumulative work. The exercise protocol could be changed interactively with respect to the imposed initial pressure, the maximum pressure, the pressure increase per level and the time a certain level was held. The whole experiment could be graphically followed on-line.

II. Concept ergometer

The whole device globally consists of a pedal, a pressurized air cylinder, air tubings, a table and data collecting equipment, allowing the patient to perform a force in the supine position by pushing the pedal with his foot using his calf muscles. The movements are carried out at a regular frequency conform the rhythm of sound signals produced by a metronome. The pedal has a rotation axis situated at the calcaneus level. By applying a force onto the pedal, the feedback pressure ($P_{feedback}$) builds up in the air cylinder while the upper pressure (P_{upper}) diminishes. On each moment, P_{upper} and $P_{feedback}$ are measured by the pressure sensors and continuously sent together with the signal from the displacement sensor to an acquisition system DT2812 (Data Translation™) via a junction box after amplification. This system communicates with an interactive input-output program written in a graphical icon-based language (DTVEE, HP™). Using the mechanical data (the upper pressure, the feedback pressure and the displacement), the work, the cumulative work and effective power developed during each bending movement were calculated repetitively and written to a spreadsheet file at the end of the exercise. It was possible to follow the course of the exercise by visualizing the displacement on-line.

III. Results and Discussion

In the first stadium, the in vitro reproducibility of the ergometer was tested for different protocols. These tests revealed that, though the deviation in produced work was markedly the highest at high working pressures, the relative error never exceeded 3%. Consequently, the ex vitro reproducibility of the data was examined with the equipment placed in the scanner. Generally, same conclusions could be derived. In a next stage, the work will be synchronized with the biomechanical data. Extreme precautions will be taken to examine each volunteer every time under the same physical and psychological conditions.