**Supplemental Figure 1.** Flow chart of patients screened for eligibility. TKI = tyrosine kinase inhibitors.

**Supplemental Figure 2.** Maximum-intensity projection of 124I PET/CTs before and after redifferentiation therapy and post-therapy whole body scintigraphy (131I-WBS) obtained 7 days after 131I therapy of the patients with successful restoration of radioiodine uptake are shown. Corresponding thyroglobulin (Tg) before redifferentiation and within one year of 131I therapy are given. 124I PET/CT is missing in patient 6 for logistical reasons. Patient numbers match with the patient numbers introduced in Figure 2. FU = follow-up within 3-12 months.

**Supplemental Figure 3.** Maximum-intensity projections of 124I-PET (A,B,D,E) before (A,D) and after (B,E) redifferentiation as well as post-131I therapy scintigraphy (C,E) of a BRAF-MUT patient with repeated redifferentiation therapy. The second redifferentiation was performed outside the study 24 months after the first due to residual metastatic disease without interim progression of disease. Overall, thyroglobulin decreased from 74,000 ng/ml to 15,000 ng/ml (80% decline) following repeat radioiodine therapy.