Alkene Diamination Using Electron Rich Amines: Hypervalent Iodine-Promoted Inter/Intramolecular C-N Bond Formation

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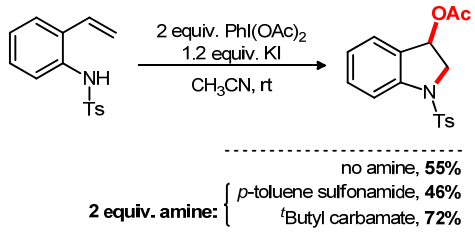
Additional Experiments

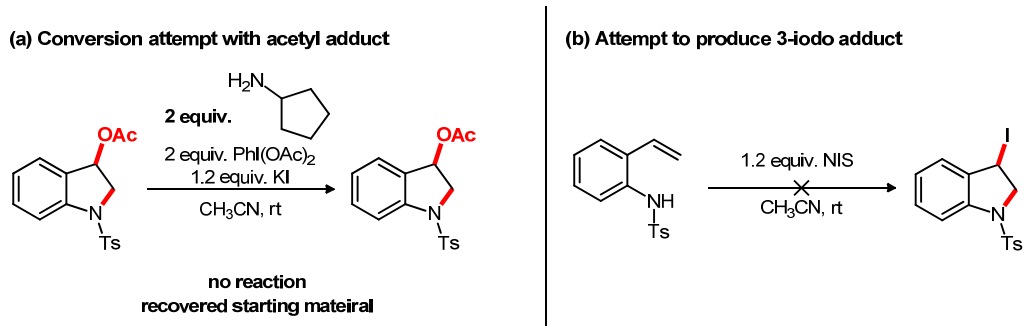
Control Experiments: Reaction outcomes (a) with electron deficient amines and (b) without amine.

The amination attempts under the standard conditions described here, but using electron deficient amines such as *p*-toluenesulfonamide and *t*-butyl carbamate did not provide the desired diamination adduct. The 3-acetoxy indoline adduct was isolated instead. The outcome was similar when no amine component was included.



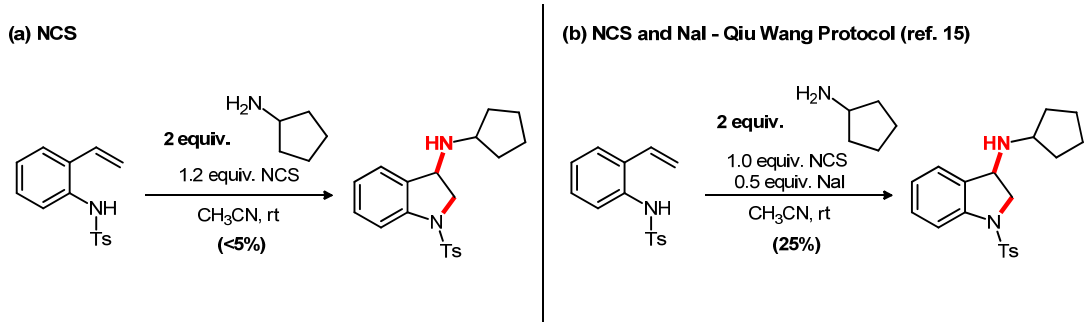
Control Experiments: (a) Resubjection of a 3-acetoxyindoline to the reaction conditions, and (b) attempted formation of the 3-iodo indoline (a potential intermediate).

The following experiments were designed to investigate the possibililty that 3-acetoxy indoline is an intermediate. When the 3-acetoxy indoline is exposed to the standard reaction conditions, no conversion is detected, and the starting material is recovered generally unchanged. In a separate reaction it was found that 5-*endo* cyclization to 3-iodo indoline is not significant, suggesting that the direct halogenation of the amine is a key step in the reaction to 3-amino indolines.



Control Experiments: Comparison of reported halogen-based aminations.

Among other oxidants, NCS the Wang protocol were examined in a case studied here. NCS alone did not promote significant conversion to 3-amino indolines. And in contrast to the productive use of stoichiometric NIS alone, a combination of stoichiometric NCS and 50 mol% NaI to generate electrophilic iodonium led to the 3-amino indoline, but in only 25% yield.[1]



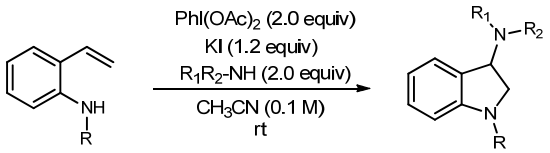
Experimental Section

All reagents and solvents were commercial grade and purified prior to use when necessary. Toluene and tetrahydrofuran was dried by passage through a column of activated alumina as described by Grubbs.[2] *N*-Iodosuccinimide was recrystallized from dioxane and carbon tetrachloride. Thin layer chromatography (TLC) was performed using glass-backed silica gel (250 μm) plates and flash chromatography utilized 230–400 mesh silica gel from Sorbent Technologies. UV light, and/or the use of CAM and potassium permanganate solutions were used to visualize products.

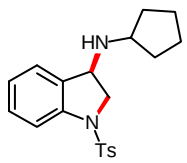
[1] Typical conditions: NCS (1 equiv), NaI (5 mol%), NaN_3 (1.2 equiv). Ortiz, G. X.; Kang, B.; Wang, Q. *J. Org. Chem.* **2014**, *79*, 571.
[2] Pangborn, A. B.; Giardello, M. A.; Grubbs, R. H.; Rosen, R. K.; Timmers, F. J. *Organometallics* **1996**, *15*, 1518-1520.

Nuclear magnetic resonance spectra (NMR) were acquired on a Bruker AV-400 (400 MHz) instrument. Chemical shifts are measured relative to residual solvent peaks as an internal standard set to δ 7.26 and δ 77.0 ($CDCl_3$). IR spectra were recorded on a Thermo Nicolet IR100 spectrophotometer and are reported in wave numbers (cm^{-1}). Compounds were analyzed as neat films on a NaCl plate (transmission). Mass spectra were recorded on a Waters LCT spectrometer by use of the ionization method noted.

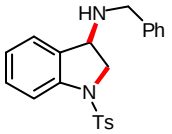
Hypervalent Iodine Mediated Intra/Intermolecular Diamination



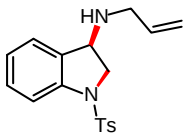
General procedure for Diamination: To a flame dried vial equipped with a stir bar was added the olefin (50.0 mg, 0.183 mmol), $PhI(OAc)_2$ (117 mg, 0.366 mmol), KI (36.0 mg, 0.219 mmol) and acetonitrile (1 mL), and amine (0.366 mmol) in acetonitrile (1 mL) was added and the reaction mixture was stirred for 18 h. The mixture was concentrated and purified using flash column chromatography (SiO_2, ethyl acetate in hexanes) to afford the 3-amino indoline.



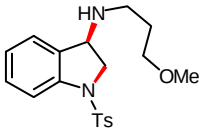
***N*-Cyclopentyl-1-tosylindolin-3-amine (2a).** Prepared according to the general procedure using cyclopentyl amine (60.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 40-60-80% ethyl acetate in hexanes) yielded an oil (54.0 mg, 83%). R_f = 0.20 (70% EtOAc/hexanes); IR (film) 3332, 2958, 1732, 1600, 1477, 1358, 1167 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 9.6 Hz, 1H), 7.67 (d, *J* = 8.4 Hz, 2H), 7.29-7.24 (m, 2H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.02 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.15 (dd, *J* = 7.6, 3.6 Hz, 1H), 3.92 (dd, *J* = 11.2, 7.6 Hz, 1H), 3.80 (dd, *J* = 11.2, 3.6 Hz, 1H), 3.47 (br s, 1H), 3.05 (ddd, *J* = 13.2, 6.4, 6.4 Hz, 1H), 2.35 (s, 3H), 1.72-1.60 (m, 4H), 1.54-1.44 (m, 2H), 1.28-1.16 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 141.6, 133.6, 133.0, 129.6, 129.2, 127.2, 125.5, 123.8, 115.4, 56.5, 56.23, 56.21, 32.9, 32.7, 23.8, 23.7, 21.4; HRMS (ESI): Exact mass calcd for $C_{20}H_{24}N_2NaO_2S$ $[M+Na]^+$ 379.1456, found 379.1458.



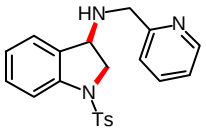
***N*-Benzyl-1-tosylindolin-3-amine (2b).** Prepared according to the general procedure using benzyl amine (40.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 5-15-40% ethyl acetate in hexanes) yielded an oil (44.0 mg, 64%). R_f = 0.50 (30% EtOAc/hexanes); IR (film) 3331, 2922, 1599, 1476, 1458, 1354, 1167 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.0 Hz, 1H), 7.65 (d, *J* = 8.4 Hz, 2H), 7.31-7.20 (m, 8H), 7.16 (d, *J* = 8.0 Hz, 2H), 7.05 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.17 (dd, *J* = 7.6, 4.0 Hz, 1H), 3.93 (dd, *J* = 11.6, 8.0 Hz, 1H), 3.83 (dd, *J* = 11.6, 4.0 Hz, 1H), 3.64 (s, 2H), 2.26 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 141.7, 139.3, 133.7, 133.3, 129.6, 129.3, 128.3, 127.9, 127.2, 127.1, 125.4, 123.9, 115.5, 57.2, 55.8, 50.4, 21.4; HRMS (ESI): Exact mass calcd for $C_{22}H_{23}N_2O_2S$ $[M+H]^+$ 379.1480, found 379.1493.



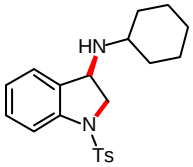
***N*-Allyl-1-tosylindolin-3-amine (2c).** Prepared according to the general procedure using allyl amine (27.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 40-60-80% ethyl acetate in hexanes) yielded an oil (45.0 mg, 75%). R_f = 0.30 (80% EtOAc/hexanes); IR (film) 3393, 2924, 1598, 1477, 1355, 1167 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.0 Hz, 1H), 7.68 (d, *J* = 8.4 Hz, 2H), 7.33-7.26 (m, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.06 (ddd, *J* = 7.2, 7.2, 0.4 Hz, 1H), 5.79 (dddd, *J* = 16, 10, 5.6, 5.6 Hz, 1H), 5.12 (d, *J* = 17.2 Hz, 1H), 5.11 (dd, *J* = 10.8, 1.2 Hz, 1H), 4.17 (dd, *J* = 7.6, 3.6 Hz, 1H), 3.93 (dd, *J* = 11.6, 7.6 Hz, 1H), 3.80 (dd, *J* = 11.6, 3.6 Hz, 1H), 3.15 (d, *J* = 5.6 Hz, 2H), 2.37 (s, 3H), 1.33 (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 141.6, 135.9, 133.6, 133.2, 129.6, 129.2, 127.1, 125.3, 123.8, 116.2, 115.4, 57.1, 55.9, 49.1, 21.4; HRMS (ESI): Exact mass calcd for $C_{18}H_{21}N_2O_2S$ $[M+H]^+$ 329.1324, found 329.1340.



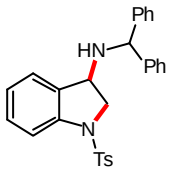
***N*-(3-Methoxypropyl)-1-tosylindolin-3-amine (2d).** Prepared according to the general procedure using 3-methoxypropyl amine (37.0 µL, 0.366 mmol over 18 hours. Flash column chromatography (SiO_2, 40-60-90% ethyl acetate in hexanes) yielded an oil (48.0 mg, 72%). R_f = 0.10 (80% EtOAc/hexanes); IR (film) 3421, 2926, 1598, 1477, 1358, 1167, 1110 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 8.0 Hz, 2H), 7.31-7.27 (m, 3H), 7.24 (d, *J* = 8.4 Hz, 2H), 7.04 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.20 (dd, *J* = 7.6, 4.0 Hz, 1H), 3.93 (dd, *J* = 11.6, 8.0 Hz, 1H), 3.81 (dd, *J* = 11.6, 4.0 Hz, 1H), 3.39 (t, *J* = 6.0, 2H), 3.31 (s, 3H), 2.65-2.55 (m, 2H), 2.38 (s, 3H), 1.63 (ddd, *J* = 12.8, 6.4, 6.4 Hz, 2H), the NH was not observed; ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 141.7, 133.7, 132.8, 129.6, 129.2, 127.2, 125.4, 123.7, 115.1, 70.9, 58.5, 57.7, 55.7, 43.7, 29.8, 21.4; HRMS (ESI): Exact mass calcd for $C_{19}H_{24}N_2NaO_3S$ $[M+Na]^+$ 383.1405, found 383.1418.



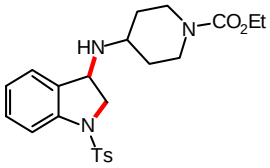
***N*-(Pyridin-2-ylmethyl)-1-tosylindolin-3-amine (2e).** Prepared according to the general procedure using 2-picolylamine (38.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-20-40% ethyl acetate in hexanes) yielded an oil (43.0 mg, 62%). R_f = 0.10 (4% MeOH/EtOAc); IR (film) 3331, 2923, 1595, 1475, 1353, 1166, 1091 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 8.54 (d, *J* = 4.8 Hz, 1H), 7.72-7.68 (m, 3H), 7.63 (ddd, *J* = 7.6, 7.6, 1.6 Hz, 1H), 7.30 (dd, *J* = 8.4, 8.0 Hz, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 8.4 Hz, 2H), 7.17-7.15 (m, 1H), 7.04 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.29 (dd, *J* = 7.6, 4.0 Hz, 1H), 3.95 (dd, *J* = 11.2, 7.6 Hz, 1H), 3.85 (dd, *J* = 11.2, 4.0 Hz, 1H), 3.79 (s, 2H), 2.31 (s, 3H), the NH was not observed; ^{13}C NMR (100 MHz, $CDCl_3$) ppm 158.8, 149.0, 144.0, 141.8, 136.4, 133.6, 132.8, 129.6, 129.2, 127.2, 125.4, 123.8, 122.1, 122.0, 115.1, 57.4, 55.9, 51.5, 21.4; HRMS (ESI): Exact mass calcd for $C_{21}H_{22}N_3O_2S$ $[M+H]^+$ 380.1433, found 380.1440.



***N*-Cyclohexyl-1-tosylindolin-3-amine (2f).** Prepared according to the general procedure using cyclohexyl amine (42.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 20-40-80% ethyl acetate in hexanes) yielded an oil (42.0 mg, 62%). R_f = 0.40 (80% EtOAc/hexanes); IR (film) 3381, 2930, 1599, 1477, 1357, 1166, 1091 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.69 (dd, *J* = 8.4, 2.0 Hz, 3H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.24 (d, *J* = 8.0 Hz, 2H), 7.04 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.21 (t, *J* = 7.2 Hz, 1H), 4.26 (dd, *J* = 7.6, 4.0 Hz, 1H), 3.96 (dd, *J* = 11.2, 7.6 Hz, 1H), 3.74 (dd, *J* = 11.6, 4.0 Hz, 1H), 2.50 (dddd, *J* = 13.6, 7.2, 3.2, 3.2 Hz, 1H), 2.37 (s, 3H), 1.73-1.60 (m, 5H), 1.37-1.01 (m, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.0, 141.5, 133.7, 129.6, 129.0, 127.2, 125.2, 123.8, 115.3, 56.9, 54.6, 53.9, 33.6, 32.9, 25.8, 24.7, 24.6, 21.4; HRMS (ESI): Exact mass calcd for $C_{21}H_{26}N_2NaO_2S$ $[M+Na]^+$ 393.1613, found 393.1609.

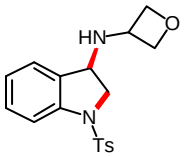


***N*-Benzhydryl-1-tosylindolin-3-amine (2g).** Prepared according to the general procedure using diphenylmethyl amine (63.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 5-15-40% ethyl acetate in hexanes) yielded an oil (47 mg, 57%). R_f = 0.60 (30% EtOAc/hexanes); IR (film) 3320, 2922, 1598, 1492, 1456, 1354, 1167, 1090 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.85-7.82 (m, 2H), 7.70-7.64 (m, 3H), 7.55-7.50 (m, 4H), 7.41-7.25 (m, 5H), 7.22-7.19 (m, 3H), 7.03-7.00 (m, 2H), 4.89 (t, *J* = 8.0 Hz, 1H), 4.05 (dd, *J* = 1.04, 8.0 Hz, 1H), 3.92-3.86 (m, 1H), 2.38 (s, 3H), the NH was not observed; ^{13}C NMR (100 MHz, $CDCl_3$) ppm 141.8, 136.1, 133.8, 132.3, 130.5, 130.1, 130.0, 129.5, 128.7, 128.2, 128.0, 127.5, 127.3, 124.8, 123.9, 115.2, 61.5, 56.7, 29.6, 21.5; HRMS (ESI): Exact mass calcd for $C_{28}H_{26}N_2NaO_2S$ $[M+Na]^+$ 477.1613, found 477.1633.

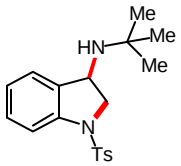


Ethyl 4-((1-tosylindolin-3-yl)amino)piperidine-1-carboxylate (2h). Prepared according to the general procedure using ethyl 4-aminopiperidine-1-carboxylate (63.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 30-60-90% ethyl acetate in hexanes) yielded an oil (74.0 mg, 91%). R_f = 0.40 (80% EtOAc/hexanes); IR (film) 3384, 2926, 1692, 1436, 1354, 1233, 1166 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 7.6 Hz, 1H), 7.68 (d, *J* = 8.0 Hz, 2H), 7.30-7.20 (m, 4H), 7.04 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.22 (dd, *J*

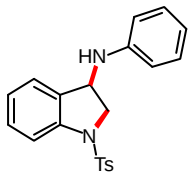
= 7.6, 4.0 Hz, 1H), 4.12 (dd, *J* = 14.4, 7.2 Hz, 2H), 3.97 (br s, 1H), 3.95 (dd, *J* = 11.2, 8.0 Hz, 1H), 3.71 (dd, *J* = 11.2, 3.6 Hz, 1H), 2.89-2.85 (m, 2H), 2.71 (ddd, *J* = 13.6, 9.6, 3.6 Hz, 1H), 2.37 (s, 3H), 1.72-1.61 (m, 2H), 1.26 (t, *J* = 7.2 Hz, 3H), 1.27-1.17 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 155.4, 144.1, 141.4, 133.7, 133.6, 129.6, 129.2, 127.2, 125.2, 123.8, 115.3, 61.2, 56.9, 54.6, 51.7, 42.0, 41.9, 32.5, 31.8, 21.4, 14.6; HRMS (ESI): Exact mass calcd for $C_{23}H_{29}N_3NaO_4S$ $[M+Na]^+$ 466.1776, found 466.1782.



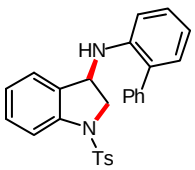
***N*-(Oxetan-3-yl)-1-tosylindolin-3-amine (2i).** Prepared according to the general procedure using oxetan-3-amine (26.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 40-60-90% ethyl acetate in hexanes) yielded an oil (59.0 mg, 94%). R_f = 0.10 (80% EtOAc/hexanes); IR (film) 3318, 2953, 2871, 1598, 1475, 1353, 1166, 1091, 971 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 9.2 Hz, 1H), 7.71 (d, *J* = 8.4 Hz, 2H), 7.33 (dd, *J* = 8.4, 8.0 Hz, 1H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.19 (d, *J* = 7.2 Hz, 1H), 7.06 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.67 (t, *J* = 6.8 Hz, 1H), 4.58 (t, *J* = 6.8 Hz, 1H), 4.20 (dd, *J* = 13.2, 6.8 Hz, 3H), 3.94-3.87 (m, 2H), 3.69 (dd, *J* = 11.6, 3.6 Hz, 1H), 2.40 (s, 3H), 2.02 (br s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.5, 141.7, 133.4, 132.2, 129.8, 129.7, 127.3, 125.1, 124.0, 115.4, 80.0, 79.6, 56.5, 56.3, 50.8, 21.4; HRMS (ESI): Exact mass calcd for $C_{18}H_{20}N_2NaO_3S$ $[M+Na]^+$ 367.1092, found 367.1083.



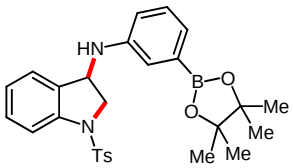
***N*-(Tert-butyl)-1-tosylindolin-3-amine (2j).** Prepared according to the general procedure using *tert*-butyl amine (38.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-20-40% ethyl acetate in hexanes) yielded an oil (12.0 mg, 20%). R_f = 0.50 (30% EtOAc/hexanes); IR (film) 3351, 2963, 2924, 1599, 1357, 1166, 1090 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.0 Hz, 2H), δ 7.66 (d, *J* = 8.4 Hz, 1H), 7.28-7.23 (m, 3H), 7.17 (d, *J* = 7.2 Hz, 1H), 7.04 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.21 (t, *J* = 7.2 Hz, 1H), 4.11 (dd, *J* = 10.8, 8.0 Hz, 1H), 3.52 (dd, *J* = 10.8, 5.6 Hz, 1H), 2.37 (s, 3H), 1.09 (s, 9H), the NH was not observed; ^{13}C NMR (100 MHz, $CDCl_3$) ppm 143.9, 141.2, 135.2, 133.8, 129.5, 128.7, 127.3, 124.7, 123.9, 115.0, 60.3, 52.6, 50.6, 29.9, 21.4; HRMS (ESI): Exact mass calcd for $C_{19}H_{24}N_2NaO_2S$ $[M+Na]^+$ 367.1456, found 367.1470.



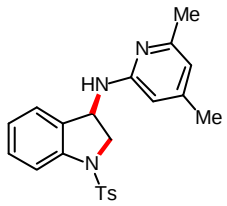
***N*-Phenyl-1-tosylindolin-3-amine (2k).** Prepared according to the general procedure using aniline (34.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-20-40% ethyl acetate in hexanes) yielded an oil (45.0 mg, 68%). R_f = 0.60 (30% EtOAc/hexanes); IR (film) 3395, 2921, 1602, 1502, 1353, 1166 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, *J* = 8.4 Hz, 1H), 7.63 (d, *J* = 8.4 Hz, 2H), 7.37 (dd, *J* = 8.4, 8.0 Hz, 1H), 7.29 (d, *J* = 7.2 Hz, 1H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.19 (d, *J* = 7.6 Hz, 2H), 7.09 (dd, *J* = 7.6, 7.6 Hz, 1H), 6.79 (dd, *J* = 7.6, 7.2 Hz, 1H), 6.45 (d, *J* = 7.6 Hz, 2H), 4.88 (dd, *J* = 7.6, 3.6 Hz, 1H), 4.14 (dd, *J* = 12.0, 7.2 Hz, 1H), 3.87 (dd, *J* = 11.6, 3.6 Hz, 1H), 2.41 (s, 3H), the NH was not observed; ^{13}C NMR (100 MHz, $CDCl_3$) ppm 145.6, 144.1, 142.0, 133.7, 132.2, 129.8, 129.6, 129.3, 127.2, 125.4, 124.3, 118.3, 115.8, 113.1, 56.6, 53.1, 21.4; HRMS (ESI): Exact mass calcd for $C_{21}H_{20}N_2NaO_2S$ $[M+Na]^+$ 387.1143, found 387.1161.



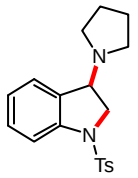
***N*-([1,1'-Biphenyl]-2-yl)-1-tosylindolin-3-amine (2l).** Prepared according to the general procedure using [1,1'-biphenyl]-2-amine (62.0 mg, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 5-15-40% ethyl acetate in hexanes) yielded an oil (64 mg, 79%). R_f = 0.70 (40% EtOAc/hexanes); IR (film) 3415, 3058, 2922, 1599, 1507, 1488, 1436, 1356, 1167, 1091 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.68 (d, *J* = 8.4 Hz, 1H), 7.50-7.45 (m, 3H), 7.39-7.36 (m, 2H), 7.32-7.19 (m, 3H), 7.17-7.13 (m, 2H), 7.01 (dd, *J* = 7.6, 7.2 Hz, 1H), 6.87 (dddd, *J* = 7.2, 7.2, 7.2, 0.8 Hz, 2H), 6.67 (d, *J* = 8.0 Hz, 1H), 4.98 (dd, *J* = 7.6, 5.6 Hz, 1H), 4.26 (dd, *J* = 10.8, 8.0 Hz, 1H), 3.72 (dd, *J* = 10.8, 5.2 Hz, 1H), 3.33(br s, 1H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 143.2, 142.9, 141.7, 139.4, 138.8, 133.7, 131.7, 130.7, 130.3, 129.6, 129.0, 128.8, 128.7, 128.4, 127.2, 127.1, 124.9, 123.9, 118.6, 118.2, 115.6, 114.7, 111.0, 57.1, 53.5, 21.5; HRMS (ESI): Exact mass calcd for $C_{27}H_{24}N_2NaO_2S$ $[M+Na]^+$ 463.1456, found 463.1470.



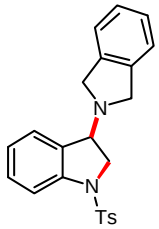
***N*-(3-(4,4,5,5-Tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)-1-tosylindolin-3-amine (2m).** Prepared according to the general procedure using 3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)aniline (80.0 mg, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 5-15-40% ethyl acetate in hexanes) yielded an oil (71.0 mg, 79%). R_f = 0.60 (40% EtOAc/hexanes); IR (film) 3394, 2978, 1601, 1580, 1477, 1359, 1166, 1093 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.77 (d, *J* = 8.0 Hz, 1H), 7.58 (d, *J* = 8.0 Hz, 2H), 7.37 (dd, *J* = 7.6, 7.6 Hz, 1H), 7.28-7.19 (m, 5H), 7.09 (dd, *J* = 7.6, 7.2 Hz, 1H), 6.83 (d, *J* = 2.4 Hz, 1H), 6.55 (d, *J* = 7.6 Hz, 1H), 4.89 (dd, *J* = 6.8, 2.8 Hz, 1H), 4.16 (dd, *J* = 12.0, 7.2 Hz, 1H), 3.85 (dd, *J* = 12.0, 3.2 Hz, 1H), 2.44 (s, 3H), 1.37 (s, 12H), the NH was not observed; ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.7, 144.1, 142.0, 133.6, 132.4, 129.8, 129.7, 128.7, 127.1, 125.4, 124.9, 124.5, 119.8, 116.3, 115.7, 83.7, 56.6, 53.2, 24.8, 21.4; HRMS (ESI): Exact mass calcd for $C_{27}H_{31}N_2NaO_2SB$ $[M+Na]^+$ 513.1995, found 513.2005.



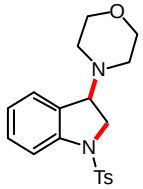
***N*-(4,6-Dimethylpyridin-2-yl)-1-tosylindolin-3-amine (2n).** Prepared according to the general procedure using 2-amino-4,6-dimethylpyridine (45.0 mg, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-20-40% ethyl acetate in hexanes) yielded an oil (30 mg, 42%). R_f = 0.60 (40% EtOAc/hexanes); IR (film) 3385, 2921, 1613, 1460, 1353, 1166 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, *J* = 8.0 Hz, 1H), 7.65 (d, *J* = 8.0 Hz, 2H), 7.33 (dd, *J* = 7.6, 7.6 Hz, 1H), 7.27 (d, *J* = 6.0 Hz, 1H), 7.22 (d, *J* = 8.0 Hz, 2H), 7.06 (dd, *J* = 7.6, 7.2 Hz, 1H), 6.37 (s, 1H), 5.89 (s, 1H), 5.23 (d, *J* = 3.2 Hz, 1H), 4.74 (br s, 1H), 4.21 (dd, *J* = 11.2, 8.0 Hz, 1H), 3.79 (dd, *J* = 11.6, 4.0 Hz, 1H), 2.40 (s, 3H), 2.35 (s, 3H), 2.21 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 156.2, 155.6, 149.6, 144.1, 142.0, 133.6, 131.9, 129.6, 127.2, 125.3, 124.2, 115.5, 114.5, 104.8, 57.0, 51.6, 23.3, 21.5, 21.1; HRMS (ESI): Exact mass calcd for $C_{22}H_{24}N_3O_2S$ $[M+H]^+$ 394.1589, found 394.1577.



3-(Pyrrolidin-1-yl)-1-tosylindoline (2o). Prepared according to the general procedure using pyrrolidine (30.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 20-40-60% ethyl acetate in hexanes) yielded an oil (42.0 mg, 67%). R_f = 0.10 (40% EtOAc/hexanes); IR (film) 2924, 1598, 1477, 1358, 1168, 1090 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 8.4 Hz, 2H), 7.39 (d, *J* = 7.2 Hz, 1H), 7.34 (dd, *J* = 8.0, 7.6 Hz, 1H), 7.27 (d, *J* = 9.6 Hz, 2H), 7.05 (dd, *J* = 7.6, 7.2 Hz, 1H), 4.55 (dd, *J* = 8.4, 2.8 Hz, 1H), 4.10 (dd, *J* = 11.6, 2.8 Hz, 1H), 3.76 (dd, *J* = 11.6, 8.4 Hz, 1H), 2.69-2.67 (m, 2H), 2.57-2.54 (m, 2H), 2.39 (s, 3H), 1.78-1.75 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.3, 142.6, 133.3, 130.0, 129.6, 127.3, 126.8, 123.4, 114.3, 60.1, 51.5, 48.6, 23.1, 21.4; HRMS (ESI): Exact mass calcd for $C_{19}H_{23}N_2O_2S$ $[M+H]^+$ 343.1480, found 343.1471.

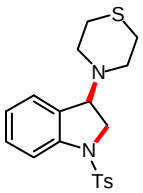


3-(Isoindolin-2-yl)-1-tosylindoline (2p). Prepared according to the general procedure using isoindoline (42.0 µl, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-20-40% ethyl acetate in hexanes) yielded an oil (52.0 mg, 73%). R_f = 0.50 (40% EtOAc/hexanes); IR (film) 2923, 1695, 1598, 1463, 1355, 1166, 1104 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.0 Hz, 1H), 7.72 (d, *J* = 8.4 Hz, 2H), 7.34 (d, *J* = 8.0 Hz, 1H), 7.32 (d, *J* = 7.2 Hz, 1H), 7.21-7.16 (m, 4H), 7.12-7.09 (m, 2H), 7.06 (dd, *J* = 8.0, 7.6 Hz, 1H), 4.58 (dd, *J* = 8.0, 3.2 Hz, 1H), 4.06 (dd, *J* = 11.6, 3.6 Hz, 1H), 3.87 (dd, *J* = 11.6, 8.4 Hz, 1H), 3.81 (d, *J* = 12.0 Hz, 2H), 3.78 (d, *J* = 12.4 Hz, 2H), 2.33 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 142.2, 139.1, 133.7, 130.9, 129.5, 129.4, 127.2, 126.7, 126.4, 123.5, 122.2, 114.7, 60.2, 54.1, 51.9, 21.4; HRMS (ESI): Exact mass calcd for $C_{23}H_{23}N_2O_2S$ $[M+H]^+$ 391.1480, found 391.1473.

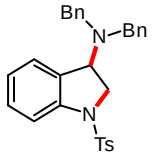


4-(1-Tosylindolin-3-yl)morpholine (2q). Prepared according to the general procedure using morpholine (32.0 µl, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 20-40-60% ethyl acetate in hexanes) yielded an oil (51.0 mg, 78%). R_f = 0.20 (40% EtOAc/hexanes); IR (film) 2855, 1598, 1477, 1354, 1169, 1115 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.0 Hz, 3H),

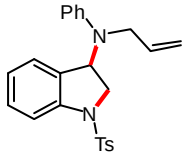
7.33-7.28 (m, 2H), 7.26 (d, J = 8.0 Hz, 2H), 7.04 (dd, J = 7.6, 7.2 Hz, 1H), 4.27 (dd, J = 8.8, 3.6 Hz, 1H), 3.99 (dd, J = 11.6, 4.0 Hz, 1H), 3.71 (dd, J = 11.6, 9.2 Hz, 1H), 3.57 (t, J = 4.4 Hz, 4H), 2.38 (s, 3H), 2.33 (ddd, J = 11.2, 4.4, 4.4 Hz, 2H), 2.21 (ddd, J = 9.2, 4.4, 4.4 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 142.5, 133.6, 130.3, 129.6, 129.5, 129.2, 127.2, 126.4, 123.3, 144.2, 66.8, 63.8, 49.9, 48.2, 21.4; HRMS (ESI): Exact mass calcd for $C_{19}H_{23}N_2O_3S$ $[M+H]^+$ 359.1429, found 359.1416.



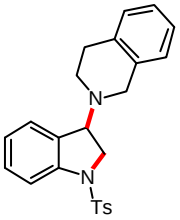
4-(1-Tosylindolin-3-yl)thiomorpholine (2r). Prepared according to the general procedure using thiomorpholine (37.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-20-40% ethyl acetate in hexanes) yielded an oil (49.0 mg, 72%). R_f = 0.50 (40% EtOAc/hexanes); IR (film) 2919, 1597, 1475, 1355, 1167, 1103 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, J = 8.4 Hz, 2H), 7.72 (d, J = 8.0 Hz, 1H), 7.31 (d, J = 7.2 Hz, 1H), 7.26 (d, J = 8.0 Hz, 2H), 7.23 (d, J = 7.6 Hz, 1H), 7.03 (ddd, J = 7.2, 7.2, 0.8 Hz, 1H), 4.27 (dd, J = 9.2, 4.0 Hz, 1H), 3.92 (dd, J = 11.2, 4.0 Hz, 1H), 3.73 (dd, J = 11.2, 9.2 Hz, 1H), 2.60-2.44 (m, 8H), 2.38 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.1, 142.4, 133.6, 129.7, 129.6, 129.4, 127.2, 126.1, 123.3, 114.2, 65.2, 50.5, 50.0, 28.1, 21.4; HRMS (ESI): Exact mass calcd for $C_{19}H_{23}N_2O_2S_2$ $[M+H]^+$ 375.1201, found 375.1204.



***N,N*-Dibenzyl-1-tosylindolin-3-amine (2s).** Prepared according to the general procedure using dibenzyl amine (57.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 20-40-70% ethyl acetate in hexanes) yielded an oil (70.0 mg, 82%). R_f = 0.60 (40% EtOAc/hexanes); IR (film) 2922, 1599, 1476, 1356, 1168 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, J = 7.6 Hz, 1H), 7.73 (d, J = 8.0 Hz, 2H), 7.36 (d, J = 7.6 Hz, 1H), 7.32-7.20 (m, 12H), 7.06 (dd, J = 7.2, 7.2 Hz, 2H), 4.44 (dd, J = 9.2, 4.4 Hz, 1H), 3.98 (dd, J = 11.6, 4.8 Hz, 1H), 3.74 (dd, J = 11.6, 9.6 Hz, 1H), 3.37 (d, J = 13.6 Hz, 2H), 3.07 (d, J = 14.0 Hz, 2H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.2, 142.4, 138.9, 133.8, 131.6, 129.6, 129.3, 128.3, 128.2, 127.1, 127.0, 125.8, 123.7, 114.4, 58.3, 53.4, 48.8, 21.3; HRMS (ESI): Exact mass calcd for $C_{29}H_{29}N_2O_2S$ $[M+H]^+$ 469.1950, found 469.1957.



***N*-Allyl-N-phenyl-1-tosylindolin-3-amine (2t).** Prepared according to the general procedure using *N*-allylamine (50.0 µL, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 5-15-40% ethyl acetate in hexanes) yielded an oil (44.0 mg, 59%). R_f = 0.80 (40% EtOAc/hexanes); IR (film) 3062, 2922, 1731, 1598, 1503, 1476, 1357, 1167 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (d, J = 8.0 Hz, 1H), 7.73 (d, J = 8.4 Hz, 2H), 7.33 (d, J = 7.6 Hz, 1H), 7.28-7.16 (m, 5H), 7.02 (dd, J = 7.6, 7.2 Hz, 1H), 6.79 (dd, J = 7.6, 7.2 Hz, 1H), 6.74 (d, J = 8.4 Hz, 2H), 5.58 (dddd, J = 15.6, 10.8, 4.8, 4.8 Hz, 1H), 5.48 (dd, J = 9.2, 5.6 Hz, 1H), 5.04 (s, 1H), 5.01 (dd, J = 8.0, 1.6 Hz, 1H), 4.15 (dd, J = 11.6, 9.6 Hz, 1H), 3.79 (dd, J = 11.2, 5.6 Hz, 1H), 3.37-3.25 (m, 2H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 148.3, 144.2, 142.3, 135.3, 133.6, 130.2, 129.7, 129.6, 129.1, 127.3, 125.9, 123.6, 118.1, 115.8, 114.7, 114.2, 58.5, 53.3, 49.0, 21.4; HRMS (ESI): Exact mass calcd for $C_{24}H_{24}N_2NaO_2S$ $[M+Na]^+$ 427.1456, found 427.1455.



2-(1-Tosylindolin-3-yl)-1,2,3,4-tetrahydroisoquinoline (2u). Prepared according to the general procedure using 1,2,3,4-tetrahydroisoquinoline (46.0 mg, 0.366 mmol) over 18 hours. Flash column chromatography (SiO_2, 10-15-40% ethyl acetate in hexanes) yielded an oil (47.0 mg, 64%). R_f = 0.60 (40% EtOAc/hexanes); IR (film) 2921, 1598, 1476, 1460, 1355, 1167, 1093 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, J = 8.0 Hz, 1H), 7.75 (d, J = 8.4 Hz, 2H), 7.35-7.25 (m, 4H), 7.13-7.02 (m, 4H), 6.82 (d, J = 6.8 Hz, 1H), 4.54 (dd, J = 9.2, 4.0 Hz, 1H), 4.02 (dd, J = 11.6, 4.4 Hz, 1H), 3.83 (dd, J = 11.6, 9.2 Hz, 1H), 3.47 (d, J = 14.8 Hz, 1H), 3.35 (d, J = 14.8 Hz, 1H), 2.75 (s, 2H), 2.59-2.47 (m, 2H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) ppm 144.18, 142.4, 134.3, 134.0, 133.8, 129.8, 129.6, 129.5, 128.6, 127.2, 126.5, 126.4, 126.0, 125.4, 123.4, 114.3, 63.6, 50.4, 49.8, 45.9, 29.4, 21.4; HRMS (ESI): Exact mass calcd for $C_{24}H_{25}N_2O_2S$ $[M+H]^+$ 405.1637, found 405.1632.