[^{11}C]Choline

[^{11}C]CH

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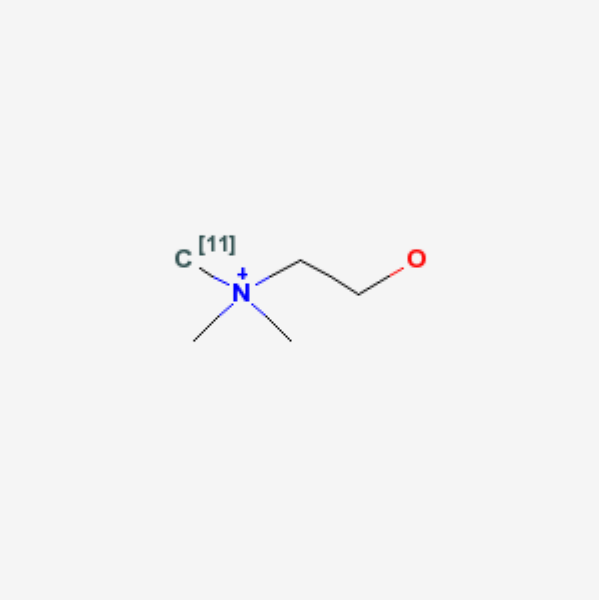
Chemical name:	[^{11}C]Choline
Abbreviated name:	[^{11}C]CH
Synonym:	[^{11}C]Trimethylethanolamine; [^{11}C]trimethyl-2-hydroxyethylammonium
Agent category:	Compound
Target:	Choline kinase
Target category:	Enzyme
Method of detection:	PET
Source of signal:	^{11}C
Activation:	No
Studies:	• *In vitro* • Rodents • Non-primate non-rodent mammals • Non-human primates • Humans



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Background

[PubMed]

Choline is an important component of phospholipids in the cell membranes. Tissues with increased metabolism will lead to an increased uptake of choline. Choline is phosphorylated by choline kinases (CHK) to phosphorylcholine within cells, and, after several biosynthetic processes, finally is integrated into phospholipids (1). Because tumor cells have a high metabolic rate, choline uptake is high in order to keep up with the demands with the synthesis of phospholipids in their cellular membranes (2). Positron emission tomography (PET) with [^{11}C]Choline has been reported to be useful for the detection and differential diagnosis of brain tumors, prostate cancer, lung cancer, and esophageal cancer (3, 4), whereas [^{18}F]2-fluoro-2-deoxyglucose (FDG) lacks of specificity or sensitivity (3).

Related Resource Links:

- Chapters in MICAD
- Gene information in NCBI (Choline kinase).
- Articles in OMIM (Choline kinase)
- Clinical trials ([^{11}C]Choline)

Synthesis

[PubMed]

[^{11}C]Methylcholine was produced by reacting [^{11}C]methyliodide with 2-dimethylaminoethanol. Purified [^{11}C]choline was produced with a measured specific activity of 11.1 GBq/μmol (>300 mCi/μmol) and a radiochemical purity >98% at 35 min after bombardment. The radiochemical yield for the synthesis and purification was approximately 22% (5). A new method of [^{11}C]choline synthesis was achieved by the reaction of [^{11}C]methyl iodide with dimethylaminoethanol at 120 °C for 5 min. Purification was performed by evaporation of the reactants, followed by passage of the aqueous solution of the product through a cation-exchange resin cartridge. The total time required for obtaining the finished chemical was 25 min. Radiochemical yield was > 98% with radiochemical purity of > 98%. Chemical purity was > 90% (6). An automated synthesis of [^{11}C]choline with a radiochemical yield of about 42% was reported (7).

In Vitro Studies: Testing in Cells and Tissues

[PubMed]

Because of the short half-life (20 min) of ^{11}C, [^{14}C]choline and [^{3}H]choline were often used in *in vitro* studies. Both [^{14}C] and [^{3}H]choline were rapidly incorporated into phospholipids into PC-3 human prostate cancer cell line (1) and human astrocytoma cell line (8)

Animal Studies

Rodents

[PubMed]

A biodistribution of [^{11}C]choline was determined at 45 min post intravenous injection in nude mice transplanted with MCF-7 human breast cancer cell line or MDA-MB-435 human breast carcinoma. The results showed that the uptake of [^{11}C]choline in these tumors was high, 2.0% dose/g in MCF-7 implanted mice and 1.8% dose/g in MDA-MB-435 implanted mice. The tumor/muscle ratios are moderate and the tumor/blood ratios are high. The major organs of [^{11}C]Choline uptake were the kidneys, liver, small intestine, heart, and spleen. The micro-PET imaging of [^{11}C]choline in both nude mice showed a clear uptake of [^{11}C]choline in the transplanted breast tumors (9).

Other Non-Primate Mammals

[PubMed]

[^{11}C]Choline PET was studied in normal rabbits. [^{11}C]Choline was taken up from blood by various tissues very rapidly, and the radioactivity remaining in blood became almost negligible 5 min after intravenous injection. The highest uptake was in the liver, followed by the kidneys and spleen at the end of this 36 min experiment (6)

Non-Human Primates

[PubMed]

Dynamic positron imaging of [^{11}C]choline in a rhesus monkey showed a rapid brain uptake, followed by a rapid decline, with a heavy late uptake in muscle (10).

Human Studies

[PubMed]

A time-course study of a normal 60-year-old man with [^{11}C]choline PET revealed the following organs with high [^{11}C]choline uptake: kidney, liver, pancreas, small intestine content, and salivary gland. Dosimetry of [^{11}C]choline in an ideal man was estimated (3). The total body absorbance dose was 0.00279 mSv/MBq (10.3 mrem/mCi). The kidneys (0.018 mGy/MBq (67 mrad/mCi)) received the highest dose of radioactivity, followed by the liver (0.017 mGy/MBq (63 mrad/mCi)), pancreas (0.013 mGy/MBq (48 mrad/mCi)), and spleen (0.008 mGy/MBq (30 mrad/mCi)). Various tumors of >1600 cancer patients were visualized with both [^{11}C]choline and [^{18}F]FDG (3). If the tumor was in an organ with high uptake, it was impossible to distinguish the tumor uptake from the normal organ uptake. If the tumor was separated from normal tissue uptake, [^{11}C]choline PET visualized tumors as small as 5 mm in diameter, and FDG PET visualized tumors of 10

mm in diameter. Lung cancer and pulmonary tuberculosis could be differentiated by comparing [^{11}C]choline PET and FDG PET images (11).

[^{11}C]choline PET is a useful tool in diagnosis of brain tumor [PubMed], lung cancer [PubMed], esophageal cancer (12), colorectal cancer (3), bladder cancer (13), and prostate cancer [PubMed].

NIH Support

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