Aim of this study was to evaluate the relative biological effectiveness (RBE) of carbon (12C) and oxygen ion (16O)-irradiation applied in the raster-scanning technique at the Heidelberg Ion beam Therapy center (HIT) based on clonogenic survival in hepatocellular carcinoma cell lines compared to photon irradiation. Four human HCC lines Hep3B, PLC, HepG2 and HUH7 were irradiated with photons, 12C and 16O using a customized experimental setting at HIT for in-vitro trials. Cells were irradiated with increasing physical photon single doses of 0, 2, 4 and 6 Gy and heavy ion-single doses of 0, 0.125, 0.5, 1, 2, 3 Gy (12C and 16O). SOBP-penetration depth and extension was 35 mm +/-4 mm and 36 mm +/-5 mm for carbon ions and oxygen ions respectively. Mean energy level and mean linear energy transfer (LET) were 130 MeV/u and 112 keV/um for 12C, and 154 MeV/u and 146 keV/um for 16O. Clonogenic survival was computed and relative biological effectiveness (RBE) values were defined. For all cell lines and both particle modalities ¿- and ¿-values were determined. As expected, ¿-values were significantly higher for 12C and 16O than for photons, reflecting a steeper decline of the initial slope of the survival curves for high-LET beams. RBE-values were in
the range of 2.1-3.3 and 1.9-3.1 for 12C and 16O, respectively. Both irradiation with 12C and 16O using the raster-scanning technique leads to an enhanced RBE in HCC cell lines. No relevant differences between achieved RBE-values for 12C and 16O were found. Results of this work will further influence biological-adapted treatment planning for HCC patients that will undergo particle therapy with 12C or 16O.