Alkylation of α-*tert*-butoxycarbonylamino ketone enolate anions. A useful synthesis of α-alkyl-α-amino ketones, 2-acylpyrrolidines, and 2-acylpiperidines[1]

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A versatile synthesis of α-alkyl-α-amino ketones **5** and cyclic α-amino ketones **7** based on the selective mono-α-alkylation and $C(\alpha),N$-cycloalkylation of α-*tert*-butoxycarbonylamino ketones **2** and subsequent acidic hydrolysis is described.

Key words: α-*tert*-butoxycarbonylamino ketones, α-alkyl-α-amino ketones, 2-acylpyrrolidines, and 2-acylpiperidines.

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On décrit une synthèse versatile des α-alkyl-α-amino cétones de type **5** et des α-amino cétones cycliques de type **7**; ces synthèses sont basées sur la mono-α-alkylation sélective et la $C(\alpha),N$-cycloalkylation des α-*tert*-butoxycarbonylamino cétones de type **2**, suivie d'une hydrolyse acide subséquente.

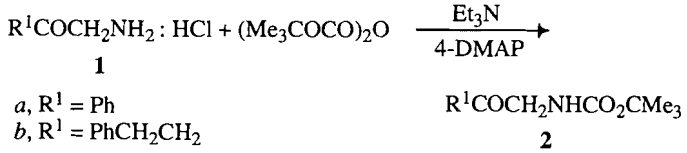
Mots clés : α-*tert*-butoxycarbonylamino cétones, α-alkyl-α-amino cétones, 2-acylpyrrolidines et 2-acylpipéridines.

[Traduit par la rédaction]

α-Amino ketones and the protected versions thereof are widely utilized as precursors of heterocyclic systems, ethanolamine derivatives of physiological interest, and peptidic natural products and congeners thereof. Numerous syntheses of these important starting materials have been devised (1) and new developments in this field continue apace (2–8). We recently demonstrated (9) that the monoanions of *N*-formylated α-amino ketones, like those of benzamidoacetone (10), are regioselectively alkylated on the α-carbon atom and that acidic hydrolysis of these products provided access to α-alkyl-α-amino ketones with satisfactory efficiency. A particular advantage of this process is that one substrate can serve as the progenitor of many new α-alkyl-α-amino ketones. This desirable characteristic is also found in the generation of such compounds based on the reaction of alkyl Grignard or alkyllithium reagents with N-protected α-amino acids (11–14) or with N-protected *O*,*N*-dialkyl-α-amino acid hydroxamates (15, 16) but is absent in many previously reported syntheses (e.g., see ref. 1 pp. 420–422, 431–432, 440–441, and 467). This paper describes studies on the mono- and dialkylation of α-*tert*-butoxycarbonylamino ketones, which show that they are also very useful substrates for the preparation of a variety of substituted α-amino ketone derivatives.

The *N*-*tert*-Boc-α-amino ketones **2** were prepared (Scheme 1) from the α-amino ketone hydrochlorides **1** and di-*tert*-butyl dicarbonate in the presence of a slight excess of triethylamine containing a catalytic amount of 4-dimethylaminopyridine.

As expected from the previous study with α-formamido ketones (9), reaction of **2** with an equivalent of sodium hydride in anhydrous dimethylformamide (DMF) generated the presumably thermodynamic, dipole-stabilized (10, 17) ketone enolates **3** (Scheme 2),[4] which on reaction with alkyl bromides or iodides led to the mono-α-alkyl derivatives **4** (Table 1) as the major products. In every case, a less polar by-product[5] was isolated and usually some starting material was recovered as well.



SCHEME 1

[1]Contribution no. 826 from the Syntex Institute of Organic Chemistry.

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[4]A referee has stated that "The structure of the α-*tert*-Boc-amino ketone enolate proposed in Scheme 2 (i.e., **3**) is virtually an impossible structure since the acidity of the NH there is very likely to be much higher than the activated methylene." The referee also suggests that alkylation is more likely to occur via a reactive dianion (i.e., $[R^1COCHNCO_2CMe_3]^{2-}$). While it is probable that such a dianion would undergo *C*-alkylation (18), and we have no evidence to exclude the presence of a small amount of this species, it is most instructive to note the following points. The monoanion **3** is undoubtedly formed under conditions of thermodynamic control. Bordwell and Algrim (19) have reported that the pK_a's of CH_3COCH_3 and CH_3CONH_2 in DMSO are 26.5 and 25.5, respectively. The inductive effect of the *N*-*t*-Boc moiety would increase the acidity of the methylene hydrogens. It is thus clear that the acidity of the NH is not likely to be "much higher" than that of the methylene hydrogens. Secondly, the pK_a of ketone enols is ca. 11 (20), which guarantees that the monoanion of **2** has structure **3** and not $R^1COCH_2NCO_2CMe_3$. Thus, there is no need to invoke the presence of a small amount of the dianion to rationalize the monoalkylation reactions described herein.

[5]For example, the alkylation of **2** (R^1 = Ph) with methyl iodide gave material which had ^1H nmr absorptions at δ 1.46, 1.53 (singlets, total ~9H), 3.26, 3.57 (singlets, total ~3H), 7.27 (s, ~4H), and 8.08 (q, ~1H) and infrared peaks at 3440 and 1700 cm^{-1}. Acidic hydrolysis under mild conditions (0.5 N HCl, room temperature) was without effect; more vigorous conditions (3 N HCl, reflux) caused resinification.

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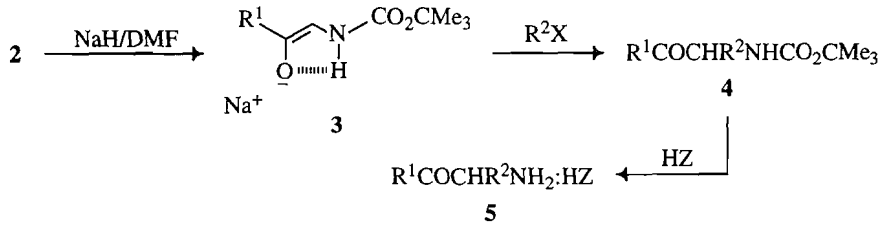
TABLE 1. Synthesis of α-alkyl-α-*tert*-butoxycarbonylamino ketones **4** and cyclic 2-acyl-*N*-*tert*-butoxycarbonylamines **6**

Alkylating agent	Product					Starting material, %
	Compound	R^1	R^2	*n*	% Yield[a]	
MeI	**4**	Ph	Me		83	
EtBr	**4**	Ph	Et		65	13
i-PrBr	**4**	Ph	*i*-Pr		37	23
n-BuBr	**4**	Ph	*n*-Bu		59	17
MeI	**4**	$PhCH_2CH_2$	Me		58	17
n-BuBr	**4**	$PhCH_2CH_2$	*n*-Bu		37	13
n-BuI	**4**	$PhCH_2CH_2$	*n*-Bu		60	ND[b]
$Br(CH_2)_3Br$	**6**	Ph		3	56	17
$Br(CH_2)_4Br$	**6**	Ph		4	41	20
$I(CH_2)_4I$	**6**	Ph		4	49	ND
$Br(CH_2)_3Br$	**4**	$PhCH_2CH_2$	$CH_2CH{=}CH_2$		19	
	6	$PhCH_2CH_2$		3	48	17
$Br(CH_2)_3Cl$	**4**	$PhCH_2CH_2$	$CH_2CH{=}CH_2$		14	
	6	$PhCH_2CH_2$		3	62	ND
$Br(CH_2)_4Br$	**6**	$PhCH_2CH_2$		4	39	32
$I(CH_2)_4I$	**6**	$PhCH_2CH_2$		4	47	ND

[a]Yield of product after column chromatographic purification.
[b]ND = not determined.



SCHEME 2

Removal of the *t*-Boc group from **4** was effected slowly with excess trifluoroacetic acid at ambient temperature or rapidly with excess methanolic hydrochloric acid at reflux temperature. The salts of the α-alkyl-α-amino ketones **5** were thus obtained in overall yields quite comparable to those reported for the α-formamido ketone process (Table 2).

The dialkylation of **2** was examined using an equivalent of a 1,3-dihalopropane or a 1,4-dihalobutane derivative in the presence of two equivalents of sodium hydride. The second alkylation took place on nitrogen to give the corresponding 2-acylpyrrolidine (**6**, $n = 3$, Scheme 3) or 2-acylpiperidine (**6**, $n = 4$). The efficiency of this cyclization was dependent, to a certain extent, on the α,ω-dihalide used (Table 1) but it was not improved by addition of the sodium hydride in two separate one-equivalent portions (i.e., stepwise alkylation). In the phenethyl series, the pyrrolidine derivative **6** (R^1 = $PhCH_2CH_2$, $n = 3$) was accompanied by appreciable amounts of the α-allyl compound **4** (R^1 = $PhCH_2CH_2$, R^2 = CH_2-$CH{=}CH_2$), which was presumably formed by dehydrohalogenation of the monoalkylated intermediate. The successful formation of the cyclic α-amino ketone derivatives **6** is not unique to the α-*tert*-butoxycarbonylamino ketones **2** since *N*-formylphenacylamine gave analogous cyclic products in comparable yields under conditions identical to those described herein.[6] Whereas *C*,*N*-cycloalkylation in these systems is synthetically useful, dialkylation in the intermolecular sense is not. For example, *N*-formylphenacylamine on attempted dialkylation with benzyl bromide gave a 1:2:3 mixture of α-mono-, α,α-di, and α,α,*N*-trialkylated compounds (9).

Deprotection of **6** with hot methanolic hydrochloric acid gave the cyclic α-amino ketones **7** (Table 2). Given the ready

[6]A. Guzman, C. Quintero, and J. M. Muchowski. Unpublished observations.

TABLE 2. Synthesis of acyclic and cyclic α-amino ketone salts **5** and **7**

Compound no.	R^1	R^2	*n*	HZ	% Yield[a]
5	Ph	Me		HCl	69
5	Ph	Me		TFA[b]	63
5	Ph	Et		HCl	65
5	Ph	Et		TFA	68
5	Ph	*i*-Pr		HCl	77
5	Ph	*i*-Pr		TFA	56
5	Ph	*n*-Bu		HCl	70
5	Ph	*n*-Bu		TFA	60
5	$PhCH_2CH_2$	Me		HCl	78
5	$PhCH_2CH_2$	*n*-Bu		HCl	67
7	Ph		3	HCl	68
7	Ph		4	HCl	78
7	$PhCH_2CH_2$		3	HCl	74
7	$PhCH_2CH_2$		4	HCl	71

[a]Yield after crystallization.
[b]Trifluoroacetic acid salt.

TABLE 3. Physical constants of α-*tert*-butoxycarbonylamino ketones and α-amino ketone salts

Compound no.	R^1	R^2	*n*	HZ	Melting point, °C	Cryst. solvent	Molecular formula	Calcd. C	Calcd. H	Calcd. N	Found C	Found H	Found N
4	Ph	Me			79–81	EtOAc–hex	$C_{14}H_{19}NO_3$	67.46	7.63	5.62	67.63	7.90	5.61
4	Ph	Et			64–65	EtOAc–hex	$C_{15}H_{21}NO_3$	68.44	7.98	5.32	68.41	8.05	5.25
4	Ph	*i*-Pr			95–96	EtOAc–hex	$C_{16}H_{23}NO_3$	69.31	8.30	5.05	69.23	8.49	4.99
4	Ph	*n*-Bu			Oil		$C_{17}H_{25}NO_3$	70.10	8.59	4.81	69.85	8.64	4.79
4	$PhCH_2CH_2$	Me			59–60	CH_2Cl_2–hex	$C_{16}H_{23}NO_3$	69.31	8.30	5.05	69.50	8.24	5.06
4	$PhCH_2CH_2$	*n*-Bu			50–51	CH_2Cl_2–hex	$C_{19}H_{29}NO_3$	71.44	9.15	4.38	71.47	8.93	4.23
4	$PhCH_2CH_2$	$CH_2CH{=}CH_2$			79–80	EtOAc–hex	$C_{18}H_{25}NO_3$	71.26	8.31	4.62	71.07	8.38	4.59
6	Ph		3		68–69	EtOAc–hex	$C_{16}H_{21}NO_3$	69.81	7.63	5.09	69.68	7.76	5.11
6	Ph		4		100–101	EtOAc–hex	$C_{17}H_{23}NO_3$	70.58	7.95	4.84	70.38	8.06	4.91
6	$PhCH_2CH_2$		3		Oil		$C_{18}H_{25}NO_3$[a]						
6	$PhCH_2CH_2$		4		80–81	EtOAc–hex	$C_{19}H_{27}NO_3$	71.89	8.57	4.41	71.65	8.39	4.35
5	Ph	Me		HCl	180–183[b]	MeOH–EtOAc	$C_9H_{12}ClNO$	58.22	6.46	7.54	58.05	6.49	7.49
5	Ph	Me		TFA[c]	150–153	EtOAc	$C_{11}H_{12}F_3NO_3$	50.19	4.56	5.32	49.92	4.65	5.29
5	Ph	Et		HCl	179–182[d]	MeOH–EtOAc	$C_{10}H_{14}ClNO$	58.82	7.16	6.86[e]	59.26	7.01	6.97
5	Ph	Et		TFA	123–126	EtOAc	$C_{12}H_{14}F_3NO_3$	51.98	5.05	5.05	51.87	5.22	4.94
5	Ph	*i*-Pr		HCl	205–207[f]	MeOH–EtOAc	$C_{11}H_{16}ClNO$	61.82	7.49	6.55	61.65	7.52	6.50
5	Ph	*i*-Pr		TFA	170–173	EtOAc	$C_{13}H_{16}F_3NO_3$	53.60	5.49	4.81	53.37	5.54	5.01
5	Ph	*n*-Bu		HCl	170–173	MeOH–EtOAc	$C_{12}H_{18}ClNO$	62.06	7.97	6.03[e]	61.92	7.83	6.12
5	Ph	*n*-Bu		TFA	95–98	EtOAc	$C_{14}H_{18}F_3NO_3$	54.28	6.02	4.52[e]	54.30	5.83	4.81
5	$PhCH_2CH_2$	Me		HCl	60–63	MeOH–EtOAc	$C_{11}H_{16}ClNO$	59.32	7.64	6.29[g]	59.14	7.40	6.19
5	$PhCH_2CH_2$	*n*-Bu		HCl	157–159	MeOH–EtOAc	$C_{14}H_{22}ClNO$	65.75	8.61	5.47	65.80	8.72	5.66
7	Ph		3	HCl	74–75	MeOH–EtOAc	$C_{11}H_{14}ClNO$	59.86	6.80	6.34[g]	60.00	6.54	6.48
7	Ph		4	HCl	225–227[h]	MeOH–EtOAc	$C_{12}H_{16}ClNO$	63.85	7.09	6.20	63.61	6.88	6.24
7	$PhCH_2CH_2$		3	HCl	149–152	MeOH–EtOAc	$C_{13}H_{18}ClNO$	65.13	7.51	5.84	64.86	7.30	5.87
7	$PhCH_2CH_2$		4	HCl	200–203	MeOH–EtOAc	$C_{14}H_{20}ClNO$	66.27	7.88	5.52	66.15	7.89	5.54

[a]Value of *m/e*: 303.1834 (calcd. for $C_{18}H_{25}NO_3$: 303.1835).
[b]Literature (24) mp 185–189°C; (25) mp 184°C.
[c]Trifluoroacetic acid salt.
[d]Literature (26) mp 178°C.
[e]Analysis calcd. for 0.25 H_2O.
[f]Literature (25) mp 208–209°C.
[g]Analysis calcd. for hemihydrate.
[h]Free base mp 89–91°C (EtOAc); lit. (21) mp 92°C.

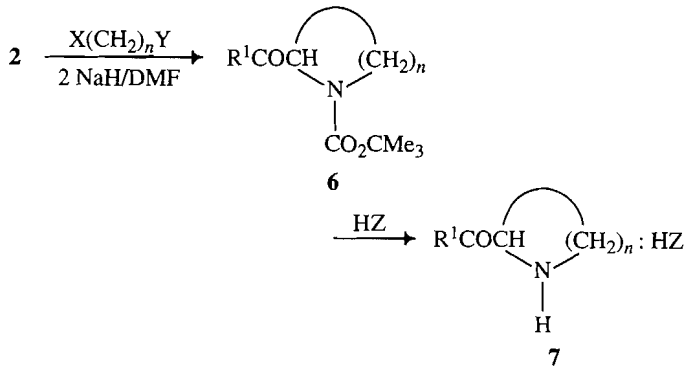
TABLE 4. Spectral properties of α-amino ketones and derivatives

Compound no.	R^1	R^2	HZ	n	Infrared (cm^{-1})[a]	Nuclear magnetic resonance (δ)[b]
4	Ph	Me			3513, 3413, 1711, 1691	1.41 (d, 2H, J = 7.15 Hz, Me), 1.46 (s, 9H, *t*-Bu), 5.30 (dd, 2H, J = 7.15 Hz, $J_{H,NH}$ = 7.5 Hz, CH), 5.58 (bd, 1H, $J \approx$ 7.5 Hz, NH), 7.46–7.65 (m, 3H), 7.98 (m, 2H)
4	Ph	*i*-Pr			3412, 1713, 1690	0.75 (d, 3H, J = 6.96 Hz, Me_2CH), 1.04 (d, 3H, J = 6.76 Hz, Me_2CH), 1.46 (s, 9H, *t*-Bu), 2.15 (m, 1H, Me_3CH), 5.23 (dd, 1H, J = 4.0 Hz, $J_{H,NH}$ = 4.0 Hz, CHNH), 5.44 (bd, 1H, NH), 7.47–7.65 (m, 3H), 7.98 (d, 1H, $J \approx$ 7.1 Hz)[c]
6	Ph			3	1698, 1683(sh)	1.27 (s, 5.4 H, *t*-Bu), 1.47 (s, 3.6 H, *t*-Bu), 1.94, 2.31 (multiplets, total 4H, CH_2CH_2), 3.42–3.77 (m, 2H, CH_2N), 5.21 (dd, 0.6 H, J_{AX} = 3.9 Hz, J_{BX} = 8.7 Hz, CHN), 5.35 (dd, 0.4H, J_{AX} = 3.2 Hz, J_{BX} = 8.9 Hz, CHN), 7.43–7.61 (m, 3H), 7.99 (m, 2H)
4	$PhCH_2CH_2$	Me			3334, 1712, 1674	1.11 (d, 3H, J = 7.3 Hz, Me), 1.44 (s, 9H, *t*-Bu), 2.66–3.03 (m, 1H, CH), 5.17 (bm, NH), 7.03–7.37 (m, 5H)[c]
6	$PhCH_2CH_2$			3	1723, 1687	1.38 (s, 5.4 H, *t*-Bu), 1.46 (s, 3.6 H, *t*-Bu), 1.80, 2.45 (multiplets, total 4H, CH_2CH_2), 2.71 (m, 4H, $PhCH_2CH_2$), 3.39–3.57 (m, 2H, CH_2N), 4.22 (dd, 0.6 H, J_{AX} = 5.3 Hz, J_{BX} = 8.4 Hz, CH), 4.33 (dd, 0.4 H, J_{AX} = 4.5 Hz, J_{BX} = 8.6 Hz, CH), 7.17–7.32 (m, 5H)
5	Ph	*n*-Bu	HCl		2635, 2525, 1701	0.78 (t, 3H, $J \approx$ 6.5 Hz, CH_3), 1.00–1.47 (Me, 4H, CH_2CH_2), 1.70–1.90 (m, 2H, $CHCH_2$), 5.08 (t, 1H, J = 5.7 Hz, CH), 7.49–7.52 (m, 3H), 8.04 (dd, 2H, J_o = 7.5 Hz, J_m = 1.2 Hz), 8.59 (bm, 3H, NH_3^+)
5	$PhCH_2CH_2$	Me	HCl		2659, 2584, 2478, 2442, 1722	1.39 (d, 3H, J = 7.0 Hz, Me), 2.69–3.08 (m, 4H, CH_2CH_2), 4.09 (q, 1H, J = 7.0 Hz, CH), 7.24 (s, 5H), 8.50 (bs, 3H, NH_3^+)
7	Ph		HCl	3	2738, 1687	1.75–2.09, 2.56 (multiplets, total 4H, CH_2CH_2), 3.28 (bt, 2H, $J \approx$ 5.7 Hz, CH_2N), 5.36 (bt, 1H, CHN), 7.59–7.81 (m, 4H), 8.10 (d, 2H, J = 8.2 Hz), 8.82 (bs, 2H, NH_2^+)
7	$PhCH_2CH_2$		HCl	3	2741, 2711, 2664, 2550, 2452, 1712	1.86, 2.33 (multiplets, total 4H, CH_2CH_2), 2.81–3.03 (m, 4H, $PhCH_2CH_2$), 3.17 (t, 2H, J = 6.6 Hz, NCH_2), 4.49 (t, 1H, J = 7.6 Hz, CHN), 7.22 (m, 5H)

[a]N-*t*-Boc compounds measured in $CHCl_3$; HCl salts obtained as dispersions in KBr.
[b]N-*t*-Boc compounds measured in $CDCl_3$; HCl salts in DMSO-d_6. Spectra measured at 200 MHz unless indicated otherwise.
[c]Measured at 90 MHz.

availability of **2**, this process constitutes a very useful route to such compounds for which few syntheses have been reported (21–23).

In summary, α-*tert*-butoxycarbonylamino ketones **2** are readily transformed into α-alkyl-α-amino ketones, 2-acylpyrrolidines, and 2-acylpiperidines. In this respect, they (i.e., **2**) are as synthetically useful as the corresponding formamido compounds and this fact adds flexibility to synthetic sequences in which the use thereof is contemplated.



SCHEME 3

Experimental

The melting points were determined in a Buchi model 510 melting point apparatus and are not corrected. The infrared spectra were measured with Perkin–Elmer 1720-X, 1420, or 197 infrared spectrophotometers. The ^1H nmr spectra were obtained with a Varian EM-390 or a Varian Gemini-200 nmr spectrometer and are expressed as parts per million (δ) from internal tetramethylsilane. The high-resolution mass spectra were obtained with a Finnigan MAT 311A mass spectrometer.

Phenacylamine hydrochloride (**1**, R^1 = Ph) and 1-amino-4-phenyl-2-butanone hydrochloride (**1**, $R^1 = PhCH_2CH_2$) were synthesized by the method of Ackrell *et al.* (9).

*2-N-tert-Butoxycarbonylaminoacetophenone (**2**, R^1 = Ph)*

Di-*tert*-butyl dicarbonate (10.36 g, 49.5 mmol), triethylamine (12.2 mL, 8.84 g, 87.5 mmol), and 4-dimethylaminopyridine (0.48 g, 3.9 mmol) were added to a stirred suspension of 2-aminoacetophenone hydrochloride (6.80 g, 39.6 mmol) in acetonitrile (100 mL). The mixture was stirred at room temperature for 0.5 h, the solvent was removed *in vacuo*, and the residue was subjected to column chromatographic purification on silica gel. The product (5.86 g, 63% yield) was eluted with hexane – ethyl acetate (95:5). After crystallization from dichloromethane–hexane it had mp 56–57°C; ir ($CHCl_3$): 3508, 3408, 1711, 1691 cm^{-1}; nmr ($CDCl_3$, 90) δ: 1.48 (s, 9H, *t*-Bu), 4.63 (d, 2H, J = 4.8 Hz, singlet after D_2O exchange, CH_2), 5.51 (bs,

1H, exchanged with D_2O, NH), 7.37–7.71 (m, 3H), 7.91–8.01 (m, 2H). Anal. calcd. for $C_{13}H_{17}NO_3$: C 66.38, H 7.23, N 5.95; found: C 66.29, H 7.25, N 5.93.

*1-N-tert-Butoxycarbonylamino-4-phenyl-2-butanone (**2**, $R^1 = PhCH_2CH_2$)*

This compound was prepared in the manner described above. It was obtained in 46% yield as an oil; ir ($CHCl_3$): 3434, 1703 cm^{-1}; nmr ($CDCl_3$, 90) δ: 1.43 (s, 9H, *t*-Bu), 2.59–2.99 (m, 4H, CH_2CH_2), 3.91 (d, 2H, J = 4.5 Hz, singlet after D_2O exchange, CH_2), 5.11 (s, 1H, exchanged with D_2O, NH), 7.08–7.24 (m, 5H, C_6H_5); *m/e*: 263.1521 (calcd. for $C_{15}H_{21}NO_3$: 263.1522).

*Monoalkylation of the α-tert-butoxycarbonylamino ketones **1***

A solution of the α-*tert*-butoxycarbonylamino ketone (2.0 mmol) in anhydrous DMF (5 mL) was added to a stirred suspension of sodium hydride (prepared from 0.10 g (2.1 mmol) of a 50% dispersion in mineral oil by washing with dry hexane) in dry DMF (5 mL) maintained in a nitrogen atmosphere at 0°C. After the addition was completed, stirring at 0°C was continued until hydrogen evolution was complete (0.25 h) and then the alkyl halide (2.4 mmol) was added. After a further 1 h at 0°C the reaction mixture was poured into saturated aqueous ammonium chloride solution, the product was extracted into ethyl acetate, the extract was washed with saturated salt solution, and then it was dried over sodium sulfate. The solvent was removed *in vacuo* and the residue was subjected to column chromatography on silica gel using hexane – ethyl acetate (95:5) as the eluting solvent. The less polar product of unknown structure was removed first, followed by the desired product and the starting material. The product yields are found in Table 1 and the physical constants in Table 3. The nmr and infrared spectra of selected compounds are found in Table 4. The remaining spectral data (Table 5) can be obtained from the Depository of Unpublished Data.[7]

*Alkylation of the α-tert-butoxycarbonylamino ketones **1** with α,ω-dihalides*

This alkylation reaction was carried out as described above except that 2.1 equivalents of sodium hydride were used.

*Synthesis of the alkylated α-amino ketone hydrochlorides of **5** and **7***

A solution of the alkylated α-*tert*-butoxycarbonylamino ketone (0.3 mmol) in methanol (15 mL) containing concentrated hydrochloric acid (0.14 mL, ~1.5 mmol) was heated at reflux temperature for 1 h. The solvent was removed *in vacuo* and the solid residue was crystallized from methanol – ethyl acetate. The product yields are found in Table 2 and the physical constants in Table 3. The spectroscopic data are compiled in Tables 4 and 5.

*Synthesis of the alkylated α-amino ketone trifluoroacetates of **5** and **7***

A solution of the alkylated α-*tert*-butoxycarbonylamino ketone (0.4 mmol) in dichloromethane (15 mL) containing trifluoroacetic acid (0.15 mL, 0.23 g, 2 mmol) was left at room temperature for 24 h. A further 2 mmol of the acid was added and after an additional 24 h the solvent was removed *in vacuo*. The solid residue was crystallized from ethyl acetate. The product yields are found in Table 2 and the physical constants are given in Table 3.

[7]This table may be purchased from: The Depository of Unpublished Data, Document Delivery, CISTI, National Research Council Canada, Ottawa, Canada K1A 0S2.

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