Tumor volume and tumor hypoxia in head and neck cancers. The amount of the hypoxic volume is important.

BACKGROUND: The prognostic impact of tumor volume and hypoxia is well established. We have investigated a possible prognostic impact of the hypoxic tumor volume which can be calculated as the product of tumor volume and hypoxia.

PATIENTS AND METHODS: 125 patients with squamous cell cancer of the head and neck were investigated. All had locoregionally confined disease. The total tumor volume was calculated from pretreatment CT scans as the sum of all visible macroscopic tumor lesions (e.g., primary tumor plus neck nodes), and all patients underwent measurement of tumor oxygenation by pO2 histography. The hypoxic tumor volume was calculated as the product of the total tumor volume and the relative frequency of pO2 readings < 5 mmHg. The nonhypoxic volume was the difference between total tumor volume and hypoxic volume. RESULTS: The total tumor volume ranged from 2 to 283 cm³ (mean 47 +/- 53 cm³), the hypoxic volume from 0 to 199 cm³ (mean 18 +/- 30 cm³), and the nonhypoxic volume from 1 to 237 cm³ (mean 29 +/- 34 cm³), and there was a strong correlation between the three parameters. 84 patients died and 41 survived in the observation period with a median survival of 12.5 months.

Tumor volume and tumor oxygenation had a significant impact on survival. The tumor volume was significantly different in patients who had died as compared to surviving patients (mean...
54 vs. 34 cm³; p = 0.017). The hypoxic volume was also different (11 vs. 22 cm³; p = 0.009), whereas the nonhypoxic volume was not significantly different (24 vs. 32 cm³; p = 0.2). If the impact of large versus small tumor volumes (total volume, hypoxic volume, and nonhypoxic volume, subdivision according to each median) on survival was analyzed, a significant impact of total tumor volume (median survival 298 vs. 485 days; p = 0.03) and a marginal impact of the hypoxic volume (342 vs. 404 days; p = 0.08), but no impact of the nonhypoxic volume were found (383 vs. 374 days; p = 0.6). In a multivariate Cox regression model, the hypoxic tumor volume was a strong and independent prognostic factor for survival (p = 0.001) and more important than the total tumor volume (p = 0.02) whereas the nonhypoxic volume had no impact on prognosis (p = 0.33). CONCLUSIONS: The total tumor volume is a major prognostic factor, but its impact mainly results from the hypoxic volume and can be explained by the strong correlation between total tumor volume and hypoxic volume. The nonhypoxic volume had no impact on survival. As a consequence, methods to measure and localize the hypoxic volume should be further developed.