ONE-POT DEUTERATION AND REDUCTION OF KETONES IN THE SYNTHESIS OF [16,16,17-$^2H_3$]-EPITESTOSTERONE*,**

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5α-Androstan-17-one and 6β-methoxy-3α,5-cyclo-5α-androstan-17-one were reduced by sodium in deuterium oxide to [16,16,17-$^2H_3$]-17β-alcohols. The 17β-tosyloxy group of [16,16,17-$^2H_3$]-6β-methoxy-3α,5-cyclo-5α-androstan-17β-ol tosylate was found to be stable under the conditions of the i-steroid rearrangement. The S_N2 reaction of the 17β-tosyloxy group with potassium nitrite yielded the corresponding 17α-hydroxy derivative without any loss of deuterium.
Key words: Steroid synthesis; Labelled epitestosterone.

Over the last 15 years the use of GC-MS for the determination of steroids in various biological samples has increased[3] considerably, and polydeuterated analytes have been used as internal standards. Since mono- and dideuterated steroids are less useful in this respect because of interference in the analysis by natural distribution of isotopes in tested compounds, trideuterated steroids seem to be the optimal choice[4]. E.g., the trideuterated testosterone standard has the labels in positions 16, 17 (refs[3–5]) or 19 (ref.[6]).

Deuterated epitestosterone is required as the standard for the determination of urinary epitestosterone in drug abuse control[7], further, it could be used in tracing a role of epitestosterone in living organisms which has not yet been fully understood[8]. [2,2,4,6,6-$^2H_5$]-Epitestosterone, prepared recently[9], contains the highest content of deuterium, though mostly in enolizable[10] positions. Attempted synthesis[9] of [16,16,17-$^2H_3$]-epitestosterone (**14**) from commercialy available [16,16,17-$^2H_3$]-testosterone by Mitsunobu reaction[11] failed. Here we present its synthesis of from 6β-methoxy-3α,5-cyclo-5α-androstan-17-one (**5**).

Model experiments, carried out with 5α-androstan-17-one (**1**) (see Scheme 1), were devised to answer two questions: can a system of sodium and deuterium oxide sub-

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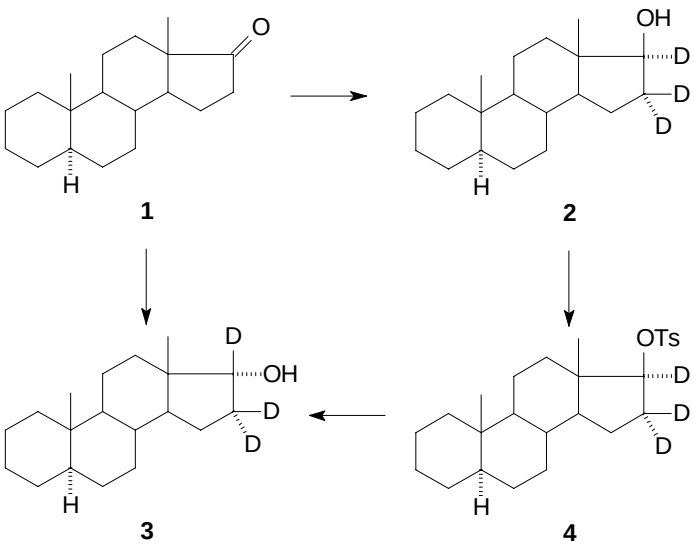
**Preliminary communication: ref.[2].

stitute for deuteride reagents in the reduction of ketones on a preparative scale? And secondly, will solvolysis of a [17α-^{2}H]-17β-tosyloxy derivative (e.g. **4**) proceed without loss of deuterium?

We found that two steps (isotope exchange and reduction) could conveniently be combined together in one pot: sodium deuteroxide, generated from sodium and deuterium oxide, first facilitated the deuteration of ketone **1** in 1,2-dimethoxyethane, and then the deuterated ketone was reduced by an additional lot of sodium. The metal was added in several portions, until the TLC demonstrated the absence of the starting ketone. Two alcohols were isolated, i.e. **2** (74%) and **3** (2%), no signals of H-17 were found in their ^{1}H NMR spectra. The major product **2** was converted in the 17β-tosyloxy derivative **4** which on heating with potassium nitrite in DMF (refs[12,13]) afforded a product **3** with the reversed configuration at carbon 17. No deuterium was lost during the operation: ^{1}H NMR spectrum of **4** revealed no signal due to H-17 proton.

The above results were utilized for the synthesis of [16,16,17-$^2H_3$]-epitestosterone (**14**): readily available[14] 6β-methoxy-3α,5-cyclo-5α-androstan-17-one (**5**) (see Scheme 2) was used as starting material. The above mentioned one-pot deuteration and reduction afforded a mixture composed mainly of 17β-alcohol **6**; the mixture was converted into tosylate **7** without purification. The acid-sensitive[15] i-steroid grouping in **7** was isomerized by the action of perchloric acid in acetone[16] under the formation of a 3β-hydroxy compound **8** which was acetylated to **9** prior to the next reaction step.

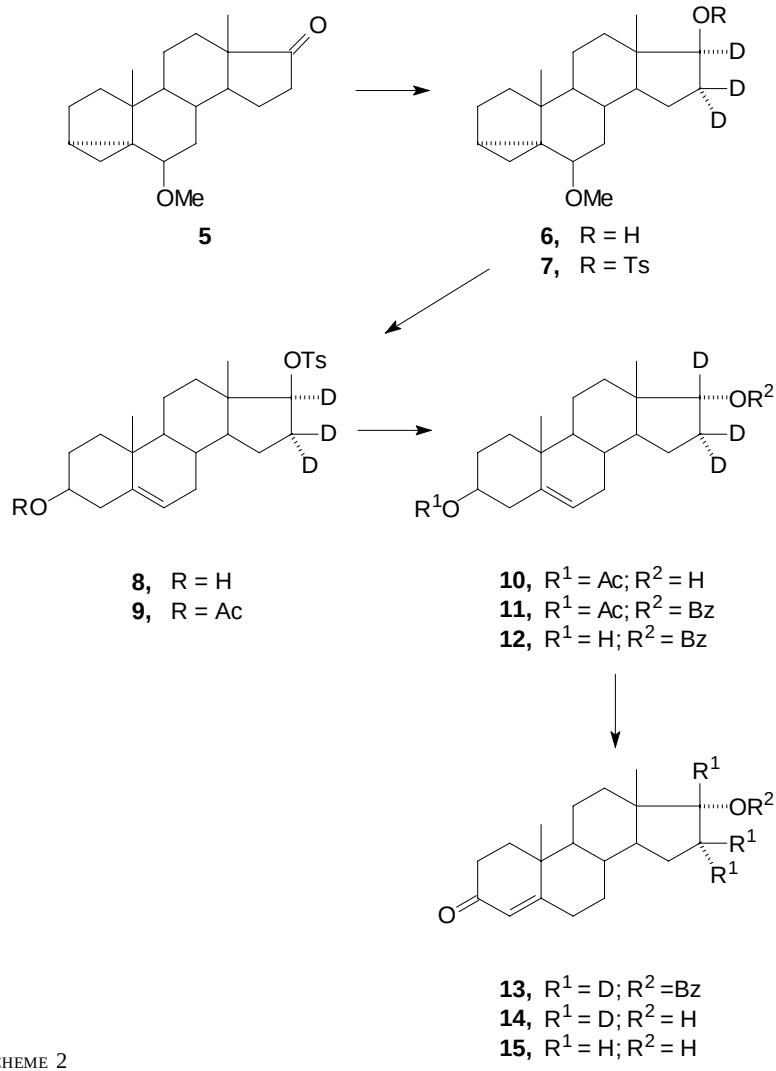
The solvolysis of the 17β-tosylate **9** was carried out using the above described conditions. The major product **10** was isolated by means of column chromatography: its R_F



SCHEME 1

on a thin layer of silica gel was found identical with that of androst-5-ene-3β,17α-diol 3-acetate[17], its NMR spectra were compatible with the proposed structure **10**.

The following reaction sequence consisted of the protection of the 17α-hydroxy group (by benzoylation to **11**), deprotection of the 3β-hydroxy group (by selective hydrolysis to **12**) and Oppenauer oxidation[18] to ketone **13**. Hydrolysis of benzoate **13** afforded [16,16,17-$^2H_3$]-epitestosterone (**14**) (yield 8% from ketone **5**). Its NMR spectra correlate well with spectra of unlabelled epitestosterone **15** (see Tables I to III) apart from absent signals of H-17 (δ 3.76), H-16α and H-16β (δ 2.18 and 1.49). Further, the



5

6, R = H
7, R = Ts

8, R = H
9, R = Ac

10, R^1 = Ac; R^2 = H
11, R^1 = Ac; R^2 = Bz
12, R^1 = H; R^2 = Bz

13, R^1 = D; R^2 =Bz
14, R^1 = D; R^2 = H
15, R^1 = H; R^2 = H

SCHEME 2

multiplicity of signals of H-15α (δ 1.80) and H-15β (δ 1.22) collapsed due to the absence of vicinal coupling with H-16 protons. No residual signal of H-17 was observed.

For unambiguous assignment of ^{13}C NMR spectra of compounds **14** and **15**, 2D NMR one bond (HMQC) ^{1}H, ^{13}C heteronuclear chemical shift correlated spectra was used[19].

Interpretation of electron impact mass spectra of compound **14** reveals the prevalence of the desired [16,16,17-$^{2}H_3$]-epitestosterone. The mass spectrum is in full accord with fragmentation patterns of 4-ene-3-ketones[20]. The structure characteristic ions and isotopic distribution in the molecular group are as follows: 1.6% $^{2}H_0$ (*m/z* 288), 0.4% $^{2}H_1$ (*m/z* 289), 8.1% $^{2}H_2$ (*m/z* 290), 86.9% $^{2}H_3$ (*m/z* 291), 1.2% $^{2}H_4$ (*m/z* 292) and 1.8% $^{2}H_5$ (*m/z* 293).

EXPERIMENTAL

The melting points were determined on a Kofler block and are uncorrected. Thin layer chromatography (ICN Silica G, TLC-60 A) was used for checking the purity of individual intermediates, unlabelled standards were used for comparison. Column chromatography was carried out on silica gel for thin layer chromatography ("Silpearl", Kavalier, Czech Republic) using a slight overpressure. Infrared spectra were recorded on a Brucker IFS 88 spectrometer in chloroform, wavenumbers are given in cm^{-1}. ^{1}H and ^{13}C NMR spectra were measured on a Varian UNITY-500 FT NMR spectrometer (499.8 MHz for ^{1}H and 125.8 MHz for ^{13}C) in deuteriochloroform. Chemical shifts were referenced to internal tetramethylsilan (δ 0.0) and $CDCl_3$ (δ 77.00) for ^{1}H and ^{13}C NMR, respectively. Coupling constants (*J*) are given in Hz. For the HMQC heteronuclear correlation experiment

TABLE I
^{1}H NMR parameters of unlabelled **15** and labelled **14** epitestosterone

Proton	**14**	**15**	Proton	**14**	**15**
1α	1.72 m	1.72 m	11α	1.66 ddt	1.66 ddt
1β	2.05 ddd	2.04 ddd	11β	1.48 dq	1.48 dq
2α	2.35 dddd	2.34 dddd	12α	1.58 dtq	1.59 dtq
2β	2.43 ddd	2.42 ddd	12β	1.53 ddd	1.52 ddd
4	5.73 dt	5.73 dt	14α	1.42 ddd	1.42 ddd
6α	2.28 bddd	2.28 bddd	15α	1.79 bdd	1.80 dddd
6β	2.40 dddd	2.40 dddd	15β	1.20 bt	1.22 dddd
7α	1.11 dddd	1.11 dddd	16α	–	2.18 dddd
7β	1.89 dddd	1.89 dddd	16β	–	1.49 dddd
8β	1.55 ddt	1.55 ddt	17β	–	3.76 dd
9α	0.98 ddd	0.98 ddd	18 (3 H)	0.71 d	0.71 d
			19 (3 H)	1.20 d	1.20 d

the standard pulse sequence with following parameters was applied: spectral width in f_1 and f_2 25 000 and 4 200 Hz, respectively, 2 048 × 2 048 Hz data matrix, 256 increments of 16 each and relaxation delay 1 s. The Fourier transformations were performed with shifted and unshifted sine-bell apodization functions in the f_1 and f_2 dimensions, respectively. Mass spectra and isotopic distribution in **14** was determined by a ZAB-EQ mass spectrometer (VG Analytical, Manchester) using a direct inlet probe. The electron energy was 70 eV and the ion source temperature was 140 °C.

[16,16,17-$^2H_3$]-5α-Androstan-17β-ol (**2**)

Sodium (0.2 g, 8.7 mmol) was dissolved in a mixture of 1,2-dimethoxyethane (10 ml) and deuterium oxide (3 ml, 97.4%) under nitrogen. 5α-Androstan-17-one (**1**; 150 mg, 0.55 mmol) was added and the mixture was stirred at 90 °C for 7 h. Additional sodium (2.6 g, 113 mmol) was added to the solution in seven portions during 16 h, until TLC certified the disappearance of the starting ketone. After addition of ethanol (4 ml), the mixture was diluted with a saturated solution of ammonium

TABLE II
Proton–proton coupling constants (*J*, Hz) of protons in ^{1}H NMR spectra of labelled **14** and unlabelled **15** epitestosterone

J(H,H)	**14**	**15**	*J*(H,H)	**14**	**15**
1α,1β	13.4	13.4	9α,11α	4.2	4.2
1α,2α	4.8	4.9	9α,11β	12.1	12.2
1α,2β	14.3	14.4	11α,11β	12.7	12.8
1α,19	0.8	0.8	11α,12α	4.1	4.1
1β,2α	3.1	3.2	11α,12β	2.5	2.6
1β,2β	5.1	5.1	11β,12α	12.8	12.4
2α,2β	16.8	16.9	11β,12β	4.3	4.2
2α,4	0.8	0.9	12α,12β	13.4	13.4
4,6α	0.7	0.6	12α,18	0.8	0.8
4,6β	1.9	1.8	14α,15α	7.3	7.2
6α,6β	14.6	14.7	14α,15β	12.3	12.2
6α,7α	4.3	4.2	15α,15β	12.5	12.2
6α,7β	2.5	2.5	15α,16α	–	2.7
6β,7α	13.7	13.9	15α,16β	–	9.5
6β,7β	5.4	5.4	15β,16α	–	10.9
7α,7β	12.8	12.8	15β,16β	–	6.7
7α,8β	11.7	11.6	16α,16β	–	15.1
7β,8β	3.5	3.6	16α,17β	–	5.9
8β,9α	10.6	10.6	16β,17β	–	0.8
8β,14α	10.9	10.8			

chloride (30 ml), and extracted with toluene (3 × 15 ml). Combined organic extracts were washed with hydrochloric acid (5%, 2 × 5 ml), saturated solution of sodium hydrogencarbonate (5 ml), water (5 ml) and dried over anhydrous magnesium sulfate. Evaporation and chromatography on silica gel column (50 g, toluene–ether, 9 : 1) afforded 115 mg (74%) of (**2**), m.p. 165–167 °C (ref.[21] gives m.p. 163–167 °C for unlabelled compound). ^{1}H NMR spectrum: 0.79 s, 3 H (3 × H-19); 0.72 s, 3 H (3 × H-18).

[16,16,17-$^2H_3$]-5α-Androstan-17α-ol (**3**)

a) Lipophilic fractions of the above chromatography (3 mg, 2%) consisted of compound **3**, with R_F identical with unlabelled compound[22]. ^{1}H NMR spectrum: 0.79 s, 3 H (3 × H-19); 0.65 s, 3 H (3 × H-18).

b) The mixture of **4** (116 mg, 0.27 mmol) and sodium nitrite (1.00 g, 14.5 mmol) in *N*,*N*-dimethylformamide (20 ml) and deuterium oxide (0.5 ml, 97.4%) was stirred at 140 °C for 8 h. The mixture was cooled at room temperature, diluted with water (40 ml) and extracted with ether (3 × 15 ml). The combined organic layers were washed with water (5 × 5 ml), dried over anhydrous magnesium sulfate, and the solvent was evaporated in a vacuum. Chromatography of the residue (90 mg) on the thin layer of silica gel (benzene–ether, 3 : 1) afforded 46 mg (59%) of **3**, m.p. 144–147 °C (ref.[22] records m.p. 142–146 °C for unlabelled compound). The product was identical with the sample prepared sub *a*).

[16,16,17-$^2H_3$]-5α-Androstan-17β-ol Tosylate (**4**)

4-Toluenesulfonyl chloride (130 mg, 0.7 mmol) was added to a solution of **2** (100 mg, 0.36 mmol) in pyridine (5 ml) cooled with an ice bath and the mixture was allowed to stand overnight at 40 °C. Then it was poured onto ice, extracted with ethyl acetate (3 × 10 ml), the combined organic layers were washed with hydrochloric acid (5%, 4 × 3 ml), water, saturated solution of sodium hydrogencarbonate (5 ml) and dried over anhydrous magnesium sulfate. Evaporation of the solvent in a vacuum afforded 116 mg (75%) of crude product **4**. TLC (benzene–ether, 4 : 1) showed identity with

TABLE III
^{13}C NMR chemical shifts (δ, ppm) of unlabelled **15** and labelled **14** epitestosterone

Carbon	**14**	**15**	Carbon	**14**	**15**
1	35.7	35.7	11	20.5	20.5
2	33.9	33.9	12	31.1	31.1
3	199.6	199.6	13	45.1	45.1
4	123.9	123.8	14	48.2	48.2
5	171.4	171.4	15	24.3	24.5
6	32.9	32.9	16	[a]	32.3
7	32.3	32.3	17	[a]	79.6
8	35.8	35.8	18	16.8	16.9
9	53.6	53.6	19	17.4	17.4
10	38.6	38.6			

[a] Value not determined.

unlabelled compound[23]. Compound **4** was used for the next conversion without purification. ^{1}H NMR spectrum: 7.75 d, 2 H, J = 8.5 (H-2 and H-6, tosylate); 7.32 d, 2 H, J = 8.5 (H-3 and H-5, tosylate); 2.44 s, 3 H (CH_3, tosylate); 0.78 s, 3 H (3 × H-19); 0.69 s, 3 H (3 × H-18).

[16,16,17-$^2H_3$]-6β-Methoxy-3α,5-cyclo-5α-androstan-17β-ol (**6**)

Potassium *tert*-butoxide (2.1 g, 18.7 mmol) was dissolved in 1,2-dimethoxyethane (25 ml) and deuterium oxide (3 ml, 94.7%) and then 6β-methoxy-3α,5-cyclo-5α-androstan-17-one[4] (**5**; 1.0 g, 3.31 mmol) was added. The mixture was stirred at 90 °C for 7 h under nitrogen. The mixture was further diluted with deuterium oxide (3.5 ml, 94.7%) and sodium (2.7 g, 129 mmol) was introduced into this solution at room temperature in seven portions over a period of 16 h, until the TLC showed the disappearance of the starting ketone. The reaction mixture was poured onto ice and left in a refrigerator overnight. The precipitate was filtered off, dissolved in toluene, washed with water, the solution was dried over anhydrous magnesium sulfate and the solvent evaporated. The residue (890 mg, 79%) consisted of compound **6** (^{1}H NMR and TLC of unlabelled compound[24]) was used for the next step without purification. ^{1}H NMR spectrum: 3.37 s, 3 H (CH_3O); 2.83 t, 1 H, J = 2.8 (H-6α); 1.05 s, 3 H (3 × H-19); 0.92 s, 3 H (3 × H-18); 0.68 dd, 1 H, J = 4.5, J' = 5.6 (H-4α); 0.47 dd, 1 H, J = 5.7, J' = 8.9 (H-4β).

[16,16,17-$^2H_3$]-6β-Methoxy-3α,5-cyclo-5α-androstan-17β-ol Tosylate (**7**)

4-Toluenesulfonyl chloride (1.5 g, 7.9 mmol) was added to a solution of **6** (890 mg, 2.61 mmol) in pyridine (10 ml) cooled with an ice bath. The mixture was allowed to stand for 40 h at 40 °C. Then it was poured onto ice and left in a refrigerator overnight. The precipitate was filtered, washed with water and dried at 20 °C. The yield of tosylate **7**, m.p. 120–122 °C (ref.[24] gives m.p. 124 °C for unlabelled compound) was 1.0 g (79%). ^{1}H NMR spectrum: 7.75 d, 2 H, J = 8.5 (H-2 and H-6, tosylate); 7.33 d, 2 H, J = 8.5 (H-3 and H-5, tosylate); 3.36 s, 3 H (3 × H, OCH_3); 2.80 t, 1 H, J = 3 (H-6α); 2.45 s, 3 H (CH_3, tosylate); 1.02 s, 3 H (3 × H-19); 0.89 s, 3 H (3 × H-18); 0.66 dd, 1 H, J = 4.5, J' = 5.5 (H-4α).

[16,16,17-$^2H_3$]-Androst-5-ene-3β,17β-diol 17-Tosylate (**8**)

Tosylate **7** (1.0 g, 2.05 mmol) in acetone (25 ml) was treated with mixture of water (0.25 ml) and perchloric acid (73%, 0.25 ml) for 5 min. Saturated hydrogencarbonate solution (0.6 ml) was added and acetone was removed in a stream of argon. Water (5 ml) was added and the product was taken up in ethyl acetate, the extract was dried with magnesium sulfate and evaporated to yield 890 mg (98%) of **8** (TLC showed identity with unlabelled standard[25]). ^{1}H NMR spectrum: 7.76 d, 2 H, J = 8.5 (H-2 and H-6, tosylate); 7.34 d, 2 H, J = 8.5 (H-3 and H-5, tosylate); 5.39 d, 1 H, J = 4.8 (H-6); 3.50 m, 1 H (H-3α); 2.44 s, 3 H (CH_3, tosylate); 0.98 s, 3 H (3 × H-19); 0.79 s, 3 H (3 × H-18).

[16,16,17-$^2H_3$]-Androst-5-ene-3β,17β-diol 3-Acetate 17-Tosylate (**9**)

Alcohol **8** (890 mg, 2.0 mmol) was acetylated with acetic anhydride (3 ml) in pyridine (4 ml). After 18 h the reaction mixture was poured onto ice, and the precipitate formed was extracted with ethyl acetate (4 × 15 ml). The combined extracts were washed with hydrochloric acid (5%, 4 × 15 ml) and then with a saturated solution of sodium hydrogencarbonate (2 × 5 ml), dried over anhydrous magnesium sulfate and evaporated. Crystallization from a mixture of light petroleum, dichloromethane and ether yielded product **9** (960 mg, 98%) m.p. 158–161 °C (ref.[25] gives 162–164 °C for unlabelled compound). ^{1}H NMR spectrum: 7.79 d, 2 H, J = 8.5 (H-2 and H-6, tosylate); 7.35 d, 2 H, J = 8.5 (H-3 and H-5, tosylate); 5.34 d, 1 H, J = 4.3 (H-6); 4.58 m, W = 32, 1 H (H-3α); 2.45 s, 3 H (CH_3,

tosylate); 2.03 s, 3 H ($OOCCH_3$); 1.00 s, 3 H (3 × H-19); 0.81 s, 3 H (3 × H-18). IR spectrum: 2 233, 2 144, 2 200 (C–D); 1 725 (C=O); 1 669 (C=C); 1 599, 1 496, 1 361, 1 178 (OTs); 1 255, 1 028, 959 (C–O).

[16,16,17-$^2H_3$]-Androst-5-ene-3β,17α-diol 3-Acetate (**10**)

Tosylate **9** (960 mg, 1.96 mmol) was added to a solution of sodium nitrite (10 g, 114 mmol) in *N*,*N*-dimethylformamide (40 ml) and deuterium oxide (1 ml, 97.4%). The mixture was stirred at 140 °C for 24 h. After cooling the precipitate was taken up, diluted with water (40 ml) and extracted with ether (3 × 15 ml). Combined organic layers were washed with hydrochloric acid (5%, 15 ml) a saturated solution of sodium hydrogencarbonate (5 ml), water (2 × 5 ml), dried over anhydrous magnesium sulfate, and evaporated in a vacuum. Chromatography of the residue on a column of silica gel (benzene–ether, 9 : 1) afforded 350 mg (54%) of hydroxy derivative **10**, m.p. 115–117 °C (ref.[17] gives 110–115 °C for unlabelled compound). ^{1}H NMR spectrum: 5.40 d, 1 H, J = 4.8 (H-6); 4.5–4.7 m, 1 H (H-3α); 2.03 s, 3 H ($OOCCH_3$); 1.03 s, 3 H (3 × H-19); 0.68 s, 1 H (3 × H-18).

[16,16,17-$^2H_3$]-Androst-5-ene-3β,17α-diol 3-Acetate 17-Benzoate (**11**)

Benzoyl chloride (4.0 ml, 35 mmol) was added to a solution of hydroxy derivative **10** (350 mg, 1.05 mmol) in pyridine (10 ml) at 0 °C. After 24 h at room temperature the reaction mixture was poured into hot water, after cooling, the precipitate was taken up in ether. The solution was washed with hydrochloric acid (5%, 4 × 20 ml), and a saturated solution of sodium hydrogencarbonate (2 × 10 ml). The extract was dried over anhydrous magnesium sulfate and evaporated. Benzoyl derivative **11** (420 mg, 90%) was obtained, m.p. 134–136 °C (ref.[17] records 130–132 °C for unlabelled compound). ^{1}H NMR spectrum: 8.00–8.09 m, 2 H (H-2 and H-6, benzoate); 7.40–7.60 m, 3 H (H-3, H-4 and H-5, benzoate); 5.39 d, 1 H, J = 4.4 (H-6); 4.54 m, 1 H (H-3α); 2.04 s, 3 H ($OOCCH_3$); 1.04 s, 3 H (3 × H-19); 0.84 s, 3 H (3 × H-18).

[16,16,17-$^2H_3$]-Androst-5-ene-3β,17α-diol 17-Benzoate (**12**)

Benzoyl derivative **11** (420 mg, 0.9 mmol) was dissolved in methanol (8 ml), and chloroform (1 ml) and hydrochloric acid (37%, 0.6 ml) were added. The mixture was heated for 7 h at 40 °C. Then it was diluted with water (100 ml) and extracted with ether (4 × 25 ml). The combined extracts were washed with water and a saturated solution of sodium hydrogencarbonate. Drying over anhydrous magnesium sulfate and evaporation of solvent yielded 370 mg (100%) of 3-hydroxy derivative **12**, m.p. 145–148 °C (ref.[26] gives 148–149 °C for unlabelled compound). ^{1}H NMR spectrum: 8.00–8.09 m, 2 H (H-2 and H-6, benzoate); 7.40–7.60 m, 3 H (H-3, H-4 and H-5, benzoate); 5.37 d, 1 H, J = 4.6 (H-6); 3.46 m, 1 H (H-3α); 1.02 s, 3 H (3 × H-19); 0.83 s, 3 H (3 × H-18).

[16,16,17-$^2H_3$]-17α-Benzoyloxyandrost-4-en-3-one (**13**)

1-Methyl-4-piperidone (1.0 ml, 8.1 mmol) was added under argon to a solution of **12** (370 mg, 0.9 mmol) in toluene (50 ml). A part (3 ml) of the toluene was distilled off and 1 M solution of aluminium isopropoxide in toluene (2.5 ml) was added. After refluxing under argon for 9 h the mixture was cooled, poured into hydrochloric acid (5%, 20 ml), water (20 ml) and a saturated solution of sodium hydrogencarbonate (20 ml). The organic layer was dried over anhydrous magnesium sulfate. Evaporation of solvents afforded ketone **13** (240 mg, 65%), m.p. 138–140 °C (ref.[25] records 138–139 °C for unlabelled compound). ^{1}H NMR spectrum: 8.00–8.09 m, 2 H (H-2 and H-6, benzoate); 7.40–7.60 m, 3 H (H-3, H-4 and H-5, benzoate); 5.75 bs, 1 H (H-4); 1.20 s, (3 × H-19); 0.87 s, 3 H (3 × H-18).

[16,16,17-$^2H_3$]-17α-Hydroxyandrost-4-en-3-one (**14**)

The solution of benzoate **13** (240 mg, 0.61 mmol) and potassium hydroxide (250 mg) in ethanol (10 ml) and benzene (10 ml) was heated to 40 °C for 4 h. The cooled mixture at room temperature was diluted with hydrochloric acid (2%, 50 ml), extracted with ether (3 × 50 ml). The combined extracts were washed with saturated solution of sodium hydrogencarbonate and dried over anhydrous magnesium sulfate. Chromatography on the column of silica gel (15 g) yielded 65 mg (36%) of $^2H_3$-epitestosterone (**14**), m.p. 221–223 °C (ref.[27] gives 216–218 °C for unlabelled compound). NMR spectra: see Tables I–III. IR spectrum: 3 617, 3 457 (O–H); 2 222, 2 189, 2 143 (C–D); 1 660 (C=O); 1 615 (C=C). Mass spectrum, *m/z* (%): 291 (M, 100), 124 (98), 149 (59), 231 (50), 249 (37), 206 (27), 168 (22), 216 (13), 273 (12).

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