Inorganica Chimica Acta, 141 (1988) 165–166

Octaethylporphyrinato(oxo)technetium(V)acetate – An Example of a New Type of Technetium Porphyrin Complex

A. J. LAWRENCE, J. R. THORNBACK*

Department of Chemistry, Loughborough University of Technology, Loughborough, Leics. LE11 3TU, U.K.

G. D. ZANELLI and A. LAWSON

M.R.C./C.R.C., Northwick Park Hospital, Harrow, Middx., U.K.

(Received July 9, 1987)

There is considerable interest in the chemistry of technetium since the short lived isotope ^{99m}Tc is the isotope of choice for diagnostic radiopharmaceuticals [1]. We have shown that when $^{99m}TcO_4^-$ is reacted with a sulphonated porphyrin in the presence of a reducing agent a species is formed which may be used to image sites of infection such as in Crohn's disease [2]. It has proved impossible to synthesise ^{99}Tc complexes by this route, although Tsutsui *et al.* have prepared a series of technetium(I) complexes from the reactions of $Tc_2(CO)_{10}$ [3, 4]. In this work we report the first example of a technetium porphyrin complex in which the technetium is in a high oxidation state, which may be of similar form to those formed in the radiopharmaceutical kit.

Experimental

Octaethylporphyrin ($OEPH_2$) was purchased from Aldrich and used without further purification. Solid NH_4TcO_4 was obtained from Amersham International and recrystallised prior to use. All other reagents were of laboratory grade from various manufacturers. Thin layer chromatography plates (0.2 mm × 20 cm) of Kieselgel 60 were purchased from Merck. Electronic spectra were measured on a Shimadzu UV-160 spectrophotometer while vibrational spectra were obtained using a Perkin-Elmer 257 spectrometer with the material dispersed in a KBr disc. FAB^+ mass spectra were observed using a Varian Mat731 spectrometer operating at 10 kV. The matrix employed was thioglycerol/erythreitol/dithioerythreitol. Electrophoresis experiments were carried out using a Shandon Southern 602 chamber with a Volkam 400/100 power pack. Whatman 3MM paper strips 25 cm long and pH 7 phosphate buffer were used and the experiment was run for 2 h at 300 V.

The complex octaethylporphyrinato(oxo)technetium(V)acetate was synthesised by the following method. This may be used to prepare a number of analogous complexes containing different porphyrins the details of which will be reported later. NH_4TcO_4 (8 mg, 4.42×10^{-5} mol) and $OEPH_2$ (23.64 mg, 4.42×10^{-5} mol) were added to glacial acetic acid (50 ml) under a nitrogen atmosphere and the mixture refluxed for 4 h. After cooling, the solution was reduced in volume to *ca.* 5 ml and the mixture chromatographed using CH_2Cl_2 as the eluting solvent. The product appeared as a green band separate from unreacted $OEPH_2$ and protonated $OEPH_4^{2+}$. The complex was isolated from the Keiselgel using ethanol. Evaporation of the ethanolic solution gave a green solid which may be recrystallised using an acetic acid/diethyl ether mixture (yield *ca.* 40%).

Results and Discussion

Re_2O_7 has been shown to react with $OEPH_2$ in phenol to give two complexes ReO(OEP)OPh and $[ReO(OEP)]_2O$ [5]. A similar reaction with NH_4TcO_4 gave only minute yields of a possibly analogous green complex, even after prolonged refluxing. The visible spectrum has a broad absorbance at 575 nm with a shoulder on the main Soret band (364 nm) at 456 nm. Due to the poor yield further characterisation of this species proved impossible. However using acetic acid as the solvent the reaction proceeded smoothly. A green product is obtained in high yield which is soluble in CH_2Cl_2 and benzene and appears neutral by electrophoresis. The electronic spectrum of the complex measured using ethanol as a solvent is reproduced in Fig. 1. It has two sharp absorptions at 499 and 470 nm with a broad absorption at 617 nm. This compares with the four banded visible spectrum of $OEPH_2$ (622, 569, 532, 498 nm) and the two banded one of $OEPH_4^{2+}$ (569, 533 nm) and is a typical metalloporphyrin spectrum. The Soret band of the complex is split in two with absorptions at 391 and 344 nm while those for the non-metallated porphyrin are at 404 and 405 nm respectively.

The vibrational spectrum has absorptions typical of a metalloporphyrin and an additional absorption at 1604 cm^{-1}. This latter vibration is similar to those observed in other octaethylporphyrinatometalacetates [6]. Two absorptions at 962 and 918 cm^{-1} are in the region typical of $\nu(Tc=O)$ [7] but an absolute assignment is impossible. ReO(OEP)F has $\nu(Re=O)$ at 953 cm^{-1} [8] and the 962 cm^{-1} absorption seems more probable. The major peak in the FAB^+ mass spectrum occurs at m/z of 647.

---

*Author to whom correspondence should be addressed.

0020-1693/88/$3.50

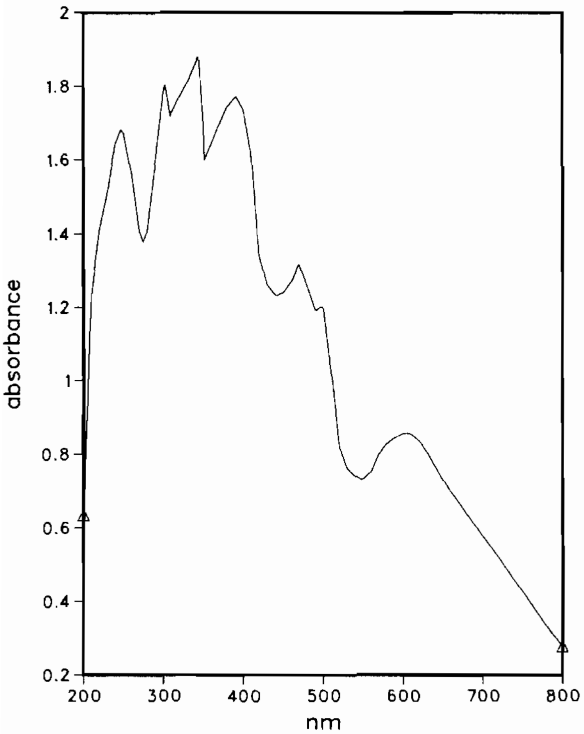

Fig. 1. Electronic spectrum of octaethylporphyrinato(oxo)-technetium(V)acetate.

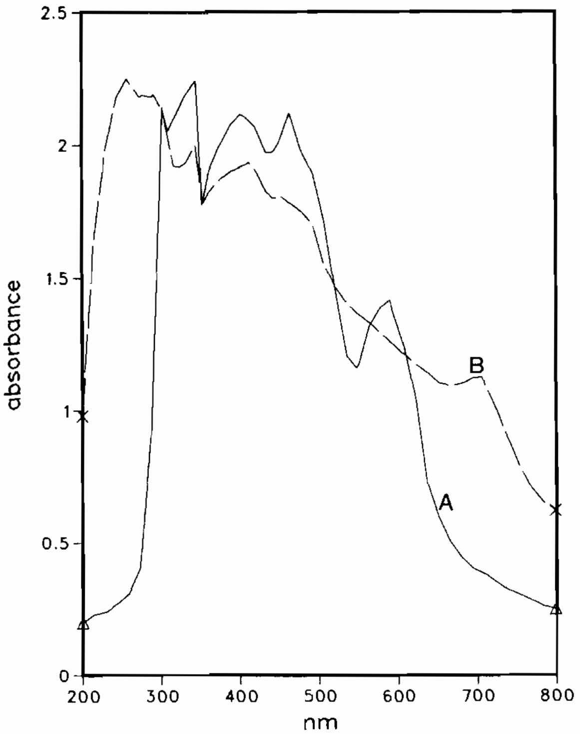

Fig. 2. Electronic spectra of: A, the reaction product of (OEP)TcO(OAc) with pyridine in ethanol; B, the reaction product of (OEP)TcO(OAc) with pyridine and sodium dithionite in ethanol.

This corresponds to $[TcO(OEP)]^+$. In FAB^+ mass spectrometry a parent ion of $(M + H)^+$ is normally observed but in those technetium species with labile ligands *trans* to an oxo the major ion is usually $(M-L)^+$ where L is the *trans* ligand. Additionally the matrix is an acidic one and loss of acetic acid by protonation to give $(M-L)^+$ could occur.

This appears to be the case for octaethylporphyrinato(oxo)technetium(V)acetate. This complex may be used to synthesise a range of other new technetium porphyrins and some preliminary data are given in Fig. 2 which shows the reaction of TcO(OEP)OAc with pyridine presumably causing ligand exchange of the *trans* acetate and on further addition of a reducing agent, sodium dithionite, additional changes in the visible spectrum occurred. This may be due to reduction of the technetium oxo core to yield a technetium(IV) or technetium(III) porphyrin. Further studies are underway to determine the exact structure of these complexes.

In conclusion, we have prepared for the first time a fully characterised technetium(V) porphyrin complex by a general synthetic route and from preliminary studies it is clear that other complexes in different oxidation states with different axial ligands may be preparable from this complex. Biological studies on water soluble derivatives of this complex are currently underway to compare with those obtained by direct reduction of TcO_4^- in the presence of the sulphonated porphyrins.

References

1 G. Subramanian, B. A. Rhodes, J. F. Cooper and V. J. Sodd (eds.), 'Radiopharmaceuticals', Society of Nuclear Medicine, New York, 1975.
2 G. D. Zanelli, I. Bjarnason, T. Smith, J. C. W. Crawley, A. J. Levi and R. I. Copeland, *Nucl. Med. Commun.*, *7*, 17 (1986).
3 M. Tsutsui and C. P. Hrung, *J. Am. Chem. Soc.*, *95*, 5777 (1973).
4 M. Tsutsui, C. P. Hrung, D. Ostfeld, T. S. Srivastava, D. L. Cullen and E. F. Meyer, *J. Am. Chem. Soc.*, *97*, 3952 (1975).
5 J. W. Buchler and K. Rohbock, *Inorg. Nucl. Chem. Lett.*, *8*, 1073 (1972).
6 J. W. Buchler, L. Puppe, K. Rohbock and H. H. Schneehage, *Ann. N.Y. Acad. Sci.*, *206*, 116 (1973).
7 B. V. dePamphilis, A. G. Jones and A. Davison, *Inorg. Chem.*, *22*, 2292 (1983).
8 J. W. Buchler, in D. H. Dolphin (ed.), 'The Porphyrins', Vol. 2, Academic Press, London, 1978, Chap. 10, p. 389.