

## Supporting Information for

### **PEGylated Hybrid Ytterbia Nanoparticles as a High-Performance Diagnostic Probe for In Vivo Magnetic Resonance and X-ray Computed Tomography Imaging with Low Systemic Toxicity**

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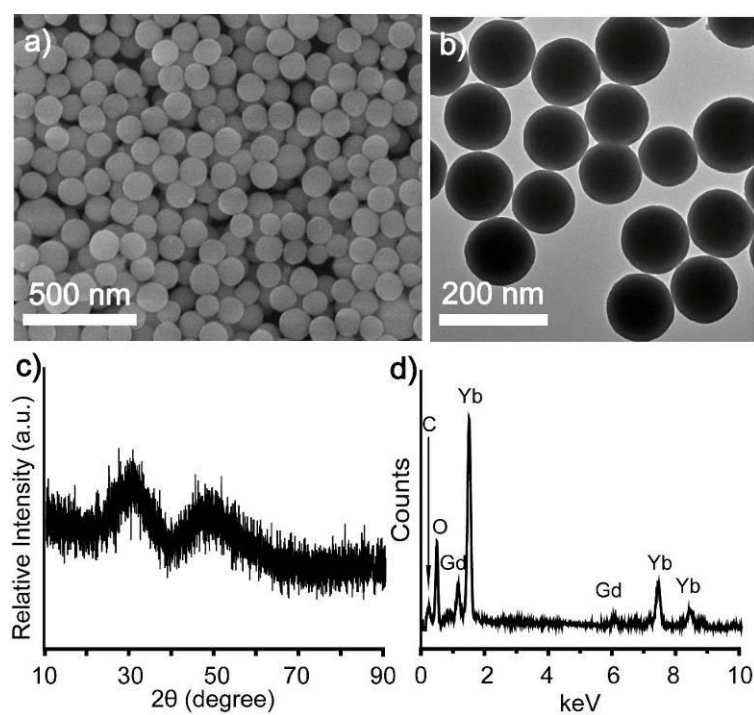
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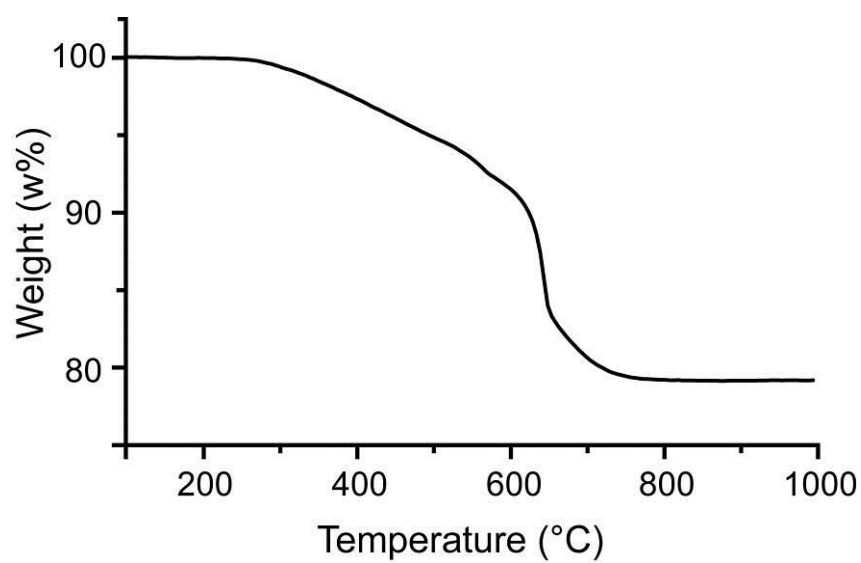
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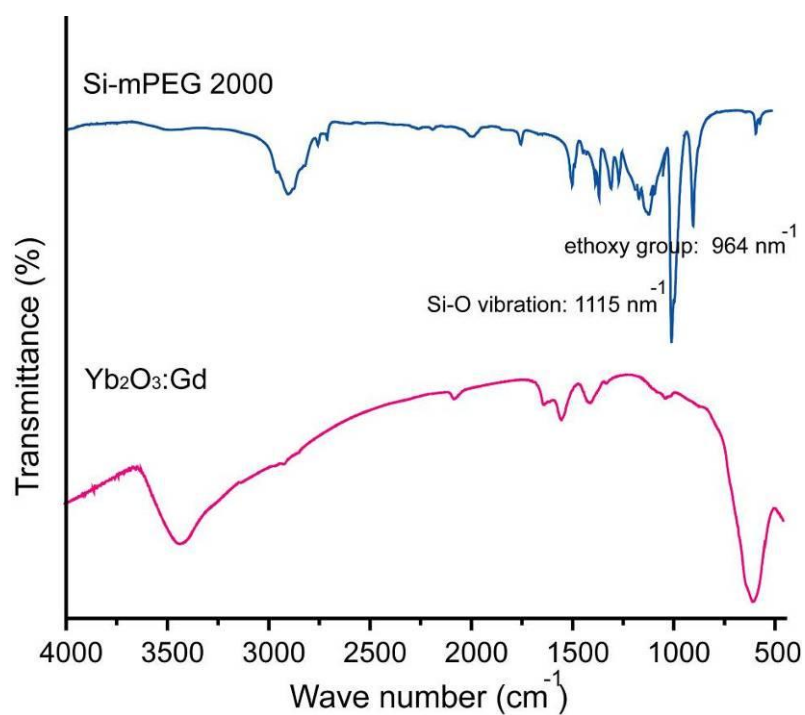
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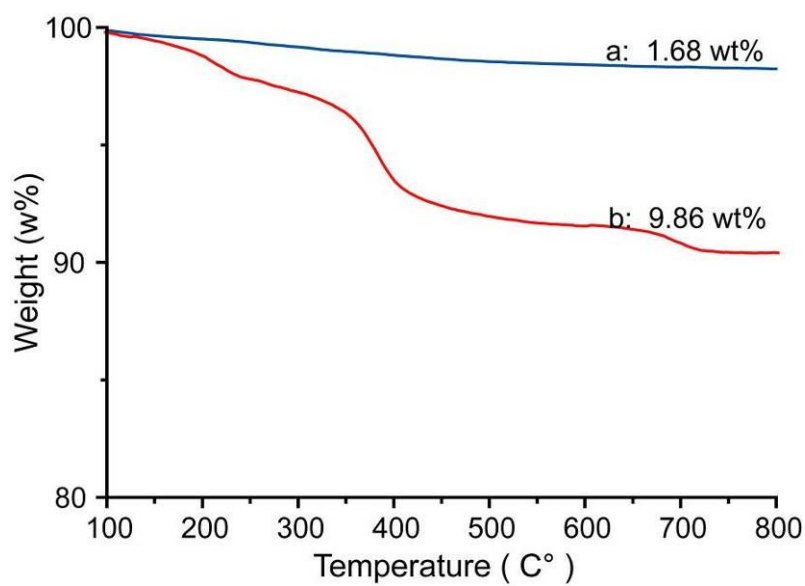
**Figure S1.** SEM image (a), TEM image (b), wide-angle XRD pattern (c), as well as EDS spectrum of the precursor  $\text{Yb(OH)CO}_3\cdot\text{Gd}$  nanoparticles.



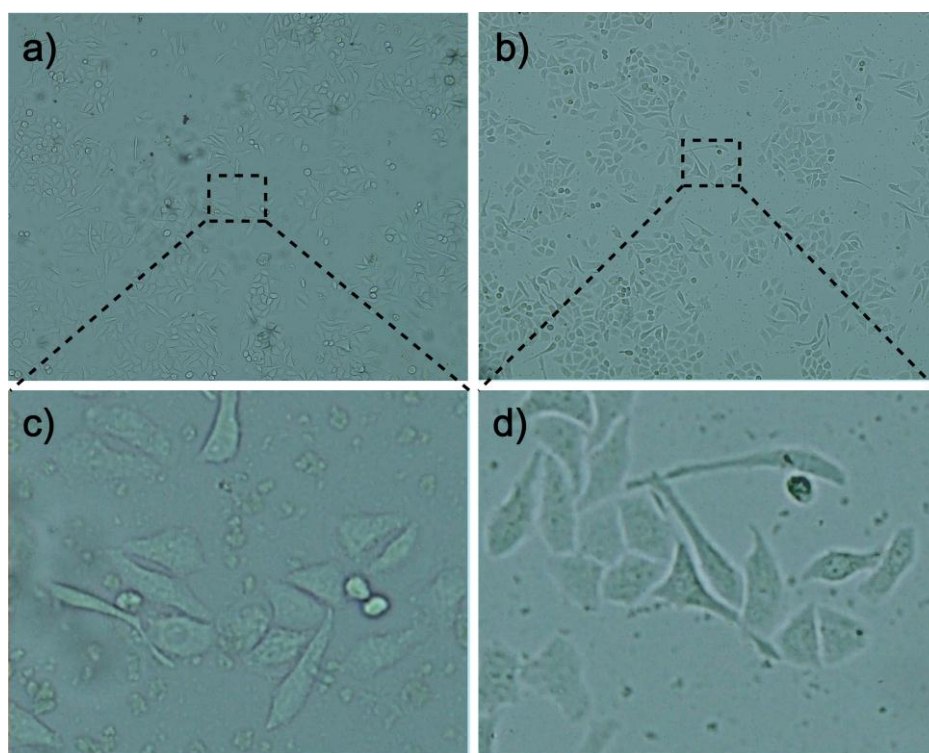
**Figure S2.** Thermogravimetric analysis curve of the precursor Yb(OH)CO<sub>3</sub>:Gd nanoparticles in air.



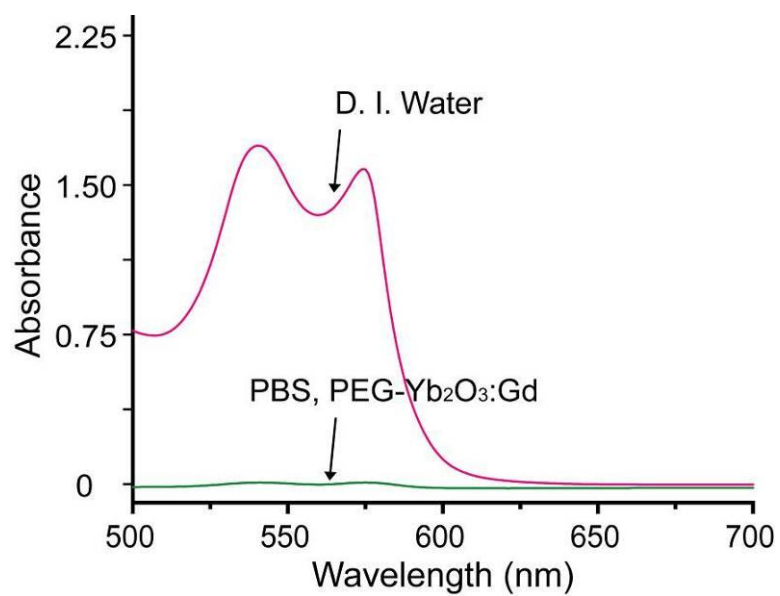
**Figure S3.** FTIR spectra of silanated mPEG and Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles.



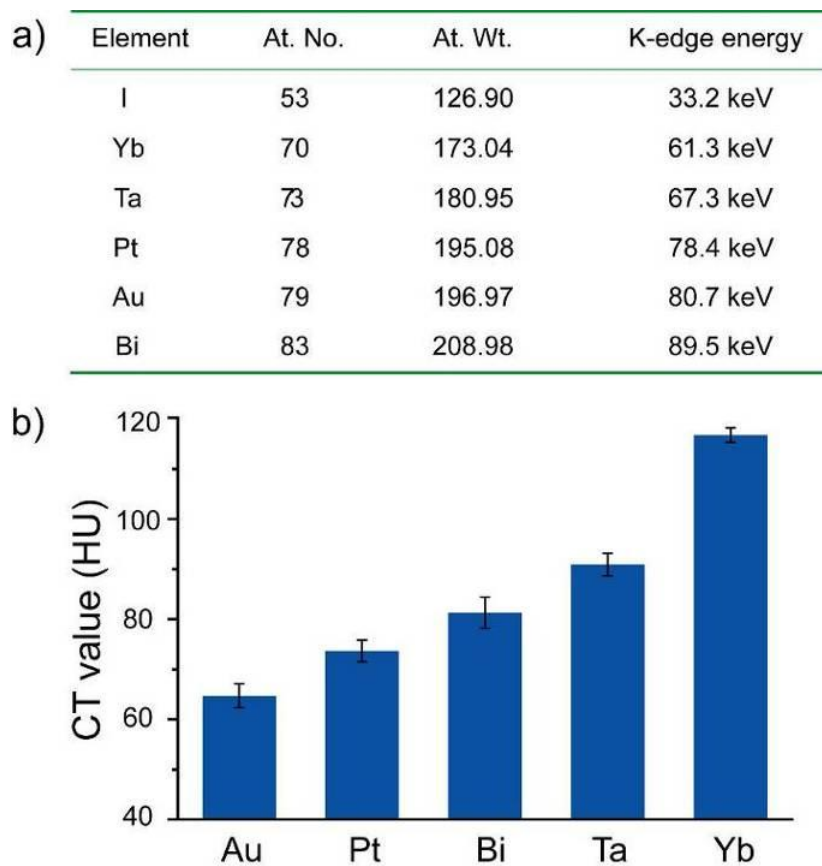
**Figure S4.** Thermogravimetric analysis curves of  $\text{Yb}_2\text{O}_3:\text{Gd}$  nanoparticles (a) and PEG- $\text{Yb}_2\text{O}_3:\text{Gd}$  nanoparticles (b).



**Figure S5.** Microscopic images of HepG2 cells incubated without (a) and with (b) PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles for 48 h. Amplificatory images: without nanoparticles (c) and with nanoparticles (d).

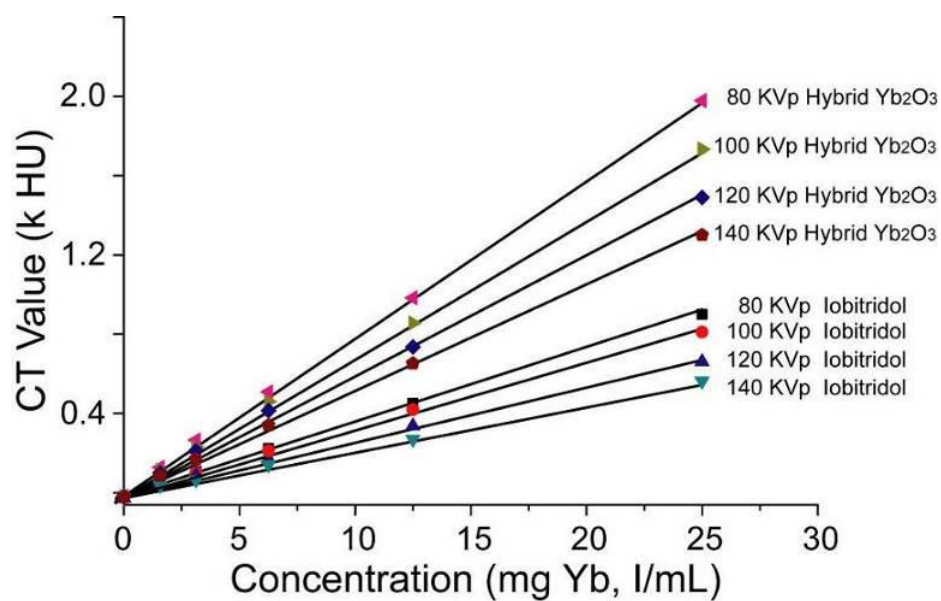


**Figure S6.** UV-vis absorption spectra to detect the presence of hemoglobin in the supernatant of PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles by using D.I. water and PBS as the positive and negative controls, respectively.



**Figure S7.** Physicochemical characterization of various CT-related elements (a), CT values of different metallic salts dispersed in ethanol with metal concentration of  $10 \text{ mg mL}^{-1}$  at clinical 120 KVp voltage (b).

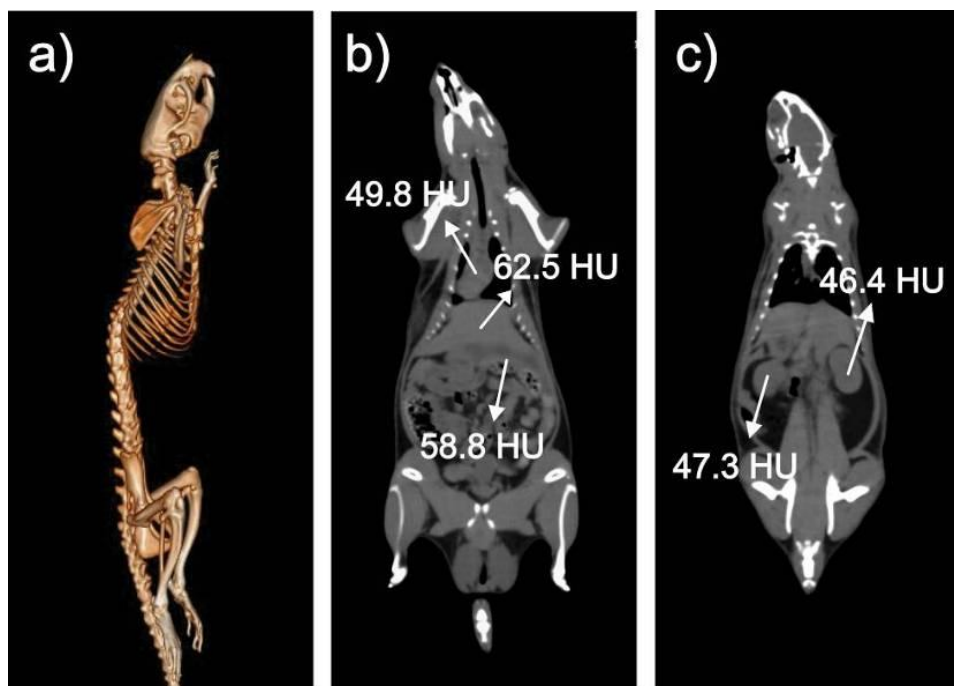




**Figure S8.** CT values of the Iobitridol and PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles with different concentrations determined at various clinical voltages.



**Figure S9.** X-ray image of nude mouse after subcutaneous injection of PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles.



**Figure S10.** In vivo CT 3D-renderings (a) and coronal view images (b, c) of the rat one month after intravenous injection of PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles.

**Table S1.** Exact value of hemolysis percentage upon PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd nanoparticles with different concentrations.

Concentrations ( mg Yb mL <sup>-1</sup> )	Value of hemolysis (%)
PBS	0
water	100
0.078125	-0.023
0.15625	0.016
0.3125	0.088
0.625	-0.102
0.125	0.127
0.25	0.089
0.50	0.142
1.00	0.244

**Table S2.** CT values of the heart, liver, spleen, kidneys, and bladder of a rat before and after intravenous administration of 1 mL of PEG-Yb<sub>2</sub>O<sub>3</sub>:Gd solution (50 mg Yb mL<sup>-1</sup>) at different timed intervals.

Time	Heart	Liver	Spleen	Kidneys	Bladder
Pre-injection	49.3	60.7	57.1	49.3/48.7	50.8
30 min	62.2	95.8	79.5	47.6/49.2	51.9
60 min	57.3	124.3	107.6	49.5/47.8	49.7
90 min	53.7	153.4	128.7	47.2/48.6	50.3
120 min	50.6	176.8	156.9	49.1/48.7	49.8

**Table S3.** CT values of the heart, liver, spleen, kidneys, and bladder of a rat before and after intravenous administration of 0.3 mL of Iobitridol (350 mg I mL<sup>-1</sup>) at different timed intervals.

Time	Heart	Liver	Spleen	Kidneys	Bladder
Pre-injection	51.7	61.4	56.8	47.3/48.6	51
5 min	49.4	62.4	55.9	457.1/459.8	52.4
15 min	50.3	59.8	57	365.7/359.6	642.1
30 min	50.3	61	56.8	269.3/273.1	843.7
60 min	51.1	60.7	55.4	48.8/48.2	521.3

**Table S4.** Pathological inflammatory responses of various viscera 30 d after intravenous administration.

Samples	Grade of Inflammation	Lymphocytes	Macrophages	Neutrophils	Eosinophils
Heart	Low	+-	+-	+-	+-
Liver	Low	+	+	+	+-
Spleen	Low	+	+	+	+-
Lung	Low	+-	+-	+-	+-
Kidney	Low	+-	+-	+-	+-

**Table S5.** Hematology analysis and blood biochemical assay 30 days after intravenous administration.

Test	Unit	Control group (mean $\pm$ sd)	Treatment group (mean $\pm$ sd)
blood cell count (WBC)	$\times 10^9/\text{L}$	$9.1 \pm 2.7$	$9.7 \pm 3.2$
red cell count (RBC)	$\times 10^{12}/\text{L}$	$9.2 \pm 1.3$	$9.4 \pm 1.9$
hemoglobin (HGB)	g/L	$158.7 \pm 34.5$	$168.5 \pm 44.3$
mean corpuscular hemoglobin (MCH)	pg	$17.3 \pm 2.1$	$16.8 \pm 3.1$
mean corpuscular hemoglobin concentration (MCHC)	g/L	$318 \pm 18.3$	$324 \pm 23.6$
alanine aminotransferase (ALT)	U/L	$44.5 \pm 8.5$	$47.3 \pm 9.8$
aspartate aminotransferase (AST)	U/L	$160.4 \pm 32.5$	$175.3 \pm 42.1$
blood urea nitrogen (BUN)	$\times 10^6/\mu\text{L}$	$8.6 \pm 1.9$	$9.1 \pm 2.3$
plasma creatinine (CRE)	$\times 10^3/\mu\text{L}$	$22.8 \pm 3.1$	$29.6 \pm 4.7$