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A new method for generation of non-stabilized α-amino-substituted carbanions by the reaction of magnesium carbenoids with *N*-lithio arylamines: their reactivity and a new synthesis of α-amino acid derivatives

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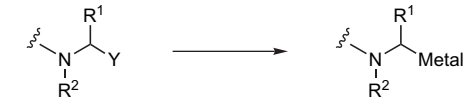
Abstract—Magnesium carbenoids were generated from aryl 1-chloroalkyl sulfoxides with *i*-PrMgCl in THF at low temperature in quantitative yields. The magnesium carbenoids were found to be reactive with *N*-lithio alkylamines to afford an olefin, which was derived from dimerization of the magnesium carbenoid, in moderate yield. On the other hand, reaction of the magnesium carbenoids with *N*-substituted *N*-lithio arylamines gave non-stabilized α-amino-substituted carbanions in good yields. Reactivity of the α-amino-substituted carbanions with some electrophiles was investigated and it was found that ethyl chloroformate reacted to give α-amino acid derivatives in good yields. As a whole, a new method for one-pot, three-component combined synthesis of α-amino acid derivatives from aryl 1-chloroalkyl sulfoxides was realized.

1. Introduction

α-Amino-substituted carbanions **2** are quite interesting reactive intermediates in the synthesis of amines and α-amino acid derivatives.[1–4] They are classified into two categories: stabilized α-amino-substituted carbanions **2a**[1,2] and non-stabilized α-amino-substituted carbanions **2b**.[3,4] The substituent R^1 of the stabilized α-amino-substituted carbanions **2a** is usually an alkyl-, alkenyl-, or aryl group and the substituent R^2 is generally a *tert*-butoxycarbonyl (Boc) group. Generation of **2a** is carried out by hydrogen–lithium (H–Li) exchange reaction or by tin–lithium (Bu_3Sn–Li) exchange reaction from the corresponding **1**.

On the other hand, non-stabilized α-amino-substituted carbanions **2b** are generated from **1** with Bu_3Sn–Li exchange reaction and fewer examples are reported.[4] Only lithium is reported so far as the metal of the α-amino-substituted carbanions **2** (Scheme 1).

Carbenes and carbenoids have been well known as a highly reactive carbon species and are recognized as useful intermediates in organic synthesis.[5] Recently, we have been interested in the generation of magnesium carbenoids from α-halo sulfoxides via sulfoxide–magnesium exchange reaction[6] and applications of the generated magnesium carbenoids to new methods for organic synthesis.[7] In continuation of our interest in the chemistry of the magnesium carbenoids, we recently studied the generation of simple magnesium carbenoids **4** from aryl 1-chloroalkyl sulfoxides **3** with isopropylmagnesium chloride and the reaction of magnesium carbenoids **4** with nitrogen nucleophiles (Scheme 2).



2a Stabilized: R^1 and/or R^2=Carbanion stabilizing group

2b Non-stabilized: R^1 and R^2=Carbanion non-stabilizing group

Scheme 1.

Interestingly, the reaction of magnesium carbenoid **4** with *N*-lithio alkylamine gave an olefin **5** (dimerized product of the carbenoid). In sharp contrast to this result, the reaction of **4** with several *N*-lithio *N*-substituted arylamines afforded

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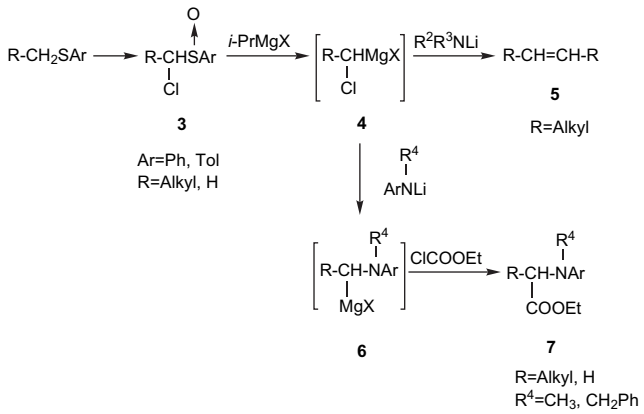


Scheme 2.

the non-stabilized α-amino-substituted carbanions **6**. We investigated the reactivity of the α-amino-substituted carbanions **6** with several electrophiles and found that the reaction with ethyl chloroformate gave α-amino acid derivatives **7** in good yields (Scheme 2).[8]

Herein we report in detail the generation of non-stabilized α-amino-substituted carbanions **6** from magnesium carbenoids **4** with *N*-lithio *N*-substituted arylamines and a study of their reactivity with some electrophiles. A new one-pot, three-component combined synthesis of α-amino acid derivatives **7** from **3**, including glycine derivatives, is described.

2. Results and discussion

2.1. Generation of the magnesium carbenoid and the reaction with *N*-lithio alkylamines

At first, 1-chloro-3-(4-methoxyphenyl)propyl phenyl sulfoxide **3a** was synthesized from 3-(4-methoxyphenyl)propyl phenyl sulfide[9] and it was treated with 2.5 equiv of *i*-PrMgCl at −70 °C in THF to give cleanly magnesium carbenoid **4a** in a quantitative yield.[9] To this solution was added 5 equiv of *N*-lithio piperidine (generated from piperidine and *n*-BuLi) through a cannula and the temperature of the reaction mixture was slowly allowed to warm to −40 °C for 1 h.

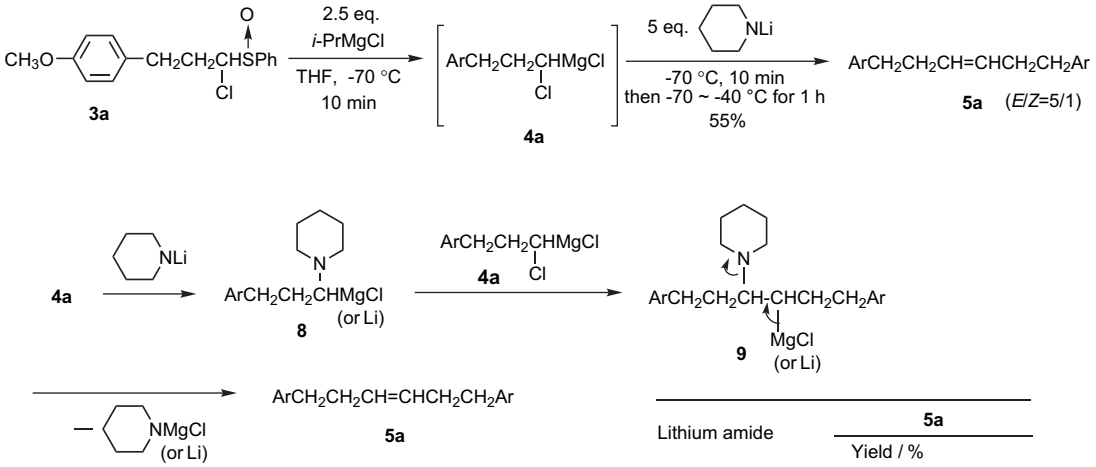
We anticipated the reaction of the carbenoid **4a** with *N*-lithio piperidine would give the *N*-alkylated product; however, unexpectedly, an olefin **5a** (dimer of the carbenoid **4a**) was obtained in 55% yield. The produced olefin **5a** was found to be a mixture of two geometrical isomers (*E*/*Z*=5:1).[10] Quite interestingly, olefin **5a** was not obtained at all from carbenoid **4a** in the absence of *N*-lithio piperidine. Obviously, *N*-lithio piperidine is essential in this olefin formation (Scheme 3).

The reaction of the generated magnesium carbenoid **4a** with lithium diisopropylamide and lithium *tert*-butylamide gave also olefin **5a** in 37% and 46% yield, respectively (see the table in Scheme 3). Again, the product **5a** was a mixture of two geometrical isomers and the ratio of the two isomers was found to be variable by the used lithium amide.

A plausible mechanism for the formation of the olefin **5a** is proposed in Scheme 3. Thus, magnesium carbenoid **4a** reacted with *N*-lithio piperidine to give the α-amino-substituted carbanion **8** (metal was magnesium or lithium), which reacted again with carbenoid **4a** to give **9**. β-Elimination of *N*-magnesio (or lithio) piperidine from **9** afforded olefin **5a**.

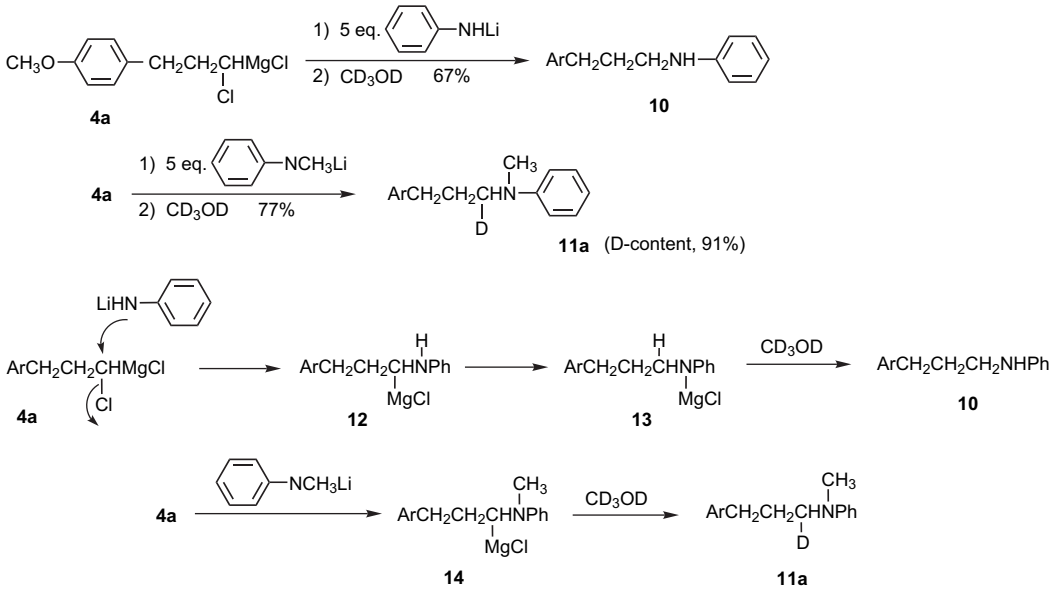
2.2. Reaction of the generated magnesium carbenoids with *N*-lithio arylamines

We next investigated the reaction of magnesium carbenoid **4a** with *N*-lithio arylamines (Scheme 4). In contrast to the reaction of **4a** with *N*-lithio alkylamines, the reaction with *N*-lithio aniline gave *N*-alkylaniline **10** in 67% yield. In order to know if the intermediate of this reaction was α-amino-substituted carbanion **12**, the reaction mixture was quenched with excess CD_3OD; however, no deuterium was incorporated on the α-carbon in the *N*-alkylaniline **10**. Next, magnesium carbenoid **4a** was treated with 5 equiv of



Lithium amide	5a Yield / %	
i-Pr_2NLi	37	*E*/*Z*=4/1
t-BuNHLi	46	*E*/*Z*=2/1

Scheme 3. Treatment of magnesium carbenoid **4a** with *N*-lithio alkylamines to give olefin **5a** and a plausible mechanism for the formation of the olefin.



Scheme 4. Treatment of magnesium carbenoid **4a** with *N*-lithio aniline and *N*-lithio *N*-methylaniline, and a plausible mechanism for the formation of *N*-alkylaniline **10** and *N*-(1-deuterated alkyl)-*N*-methylaniline **11a**.

N-lithio *N*-methylaniline under the same conditions as above, and the reaction mixture was quenched with excess CD_3OD. We obtained the *N*,*N*-dialkylaniline **11a** in 77% yield and the product was deuterated on the α-carbon and the deuterium incorporation was found to be 91% judging from its ^1H NMR spectra. A plausible mechanism of this interesting reaction is shown in Scheme 4.

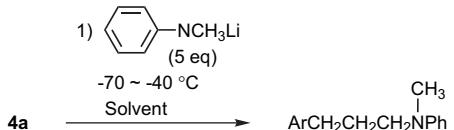
The reaction of the magnesium carbenoid with *N*-lithio aniline gave the desired α-amino-substituted carbanion **12**. As carbanion **12** has an acidic hydrogen on the nitrogen, the carbanion quickly picks up this acidic hydrogen to give **13**. So, as described above, on quenching this reaction with CD_3OD no deuterium was incorporated on the α-carbon. In contrast to this, the reaction of **4a** with *N*-lithio *N*-methylaniline provided the α-amino-substituted carbanion **14**, which has no acidic hydrogen on the nitrogen, to give the product **11a** deuterated at the α-position.

Generation of the non-stabilized α-amino-substituted carbanions is well recognized to be quite difficult from unactivated amines. The results obtained in this study are highly notable as a new method for generation of non-stabilized α-amino carbanions.[3,4]

We investigated the best conditions for the reaction of **4a** with *N*-lithio *N*-methylaniline and the results are summarized in Table 1. As shown in Table 1, DME or HMPA as additive gave almost the same results (entries 2 and 3). Toluene as a solvent gave much lower yield (entry 4). A mixture of toluene–DME and diethyl ether–THF did not show any good result (entries 5 and 6). We decided to use THF as a solvent without any additive throughout this study.

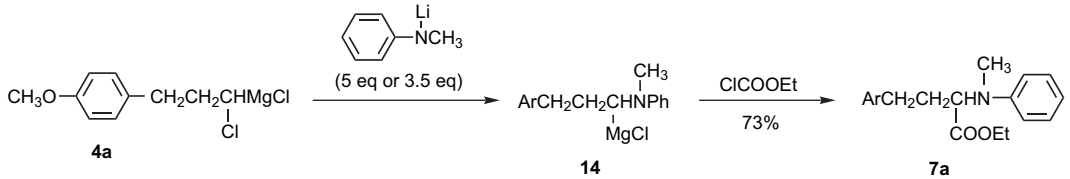
Next, we investigated trapping the generated non-stabilized α-amino carbanion **14** with electrophiles other than deuterium (Scheme 5). After the generation of carbanion **14** at −70 to −40 °C, 5 equiv of aldehydes (benzaldehyde and propionaldehyde), acetophenone, benzoyl chloride, or propionyl chloride were added. Carbanion **14** proved to show quite low reactivity and all these reactions gave only a rather complex mixture with the protonated product **11b**.

Table 1. Reaction of magnesium carbenoid **4a** with *N*-lithio *N*-methylaniline in several solvents



Entry	Solvent	**11b**
		Yield/%
1	THF	77
2	THF+DME (6 equiv)[a]	79
3	THF+HMPA (6 equiv)[a]	78
4	Toluene	47
5	Toluene+DME (6 equiv)[a]	56
6	Diethyl ether+THF (4:1)	49

[a] Corresponding to **4a**.



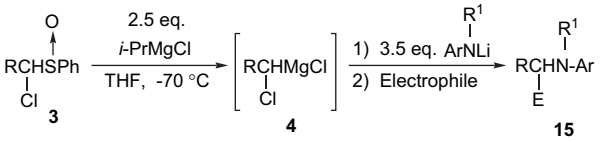
Scheme 5. Treatment of magnesium carbenoid **4a** with *N*-lithio *N*-methylaniline followed by ethyl chloroformate to give α-amino acid derivative **7a**.

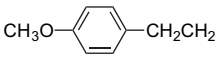
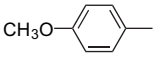
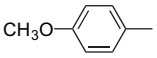
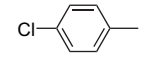
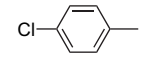
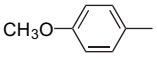
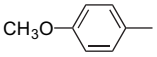
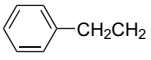
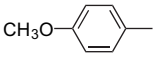
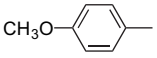
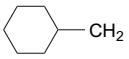
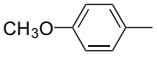
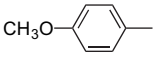
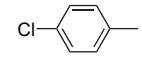
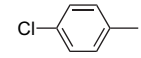
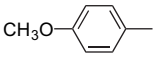
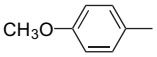
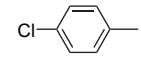
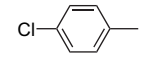
Fortunately, addition of 5 equiv of ethyl chloroformate gave a clean reaction mixture and the desired ethoxycarbonylated product, α-amino acid ester, **7a** was obtained in 73% yield (Scheme 5). After some further investigation for improvement of this reaction, reducing of *N*-lithio *N*-methylaniline to 3.5 equiv was found to be enough to give the same yield. We used 3.5 equiv of *N*-lithio *N*-substituted arylamines and 5 equiv of ethyl chloroformate in this new method for the synthesis of α-amino acid derivatives **7** (vide infra).

2.3. Investigation for generality of the new synthetic method of α-deuterio amines and α-amino acid ethyl esters

Generality of the above-mentioned reaction was investigated using four kinds of 1-chloroalkyl phenyl sulfoxides **3** and *N*-methyl-*p*-anisidine, *N*-benzyl-*p*-anisidine, and *N*-methyl-*p*-chloroaniline. The results are summarized in Table 2.

Table 2. Synthesis of α-deuterio *N*,*N*-dialkyl arylamines and α-amino acid esters from magnesium carbenoids **4** by the reaction with *N*-lithio *N*-substituted arylamines followed by methanol-d_4 or ethyl chloroformate



Entry	3	Ar	R^1	Electrophile	E	15
	R					Yield/%
1	 **3a**		CH_3	CD_3OD	D	**15a** 81%[a]
2	**3a**		CH_3	ClCOOEt	COOEt	**15b** 74%
3	**3a**		CH_3	CD_3OD	D	**15c** 79%[a]
4	**3a**		CH_3	ClCOOEt	COOEt	**15d** 73%
5	**3a**		$PhCH_2$	CD_3OD	D	**15e** 69%[b]
6	**3a**		$PhCH_2$	ClCOOEt	COOEt	**15f** 67%
7	 **3b**		$PhCH_2$	CD_3OD	D	**15g** 73%[c]
8	**3b**		$PhCH_2$	ClCOOEt	COOEt	**15h** 71%
9	 **3c**		CH_3	CD_3OD	D	**15i** 70%[b]
10	**3c**		CH_3	ClCOOEt	COOEt	**15j** 68%
11	**3c**		CH_3	CD_3OD	D	**15k** 72%[c]
12	**3c**		CH_3	ClCOOEt	COOEt	**15l** 68%
13	 **3d**		CH_3	CD_3OD	D	**15m** 48%[d]
14	**3d**		CH_3	ClCOOEt	COOEt	**15n** 48%
15	**3d**		CH_3	CD_3OD	D	**15o** 42%[b]
16	**3d**		CH_3	ClCOOEt	COOEt	**15p** 41%

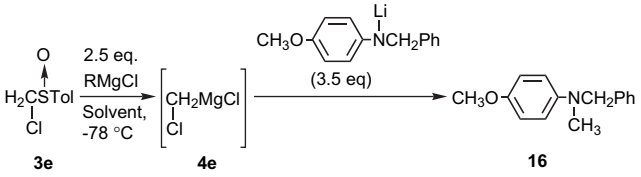
[a] D-content 90%.
[b] D-content 97%.
[c] D-content 95%.
[d] D-content 99%.

Entries 1–6 show that the reaction of the magnesium carbenoid generated from **3a** with three kinds of arylamines, *N*-methyl-*p*-anisidine, *N*-methyl-*p*-chloroaniline, and *N*-benzyl-*p*-anisidine, gave equally good yields (67–81%) of the α-deuterio amines or α-amino acid derivatives. The reaction starting from the sulfoxide having a 2-phenylethyl group as R (**3b**) gave similar results (entries 7 and 8). Entries 9–12 show the reaction starting from sulfoxide **3c** having a cyclohexylmethyl group as R. The results were shown to be almost equal to those described above. Interestingly, the reaction starting from the sulfoxide having a cyclohexyl group as R (**3d**) showed markedly diminished yield of the α-deuterio amines and α-amino acid derivatives (entries 13–16). Steric hindrance or the stability of the generated magnesium carbenoid is thought to be the reason for the lowering of the yield.

2.4. Synthesis of glycine derivatives

We further investigated the generation of magnesium methylidene **4e** from chloromethyl *p*-tolyl sulfoxide **3e** with *i*-PrMgCl at −78 °C and trapping of the carbenoid with *N*-lithio *N*-benzyl-*p*-anisidine (Table 3). Thus, a solution of **3e** in THF was added to a solution of *i*-PrMgCl (2.5 equiv) in THF at −78 °C and after 10 min a solution of *N*-lithio *N*-benzyl-*p*-anisidine was added to the reaction mixture. The temperature of the reaction mixture was slowly allowed to warm to −40 °C. We obtained the desired **16**; however, the yield was only 23% (entry 1).

Table 3. Generation of magnesium carbenoid **4e** from chloromethyl *p*-tolyl sulfoxide **3e** with Grignard reagent and the trapping of **4e** with *N*-lithio *N*-benzyl-*p*-anisidine



Entry	Solvent	RMgCl	Temperature	**16**
				Yield/%
1	THF	*i*-PrMgCl	−78 to −40 °C[a]	23
2	THF	*i*-PrMgCl	−78 to −70 °C[b]	36
3	THF	*i*-PrMgCl	−78 to −40 °C[b]	65
4	THF	*i*-PrMgBr	−78 to −40 °C[b]	32
5	THF	EtMgCl	−78 to −40 °C[b]	15
6	Toluene	*i*-PrMgCl	−78 to −40 °C[b]	20

[a] *N*-Lithio arylamine was added after 10 min.
[b] *N*-Lithio arylamine was added immediately after generation of magnesium carbenoid **4e**.

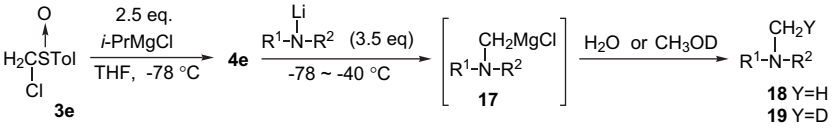
After some investigation, as we found that the generated carbenoid **4e** was fairly unstable, it was immediately treated with *N*-lithio *N*-benzyl-*p*-anisidine to give better yield (entry 2). Finally, the conditions shown in entry 3 were found to be the choice for this reaction. We further investigated other conditions shown in entries 4–6; however, all the trials were ineffective.

Next, magnesium carbenoid **4e** was treated with *N*-lithio amines and the generated α-amino-substituted carbanions **17** were treated with water or methanol-d_1 (Table 4). The reaction of **4e** with *N*-lithio *N*-benzyl-*p*-anisidine followed by CH_3OD gave the deuterated amine **19a** with 96% deuterium incorporation (entry 2). The reaction with *N*-lithio *N*-methyl-*p*-anisidine gave the desired amine **18b** or deuterated amine **19b**; however, the yield was not satisfactory (entries 3 and 4). Interestingly the reaction of the magnesium methylidene **4e** with *N*-lithio alkylamine (dibenzylamine) gave **18c** and **19c** in 31% yield.

Finally, we studied the reaction for the synthesis of glycine derivatives by the trapping of the generated α-amino-substituted carbanions **17** with ethyl chloroformate (Table 5). The reaction of magnesium carbenoid **4e** with *N*-lithio *N*-benzyl-*p*-anisidine followed by ethyl chloroformate gave the desired α-amino acid ester **20a** in 58% yield. Although the yield of the corresponding amine **18b** was 35%, the glycine derivative **20b** was obtained in moderate yield (entry 2). The reaction using *N*-methyl-*p*-chloroaniline and *N*-methylaniline gave the desired amino acid ethyl ester **20c** and **20d**; however, the yields were low (entries 3 and 4). As shown in entry 5, although the yield was low, *N*,*N*-dibenzylglycine ethyl ester **20e** could be synthesized by this method.

In conclusion, we have found a novel and versatile method for generation of non-stabilized α-amino-substituted carbanions by the reaction of magnesium carbenoids with *N*-lithio *N*-alkyl arylamines. Trapping the non-stabilized

Table 4. Generation of magnesium carbenoid **4e** from chloromethyl *p*-tolyl sulfoxide **3e** with Grignard reagent and the trapping of **4e** with *N*-lithio amines followed by water or methanol-d_1



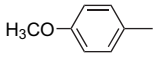
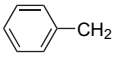
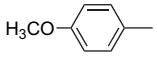
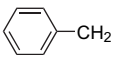
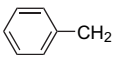
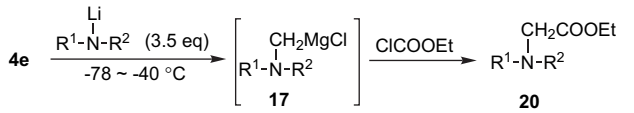
Entry	Amine		Electrophile	**16**, **18** or **19**	
	R^1	R^2		Yield/%	(D content/%)
1			H_2O	**16**	65
2			CH_3OD	**19a**	65 (96)
3		CH_3	H_2O	**18b**	35
4			CH_3OD	**19b**	35 (99)
5			H_2O	**18c**	31
6			CH_3OD	**19c**	31 (99)

Table 5. Synthesis of glycine derivatives **20** from magnesium carbenoid **4e** with *N*-lithio amines followed by ethyl chloroformate



Entry	Amine		**20**
	R^1	R^2	Yield/%
1	H_3CO	CH_2	**20a** 58
2	H_3CO	CH_3	**20b** 61
3	Cl	CH_3	**20c** 30
4		CH_3	**20d** 23
5	CH_2	CH_2	**20e** 25
6			0

α-amino-substituted carbanions with deuterated methanol gave amines having the alkyl group deuterated at the α-position. Trapping the carbanions with ethyl chloroformate gave α-amino acid ethyl esters. As a whole, a novel method for the synthesis of α-amino acid derivatives from three components, aryl 1-chloroalkyl sulfoxide, *N*-alkyl arylamines, and ethyl chloroformate, in one flask was realized.

3. Experimental

3.1. General

^{1}H NMR spectra were measured in a $CDCl_3$ solution with JOEL JNM-LA 500 spectrometer. Electron-impact mass spectra (MS) were obtained at 70 eV by direct insertion. Silica gel 60 (Merck) containing 0.5% fluorescence reagent 254 and a quartz column were used for column chromatography and the products having UV absorption were detected by UV irradiation. In experiments requiring a dry reagent and solvent, THF was distilled from diphenylketyl. Piperidine, diisopropylamine, *tert*-butylamine, and toluene were dried over CaH and distilled before use. HMPA were dried over $CaSO_4$ and distilled before use. 1-Chloroalkyl phenyl sulfoxides **3a–d** were synthesized from the corresponding alcohols (or halides) via the sulfides in the same way as described before.[9,12]

3.1.1. 1,6-Di(4-methoxyphenyl)-3-hexene (5a). To a solution of *i*-PrMgCl (0.5 mmol) in 0.5 mL of dry THF in a flame-dried flask at −70 °C under argon atmosphere was added a solution of **3a**[9] (62 mg; 0.2 mmol) in 0.4 mL of dry THF dropwise with stirring. The reaction mixture was stirred at −70 °C for 10 min. To a solution of the generated magnesium carbenoid **4a** was added a solution of *N*-lithio piperidine [prepared from piperidine (1 mmol) and *n*-BuLi (1.2 mmol) in 2 mL of THF at 0 °C and the solution was cooled to −70 °C] through a cannula with stirring. The reaction mixture was slowly allowed to warm to −40 °C for 1 h and the reaction mixture was quenched with satd aq NH_4Cl. The whole was extracted with $CHCl_3$ and the organic layer was washed with satd aq NH_4Cl and dried over $MgSO_4$. The product was purified by silica gel column chromatography to afford **5a** (33 mg; 55%) as a colorless oil (a mixture of two geometrical isomers; the ratio is about *E*/*Z*=5:1). IR (neat) 3010, 2933, 1611, 1510, 1245, 1037, 757 cm^{-1}; ^{1}H NMR δ 2.24–2.26 (4H, m), 2.52 (0.7H, t, *J*=7.8 Hz), 2.59 (3.3H, t, *J*=7.8 Hz), 3.78 (6H, s), 5.40 (0.3H, t, *J*=4.7 Hz), 5.46 (1.7H, t, *J*=3.7 Hz), 6.81 (4H, d, *J*=8.5 Hz), 7.07 (4H, d, *J*=8.5 Hz). MS *m*/*z* (%) 296 (M^+, 15), 121 (100). Calcd for $C_{20}H_{24}O_2$: M, 296.1774. Found: *m*/*z* 296.1774.

3.1.2. Ethyl 4-(4-methoxyphenyl)-2-(*N*-methyl-*N*-phenylamino)butyrate (7a). To a solution of *i*-PrMgCl (0.5 mmol) in 0.5 mL of dry THF in a flame-dried flask at −70 °C under argon atmosphere was added a solution of **3a** (62 mg; 0.2 mmol) in 0.4 mL of dry THF dropwise with stirring. The reaction mixture was stirred at −70 °C for 10 min. To a solution of the generated magnesium carbenoid **4a** was added a solution of *N*-lithio *N*-methylaniline [prepared from *N*-methylaniline (1 mmol) and *n*-BuLi (1.2 mmol) in 2 mL of THF at 0 °C and the solution was cooled to −70 °C] through a cannula with stirring. The reaction mixture was slowly allowed to warm to −40 °C for 1 h. To a solution of the α-amino-substituted carbanion **14** was added ethyl chloroformate (1 mmol) dropwise at −40 °C with stirring. After 20 min, the reaction mixture was quenched with satd aq NH_4Cl. The whole was extracted with $CHCl_3$ and the organic layer was washed with satd aq NH_4Cl and dried over $MgSO_4$. The product was purified by silica gel column chromatography to afford **7a** (48 mg; 73%) as colorless oil; IR (neat) 2955, 1731 (CO), 1600, 1512, 1301, 1247, 1179, 1036, 751, 693 cm^{-1}; ^{1}H NMR δ 1.21 (3H, t, *J*=7.0 Hz), 2.11–2.18 (1H, m), 2.20–2.28 (1H, m), 2.53–2.59 (1H, m), 2.64–2.70 (1H, m), 2.93 (3H, s), 3.78 (3H, s), 4.09–4.17 (2H, m), 4.31 (1H, dd, *J*=9.3, 5.5 Hz), 6.75 (3H, m), 6.80 (2H, d, *J*=8.6 Hz), 7.05 (2H, d, *J*=8.6 Hz), 7.22 (2H, m). MS *m*/*z* (%) 327 (M^+, 20), 254 (75), 132 (9), 121 (100), 91 (9). Calcd for $C_{20}H_{25}NO_3$: M, 327.1835. Found: *m*/*z* 327.1838.

3.1.3. *N*-[3-(4-Methoxyphenyl)propyl]aniline (10). To a solution of *i*-PrMgCl (0.5 mmol) in 0.5 mL of dry THF in a flame-dried flask at −70 °C under argon atmosphere was added a solution of **3a** (62 mg; 0.2 mmol) in 0.4 mL of dry THF dropwise with stirring. The reaction mixture was stirred at −70 °C for 10 min. To a solution of the generated magnesium carbenoid **4a** was added a solution of *N*-lithio aniline [prepared from aniline (1 mmol) and *n*-BuLi (1.2 mmol) in 2 mL of THF at 0 °C and the solution was cooled to −70 °C] through a cannula with stirring. The reaction mixture was slowly allowed to warm to −40 °C for 1 h. The reaction mixture was quenched with excess CD_3OD. The whole was extracted with $CHCl_3$. The organic layer was washed satd aq NH_4Cl and dried over $MgSO_4$. The product was purified by silica gel column chromatography to afford **10** (32 mg; 67%) as colorless oil; IR (neat) 3404, 2933, 2835, 1604, 1512, 1246, 1178, 1035, 750, 693 cm^{-1}; ^{1}H NMR δ 1.91 (2H, quintet, *J*=7.3 Hz), 2.67 (2H, t, *J*=7.3 Hz), 3.12 (2H, t, *J*=7.3 Hz), 3.59 (1H, s), 3.79 (3H,

s), 6.57 (2H, d, J=8.8 Hz), 6.68 (1H, t, J=7.3 Hz), 6.83 (2H, d, J=8.6 Hz), 7.11 (2H, d, J=8.3 Hz), 7.16 (2H, m). MS m/z (%) 241 (M^+, 50), 148 (37), 121 (13), 106 (100), 93 (11), 77 (16). Calcd for $C_{16}H_{19}NO$: M, 241.1465. Found: m/z 241.1463.

3.1.4. *N*-[1-Deuterio-3-(4-methoxyphenyl)propyl]-*N*-methylaniline (11a). Colorless oil; IR (neat) 2934, 1600, 1511, 1300, 1245, 1177, 1035, 748, 692 cm^{-1}; ^1H NMR δ 1.89 (2H, q, J=7.7 Hz), 2.59 (2H, t, J=7.7 Hz), 2.91 (3H, s), 3.30 (1H, t, J=7.7 Hz), 3.79 (3H, s), 6.63–6.69 (3H, m), 6.83 (2H, d, J=8.6 Hz), 7.10 (2H, d, J=8.6 Hz), 7.18–7.22 (2H, m). MS m/z (%) 256 (M^+, 25), 121 (100), 107 (15), 77 (12). Calcd for $C_{17}H_{20}DNO$: M, 256.1685. Found: m/z 256.1687.

3.1.5. *N*-Methyl-*N*-[3-(4-methoxyphenyl)propyl]aniline (11b). Colorless oil; IR (neat) 2935, 1600, 1511, 1371, 1246, 1178, 1035, 749, 693 cm^{-1}; ^1H NMR δ 1.87 (2H, quintet, J=7.6 Hz), 2.59 (2H, t, J=7.6 Hz), 2.91 (3H, s), 3.32 (2H, t, J=7.6 Hz), 3.79 (3H, s), 6.64–6.69 (3H, m), 6.82 (2H, d, J=8.6 Hz), 7.10 (2H, d, J=8.6 Hz), 7.18–7.22 (2H, m). MS m/z (%) 255 (M^+, 30), 120 (100), 107 (13), 77 (11). Calcd for $C_{17}H_{21}NO$: M, 255.1623. Found: m/z 255.1616.

3.1.6. *N*-[1-Deuterio-3-(4-methoxyphenyl)propyl]-*N*-methyl-*p*-anisidine (15a). Colorless oil; IR (neat) 2932, 1611, 1508, 1243, 1037, 814 cm^{-1}; ^1H NMR δ 1.83 (2H, q, J=7.6 Hz), 2.57 (2H, t, J=7.6 Hz), 2.84 (3H, s), 3.21 (1H, t, J=7.5 Hz), 3.75 (3H, s), 3.79 (3H, s), 6.66 (2H, d, J=9.2 Hz), 6.79–6.84 (4H, m), 7.09 (2H, d, J=8.6 Hz). MS m/z (%) 286 (M^+, 40), 151 (100), 137 (13), 121 (20). Calcd for $C_{18}H_{22}DNO_2$: M, 286.1791. Found: m/z 286.1796.

3.1.7. Ethyl 4-(4-methoxyphenyl)-2-[*N*-(4-methoxyphenyl)-*N*-methylamino]butyrate (15b). Colorless oil; IR (neat) 2936, 1729 (CO), 1612, 1511, 1464, 1299, 1245, 1179, 1037, 818 cm^{-1}; ^1H NMR δ 1.19 (3H, t, J=7.3 Hz), 2.08–2.23 (2H, m), 2.55–2.61 (1H, m), 2.65–2.71 (1H, m), 2.88 (3H, s), 3.76 (3H, s), 3.79 (3H, s), 4.08–4.11 (2H, m), 4.14–417 (1H, m), 6.74 (2H, d, J=8.9 Hz), 6.79–6.82 (4H, m), 7.06 (2H, d, J=8.6 Hz). MS m/z (%) 357 (M^+, 35), 284 (80), 122 (10), 121 (100). Calcd for $C_{21}H_{27}NO_4$: M, 357.1938. Found: m/z 357.1936.

3.1.8. *N*-[1-Deuterio-3-(4-methoxyphenyl)propyl]-*N*-methyl-4-chloroaniline (15c). Colorless oil; IR (neat) 2934, 1596, 1505, 1245, 809 cm^{-1}; ^1H NMR δ 1.84 (2H, q, J=7.6 Hz), 2.58 (2H, t, J=7.6 Hz), 2.88 (3H, s), 3.26 (1H, t, J=7.6 Hz), 3.79 (3H, s), 6.53 (2H, d, J=9.2 Hz), 6.83 (2H, d, J=8.5 Hz), 7.08–7.13 (4H, m). MS m/z (%) 290 (M^+, 40), 155 (100), 141 (20), 121 (10). Calcd for $C_{17}H_{19}DClNO$: M, 290.1294. Found: m/z 290.1292.

3.1.9. Ethyl 2-[*N*-(4-chlorophenyl)-*N*-methylamino]-4-(4-methoxyphenyl)butyrate (15d). Colorless oil; IR (neat) 2956, 1732 (CO), 1597, 1513, 1301, 1247, 1179, 1102, 1036, 812 cm^{-1}; ^1H NMR δ 1.20 (3H, t, J=7.5 Hz), 2.10–2.17 (1H, m), 2.20–2.27 (1H, m), 2.51–2.57 (1H, m), 2.64–2.69 (1H, m), 2.90 (3H, s), 3.79 (3H, s), 4.11–4.17 (2H, m), 4.20–4.23 (1H, m), 6.64 (2H, d, J=7.5 Hz), 6.80 (2H, d, J=6.0 Hz), 7.03 (2H, d, J=6.0 Hz), 7.14 (2H, d, J=7.5 Hz). MS m/z (%) 361 (M^+, 20), 290 (20), 288 (55), 122 (10), 121 (100). Calcd for $C_{20}H_{24}ClNO_3$: M, 361.1443. Found: m/z 361.1442.

3.1.10. *N*-Benzyl-*N*-[1-deuterio-3-(4-methoxyphenyl)-propyl]-*p*-anisidine (15e). Colorless oil; IR (neat) 2933, 1611, 1510, 1452, 1242, 1178, 1037, 814 cm^{-1}; ^1H NMR δ 1.89 (2H, q, J=7.6 Hz), 2.57 (2H, t, J=7.6 Hz), 3.29 (1H, t, J=7.6 Hz), 3.72 (3H, s), 3.78 (3H, s), 4.42 (2H, s), 6.61 (2H, d, J=9.2 Hz), 6.76 (2H, d, J=9.2 Hz), 6.81 (2H, d, J=8.6 Hz), 7.06 (2H, d, J=8.6 Hz), 7.20–7.24 (3H, m), 7.27–7.30 (2H, m). MS m/z (%) 362 (M^+, 60), 227 (70), 137 (15), 121 (20), 91 (100). Calcd for $C_{24}H_{26}DNO_2$: M, 362.2102. Found: m/z 362.2096.

3.1.11. Ethyl 2-[benzyl(4-methoxyphenyl)amino]-4-(4-methoxyphenyl)butyrate (15f). Colorless oil; IR (neat) 2935, 1732 (CO), 1612, 1512, 1454, 1300, 1246, 1178, 1039, 819, 755 cm^{-1}; ^1H NMR δ 1.22 (3H, t, J=7.0 Hz), 2.04–2.12 (1H, m), 2.20–2.26 (1H, m), 2.60–2.73 (2H, m), 3.72 (3H, s), 3.78 (3H, s), 4.12 (2H, q, J=7.0 Hz), 4.25 (1H, t, J=7.2 Hz), 4.51 (1H, d, J=17.1 Hz), 4.57 (1H, d, J=17.1 Hz), 6.73 (4H, s), 6.78 (2H, d, J=8.6 Hz), 6.97 (2H, d, J=8.6 Hz), 7.19–7.21 (1H, m), 7.27–7.32 (4H, m). MS m/z (%) 433 (M^+, 35), 360 (100), 212 (18), 147 (8), 121 (80), 91 (55), 77 (8). Calcd for $C_{27}H_{31}NO_4$: M, 433.2253. Found: m/z 433.2260.

3.1.12. *N*-Benzyl-*N*-(1-deuterio-3-phenylpropyl)-*p*-anisidine (15g). Colorless oil; IR (neat) 2935, 1512, 1453, 1242, 1044, 814, 699 cm^{-1}; ^1H NMR δ 1.93 (2H, q, J=7.6 Hz), 2.62 (2H, t, J=7.6 Hz), 3.31 (1H, t, J=7.6 Hz), 3.72 (3H, s), 4.43 (2H, s), 6.61 (2H, d, J=8.9 Hz), 6.76 (2H, d, J=8.9 Hz), 7.15–7.18 (3H, m), 7.21–7.23 (3H, m), 7.26–7.30 (4H, m). MS m/z (%) 332 (M^+, 50), 269 (10), 227 (70), 137 (10), 91 (100). Calcd for $C_{23}H_{24}DNO$: M, 332.1996. Found: m/z 332.1995.

3.1.13. Ethyl 2-[benzyl(4-methoxyphenyl)amino]-4-phenylbutyrate (15h). Colorless oil; IR (neat) 2935, 1732 (CO), 1604, 1512, 1453, 1244, 1179, 1040, 818, 737, 700 cm^{-1}; ^1H NMR δ 1.22 (3H, t, J=7.0 Hz), 2.08–2.16 (1H, m), 2.23–2.30 (1H, m), 2.66–2.71 (1H, m), 2.73–2.79 (1H, m), 3.72 (3H, s), 4.13 (2H, q, J=7.0 Hz), 4.27 (1H, t, J=7.2 Hz), 4.52 (1H, d, J=17.1 Hz), 4.57 (1H, d, J=17.1 Hz), 6.72–6.76 (4H, m), 7.07 (2H, d, J=7.7 Hz), 7.16–7.22 (2H, m), 7.23–7.25 (2H, m), 7.28–7.33 (4H, m). MS m/z (%) 403 (M^+, 20), 330 (100), 285 (18), 134 (10), 91 (80). Calcd for $C_{26}H_{29}NO_3$: M, 403.2146. Found: m/z 403.2160.

3.1.14. *N*-(1-Deuterio-2-cyclohexylethyl)-*N*-methyl-*p*-anisidine (15i). Colorless oil; IR (neat) 2922, 2851, 1515, 1448, 1244, 1042, 813 cm^{-1}; ^1H NMR δ 0.87–0.98 (2H, m), 1.11–1.27 (4H, m), 1.40 (2H, t, J=7.6 Hz), 1.64–1.74 (5H, m), 2.83 (3H, s), 3.22 (1H, t, J=7.6 Hz), 3.76 (3H, s), 6.69 (2H, d, J=9.2 Hz), 6.83 (2H, d, J=9.2 Hz). MS m/z (%) 248 (M^+, 30), 151 (100), 136 (10), 121 (8). Calcd for $C_{16}H_{24}DNO$: M, 248.1997. Found: m/z 248.2007.

3.1.15. Ethyl 3-cyclohexyl-2-[*N*-(4-methoxyphenyl)-*N*-methylamino]propionate (15j). Colorless oil; IR (neat) 2924, 2852, 1732 (CO), 1514, 1448, 1247, 1182, 1040,

817 cm^{-1}; ^1H NMR δ 0.87–1.02 (2H, m), 1.11–1.16 (2H, m), 1.19 (3H, t, J=7.3 Hz), 1.29–1.38 (1H, m), 1.58–1.78 (8H, m), 2.84 (3H, s), 3.76 (3H, s), 4.07–4.14 (2H, m), 4.30 (1H, t, J=7.6 Hz), 6.77–6.83 (4H, m). MS m/z (%) 319 (M^+, 15), 246 (100), 164 (8), 55 (8). Calcd for $C_{19}H_{29}NO_3$: M, 319.2145. Found: m/z 319.2143.

3.1.16. *N*-(1-Deuterio-2-cyclohexylethyl)-*N*-methyl-4-chloroaniline (15k). Colorless oil; IR (neat) 2923, 2852, 1597, 1505, 1448, 1216, 808, 760 cm^{-1}; ^1H NMR δ 0.90–0.99 (2H, m), 1.13–1.27 (4H, m), 1.41 (2H, t, J=7.3 Hz), 1.64–1.73 (5H, m), 2.87 (3H, s), 3.27 (1H, t, J=7.3 Hz), 6.57 (2H, d, J=8.9 Hz), 7.13 (2H, d, J=8.9 Hz). MS m/z (%) 252 (M^+, 20), 155 (100), 140 (10). Calcd for $C_{15}H_{21}DClN$: M, 252.1502. Found: m/z 252.1505.

3.1.17. Ethyl 2-[*N*-(4-chlorophenyl)-*N*-methylamino]-3-cyclohexylpropionate (15l). Colorless oil; IR (neat) 2925, 2852, 1733 (CO), 1598, 1499, 1188, 1140, 1104, 811 cm^{-1}; ^1H NMR δ 0.87–1.02 (2H, m), 1.14–1.16 (2H, m), 1.21 (3H, t, J=7.3 Hz), 1.26–1.31 (1H, m), 1.56–1.69 (6H, m), 1.77 (2H, t, J=7.3 Hz), 2.87 (3H, s), 4.09–4.16 (2H, m), 4.37 (1H, t, J=7.3 Hz), 6.71 (2H, d, J=8.3 Hz), 7.17 (2H, d, J=8.3 Hz). MS m/z (%) 323 (M^+, 10), 250 (100), 168 (15), 154 (20), 55 (17). Calcd for $C_{18}H_{26}ClNO_2$: M, 323.1650. Found: m/z 323.1648.

3.1.18. *N*-[Cyclohexyl(deuterio)methyl]-*N*-methyl-*p*-anisidine (15m). Colorless oil; IR (neat) 2923, 2851, 1513, 1448, 1245, 1181, 1121, 1042, 811, 757, 692 cm^{-1}; ^1H NMR δ 0.86–0.95 (2H, m), 1.11–1.26 (3H, m), 1.64–1.75 (6H, m), 2.88 (3H, s), 3.00 (1H, d, J=6.7 Hz), 3.75 (3H, s), 6.63 (2H, d, J=8.9 Hz), 6.82 (2H, d, J=8.9 Hz). MS m/z (%) 234 (M^+, 25), 151 (100), 136 (10). Calcd for $C_{15}H_{22}DNO$: M, 234.1841. Found: m/z 234.1844.

3.1.19. Ethyl cyclohexyl[*N*-(4-methoxyphenyl)-*N*-methylamino]acetate (15n). Colorless oil; IR (neat) 2929, 2852, 1731 (CO), 1512, 1449, 1279, 1246, 1176, 1039, 818 cm^{-1}; ^1H NMR δ 0.85–0.93 (1H, m), 0.98–1.06 (1H, m), 1.15–1.34 (3H, m), 1.19 (3H, t, J=7.3 Hz), 1.62–1.81 (5H, m), 1.94–2.02 (1H, m), 2.85 (3H, s), 3.75 (3H, s), 3.86 (1H, d, J=10.7 Hz), 4.10 (2H, q, J=7.3 Hz), 6.81 (4H, s). MS m/z (%) 305 (M^+, 20), 232 (100), 222 (30), 194 (12), 150 (15). Calcd for $C_{18}H_{27}NO_3$: M, 305.1989. Found: m/z 305.1980.

3.1.20. *N*-[Cyclohexyl(deuterio)methyl]-*N*-methyl-4-chloroaniline (15o). Colorless oil; IR (neat) 2924, 2852, 1598, 1505, 1448, 1331, 807 cm^{-1}; ^1H NMR δ 0.88–0.95 (2H, m), 1.12–1.25 (3H, m), 1.65–1.73 (6H, m), 2.92 (3H, s), 3.07 (1H, d, J=6.7 Hz), 6.55 (2H, d, J=9.2 Hz), 7.13 (2H, d, J=9.2 Hz). MS m/z (%) 238 (M^+, 15), 155 (100), 140 (8). Calcd for $C_{14}H_{19}DClN$: M, 238.1346. Found: m/z 238.1346.

3.1.21. Ethyl [*N*-(4-chlorophenyl)-*N*-methylamino]cyclohexylacetate (15p). Colorless oil; IR (neat) 2928, 2853, 1732 (CO), 1597, 1499, 1449, 1176, 1105, 1027, 810, 757 cm^{-1}; ^1H NMR δ 0.81–0.96 (1H, m), 0.99–1.08 (1H, m), 1.14–1.36 (3H, m), 1.21 (3H, t, J=7.3 Hz), 1.63–1.78 (5H, m), 1.97–2.04 (1H, m), 2.89 (3H, s), 3.92 (1H, d, J=10.7 Hz), 4.08–4.16 (2H, m), 6.75 (2H, d, J=8.9 Hz), 7.15 (2H, d, J=8.9 Hz). MS m/z (%) 309 (M^+, 18), 236 (100), 226 (23), 198 (13), 154 (40), 138 (8). Calcd for $C_{17}H_{24}ClNO_2$: M, 309.1494. Found: m/z 309.1498.

3.1.22. *N*-Benzyl-*N*-methyl-*p*-anisidine (16). To a solution of *i*-PrMgCl (0.5 mmol) in 0.5 mL of dry THF in a flame-dried flask at −78 °C under argon atmosphere was added a solution of **3e** (38 mg; 0.2 mmol) in 0.4 mL of dry THF dropwise with stirring. Immediately, to a solution of the generated magnesium carbenoid **4e** was added a solution of *N*-lithio *N*-benzyl-*p*-anisidine [prepared from *N*-benzyl-*p*-anisidine (0.7 mmol) and *n*-BuLi (0.77 mmol) in 2 mL of THF at 0 °C and the solution was cooled to −78 °C] through a cannula with stirring. The reaction mixture was slowly allowed to warm to −40 °C for 1 h. The reaction mixture was quenched with satd aq NH_4Cl. The whole was extracted with $CHCl_3$ and the organic layer was washed with satd aq NH_4Cl and dried over $MgSO_4$. The product was purified by silica gel column chromatography to afford **16** (30 mg; 65%) as a colorless oil.[11]

3.1.23. *N*,*N*-Dimethyl-*p*-anisidine (18b). Colorless oil; IR (neat) 2933, 1515, 1245, 1038, 817 cm^{-1}; ^1H NMR δ 2.86 (6H, s), 3.76 (3H, s), 6.75 (2H, d, J=8.9 Hz), 6.84 (2H, d, J=8.9 Hz). MS m/z (%) 151 (M^+, 65), 136 (100), 108 (12), 65 (8). Calcd for $C_9H_{13}NO$: M, 151.0996. Found: m/z 151.0998.

3.1.24. *N*-Methyldibenzylamine (18c). Colorless oil; IR (neat) 3028, 2786, 1495, 1453, 1366, 1024, 736, 698 cm^{-1}; ^1H NMR δ 2.18 (3H, s), 3.52 (4H, s), 7.21–7.25 (2H, m), 7.29–7.33 (4H, m), 7.35–7.37 (4H, m). MS m/z (%) 211 (M^+, 40), 134 (40), 120 (20), 91 (100). Calcd for $C_{15}H_{17}N$: M, 211.1360. Found: m/z 211.1364.

3.1.25. *N*-Benzyl-*N*-deuteriomethyl-*p*-anisidine (19a). Colorless oil; IR (neat) 2932, 2831, 1509, 1451, 1241, 1040, 813 cm^{-1}; ^1H NMR δ 2.89 (2H, t, J=1.5 Hz), 3.75 (3H, s), 4.42 (2H, s), 6.73 (2H, d, J=8.9 Hz), 6.82 (2H, d, J=8.9 Hz), 7.22–7.32 (5H, m). MS m/z (%) 228 (M^+, 100), 213 (10), 151 (20), 137 (95), 91 (65). Calcd for $C_{15}H_{16}DNO$: M, 228.1372. Found: m/z 228.1375.

3.1.26. *N*-Deuteriomethyl-*N*-methyl-*p*-anisidine (19b). Colorless oil; IR (neat) 2951, 2832, 1512, 1244, 1038, 817 cm^{-1}; ^1H NMR δ 2.84 (2H, t, J=1.8 Hz), 2.86 (3H, s), 3.76 (3H, s), 6.75 (2H, d, J=9.2 Hz), 6.84 (2H, d, J=9.2 Hz). MS m/z (%) 152 (M^+, 70), 137 (100), 109 (10), 65 (10). Calcd for $C_9H_{12}DNO$: M, 152.1060. Found: m/z 152.1062.

3.1.27. *N*-Deuteriomethyldibenzylamine (19c). Colorless oil; IR (neat) 3063, 3028, 2794, 1603, 1495, 1454, 1367, 1028, 735, 698 cm^{-1}; ^1H NMR δ 2.16 (2H, br s), 3.52 (4H, s), 7.22–7.26 (2H, m), 7.29–7.37 (8H, m). MS m/z (%) 212 (M^+, 40), 135 (40), 121 (20), 91 (100), 65 (14). Calcd for $C_{15}H_{16}DN$: M, 212.1423. Found: m/z 212.1425.

3.1.28. Ethyl [benzyl(4-methoxyphenyl)amino]acetate (20a). To a solution of *i*-PrMgCl (0.5 mmol) in 0.5 mL of dry THF in a flame-dried flask at −78 °C under argon atmosphere was added a solution of **3e** (38 mg; 0.2 mmol) in 0.4 mL of dry THF dropwise with stirring. Immediately,

to a solution of the generated magnesium carbenoid **4e** was added a solution of *N*-lithio *N*-benzyl-*p*-anisidine [prepared from *N*-benzyl-*p*-anisidine (0.7 mmol) and *n*-BuLi (0.77 mmol) in 2 mL of THF at 0 °C and the solution was cooled to −78 °C] through a cannula with stirring. The reaction mixture was slowly allowed to warm to −40 °C for 1 h. To a solution of the α-amino-substituted carbanion **17** was added ethyl chloroformate (1 mmol) dropwise at −40 °C with stirring. After 20 min, the reaction mixture was quenched with satd aq NH_4Cl. The whole was extracted with $CHCl_3$. The organic layer was washed with satd aq NH_4Cl and dried over $MgSO_4$. The product was purified by silica gel column chromatography to afford **20a** (35 mg; 58%) as a colorless oil; IR (neat) 2935, 1745 (CO), 1514, 1244, 1187, 1029, 815, 739, 698 cm^{-1}, ^1H NMR δ 1.24 (3H, t, J=7.0 Hz), 3.73 (3H, s), 4.01 (2H, s), 4.18 (2H, q, J=7.0 Hz), 4.58 (2H, s), 6.66 (2H, d, J=8.9 Hz), 6.79 (2H, d, J=8.9 Hz), 7.23–7.35 (5H, m). MS *m*/*z* (%) 299 (M^+, 47), 226 (75), 195 (40), 120 (10), 91 (100). Calcd for $C_{18}H_{21}NO_3$: M, 299.1520. Found: *m*/*z* 299.1519.

3.1.29. Ethyl [*N*-(4-methoxyphenyl)-*N*-methylamino]-acetate (20b). Colorless oil; IR (neat) 2937, 1747 (CO), 1515, 1245, 1188, 1118, 1038, 948, 816 cm^{-1}. ^1H NMR δ 1.23 (3H, t, J=7.0 Hz), 3.01 (3H, s), 3.75 (3H, s), 3.99 (2H, s), 4.16 (2H, q, J=7.0 Hz), 6.68 (2H, d, J=8.9 Hz), 6.82 (2H, d, J=8.9 Hz). MS *m*/*z* (%) 223 (M^+, 28), 150 (100), 135 (15), 120 (10). Calcd for $C_{12}H_{17}NO_3$: M, 223.1207. Found: *m*/*z* 223.1208.

3.1.30. Ethyl [*N*-(4-chlorophenyl)-*N*-methylamino]-acetate (20c). Colorless oil; IR (neat) 2982, 1747 (CO), 1598, 1504, 1370, 1192, 1119, 1029, 811 cm^{-1}. ^1H NMR δ 1.24 (3H, t, J=7.0 Hz), 3.04 (3H, s), 4.03 (2H, s), 4.17 (2H, q, J=7.0 Hz), 6.60 (2H, d, J=9.2 Hz), 7.17 (2H, d, J=9.2 Hz). MS *m*/*z* (%) 227 (M^+, 20), 154 (100), 139 (10). Calcd for $C_{11}H_{14}ClNO_2$: M, 227.0712. Found *m*/*z* 227.0711.

3.1.31. Ethyl (*N*-methyl-*N*-phenylamino)acetate (20d). Colorless oil; IR (neat) 2931, 1748 (CO), 1602, 1508, 1369, 1191, 1029, 749, 691 cm^{-1}. ^1H NMR δ 1.24 (3H, t, J=7.0 Hz), 3.07 (3H, s), 4.05 (2H, s), 4.17 (2H, q, J=7.0 Hz), 6.69 (2H, d, J=7.9 Hz), 6.75 (1H, t, J=7.3 Hz), 7.23 (2H, m). MS *m*/*z* (%) 193 (M^+, 29), 120 (100), 105 (7), 77 (10). Calcd for $C_{11}H_{15}NO_2$: M, 193.1102. Found *m*/*z* 193.1096.

3.1.32. Ethyl (dibenzylamino)acetate (20e). Colorless oil; IR (neat) 2854, 1729 (CO), 1455, 1190, 1029, 746, 698 cm^{-1}. ^1H NMR δ 1.26 (3H, t, J=7.0 Hz), 3.28 (2H, s), 3.81 (4H, s), 4.15 (2H, q, J=7.0 Hz), 7.22–7.26 (2H, m), 7.29–7.32 (4H, m), 7.37–7.41 (4H, m). MS *m*/*z* (%) 283 (M^+, 4), 210 (98), 192 (10), 91 (100). Calcd for $C_{18}H_{21}NO_2$: M, 283.1571. Found *m*/*z* 283.1575.

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