**Electronic Supplementary Information**

New rearrangement of isoxazolidines to tetrahydro-1,3-oxazines for the synthesis of chiral pyrrolidines

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General Experimental

Unless otherwise stated, all chemicals were purchased as the highest purity commercially available and were used without further purification. IR spectra were recorded on a BOMEM 100 FT-IR or an AVATAR 370 FT-IR Thermo Nicolet spectrophotometers. $^1$H and $^{13}$C NMR spectra were performed in CDCl$_3$ and referenced to the residual peak of CHCl$_3$ at δ 7.26 ppm and δ 77.0 ppm, for $^1$H and $^{13}$C, respectively, using Varian 200 VX and Bruker DRX 400 instruments. Chemical shifts are reported in δ ppm and coupling constants (J) are given in hertz. MS were performed at a VG-TS 250 spectrometer at 70 eV ionising voltage. Mass spectra are presented as m/z (% rel int.). HRMS were recorded on a VG Platform (Fisons) spectrometer using chemical ionisation (ammonia as gas) or Fast Atom Bombardment (FAB) technique. For some of the samples, QSTAR XL spectrometer was employed for electrospray ionisation (ESI). Optical rotations were determined on a Perkin-Elmer 241 polarimeter in 1 dm cell. Dichloromethane was distilled from calcium hydride; tetrahydrofuran and diethyl ether were distilled from sodium/benzophenone ketyl under argon atmosphere prior to use. Hexane was distilled prior to use.

N-O cleavage of Isoxazolidines using Mo(CO)$_6$: Standard Procedure.
To a stirred solution of isoxazolidine (1 mmol) in 1 mL of H$_2$O and 15 mL of MeCN was added 0.7 mmol of Mo(CO)$_6$ and heated at reflux. The solution was stirred for 24 h. Then it was concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 1:1) to obtain rearranged compound.

To a stirred solution of isoxazolidine (1 mmol) in CHCl$_3$ (0.06M) was added dropwise RBr (1 mmol) and heated at 60ºC. The solution was stirred at 60 ºC for 20 h. Then it was quenched with saturated aqueous solution of NH$_4$Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na$_2$SO$_4$), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain rearranged compound.

To a stirred solution of Rearranged compound (1 mmol) in Et$_2$O (0.08M) was added dropwise RMgBr (10 mmol) at -60ºC. The solution was stirred at -60 ºC for 2 h. Then the mixture was allowed to warm slowly to room temperature. It was quenched with saturated aqueous solution of NH$_4$Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na$_2$SO$_4$), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 1:1) to obtain pyrrolidines.

To a stirred solution of isoxazolidine 2c (460 mg, 1.42 mmol) in 1.50 mL of H_{2}O and 21 mL of MeCN was added 265 mg (1 mmol) of Mo(CO)_{5} and heated at 80°C. The solution was stirred for 24 h. Then it was concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 10 (232 mg, 50%) and 4c (232 mg, 50%). \([\alpha]_{D}^{20} = -2.7 (c=0.7, \text{CHCl}_{3}); \text{IR (film)}: 2981.95, 2933.73, 2881.65, 1301.41, 1147.75, 732.95 \text{ cm}^{-1}; ^{1}H \text{ NMR (200 MHz, CDCl}_{3} \delta 7.94 (2H, d, J = 8.0 \text{ Hz, } H_{\text{meta}}), 7.70-7.56 (3H, m, H_{\text{ortho}} and H_{\text{para}}), 4.86 (1H, s, H-1), 4.75 (1H, dd, J = 1.2 and 5.4 Hz, H-6), 4.55 4.48 (2H, m, H-7 and H_{\text{para}-3}), 3.87 (1H, dd, J = 5.8 and 14.2 Hz, H_{\text{meta}-3}), 3.77 (1H, sa, H-5), 2.73 (1H, dd, J = 3.0 and 5.8 Hz, H-4), 1.45 (3H, s, Me-acetonide), 1.31 (3H, s, Me-acetonide); ^{13}C \text{ NMR (50 MHz, CDCl}_{3} \delta 137.5, 134.6, 129.8, 128.9, 112.9, 88.8, 81.9, 78.7, 59.1, 57.9, 56.5, 26.1, 24.9; HRMS (EI) calc for C_{11}H_{16}NO_{3}S requires (M+H)^{+} 326.1056; found 326.1068.

(1R,4S,5R,6S,7S)-4-phenylsulfonyl-6,7-isopropilendioxio-2-oxa-8-azabicyclo[3.2.1]octane 11.

To a stirred solution of isoxazolidine 3c (530 mg, 1.63 mmol) in 1.70 mL of H_{2}O and 25 mL of MeCN was added 300 mg (1.14 mmol) of Mo(CO)_{5} and heated at 80°C. The solution was stirred for 24 h. Then it was concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 11 (282 mg, 53%) and 5c (105 mg, 20%). \([\alpha]_{D}^{20} = +20.0 (c=0.9, \text{CHCl}_{3}); \text{IR (film)}: 3412, 3338, 2974, 2929, 1373, 1140, 1033 \text{ cm}^{-1}; ^{1}H \text{ NMR (400 MHz, CDCl}_{3} \delta 7.82 (2H, d, J = 8.0 \text{ Hz, } H_{\text{meta}}), 7.70 (1H, t, J = 7.6 \text{ Hz, } H_{\text{ortho}}), 7.60 (2H, d, J = 7.6 \text{ Hz, } H_{\text{para}}), 5.52 (1H, d, J = 5.4 \text{ Hz, H-6}), 4.77 (1H, s, H-1), 4.72 (1H, d, J = 5.4 \text{ Hz, H-7}), 4.01 (1H, dd, J = 5.8 and 11.8 Hz, H_{\text{para}-3}), 3.87 (1H, t, J = 11.8 \text{ Hz, H}_{\text{meta}-3}), 3.77 (1H, sa, H-5), 3.50 (1H, ddd, J = 2.6, 5.8 and 8.4 Hz, H-4), 1.45 (3H, s, Me-acetonide), 1.38 (3H, s, Me-acetonide); ^{13}C \text{ NMR (100 MHz, CDCl}_{3} \delta 137.7, 134.8, 129.6, 128.7, 128.4, 128.2, 111.7, 88.8, 81.8, 78.7, 61.3, 59.6, 57.9, 25.7, 24.4; HRMS (EI) calc for C_{11}H_{16}NO_{3}S requires (M+H)^{+} 326.1056; found 326.1068.

(1R,4R,5R,6S,7S)-8-benzyl-4-phenylsulfonyl-6,7-isopropilendioxio-2-oxa-8-azabicyclo[3.2.1]octane 12a.

To a stirred solution of isoxazolidine 2c (37.40 mg, 0.11 mmol) in CHCl_{3} (1.50 mL) was added dropwise BnBr (13.6 mL, 0.11 mmol) and heated at 60°C. The solution was stirred at 60°C for 20 h. Then it was quenched with saturated aqueous solution of NH_{4}Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na_{2}SO_{4}), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 12a (21.7 mg, 46%). \([\alpha]_{D}^{20} = -31.7 (c=0.6, \text{CHCl}_{3}); \text{IR (film)}: 3391, 3060, 2970, 2921, 1446, 1385, 1152 \text{ cm}^{-1}; ^{1}H \text{ NMR (200 MHz, CDCl}_{3} \delta 7.85-7.30 (10H, m, H_{A}), 4.71 (1H, s, H-1), 4.62 (1H, d, J = 5.0 \text{ Hz, H-7}), 4.52 (1H, d, J = 5.0 \text{ Hz, H-6}), 4.38 (1H, d, J = 12.0 \text{ Hz, H}_{\text{meta}-3}), 4.26-4.23 (1H, m, H_{\text{ortho}-3}), 4.20 (1H, d, J = 12.0 \text{ Hz, H}_{\text{meta}-1}), 4.13 (1H, s, H-5), 3.85-3.75 (1H, m, H_{\text{ortho}-3}), 3.10 (1H, t, J = 6.2 \text{ Hz, H-4}), 1.52 (3H, s, Me-acetonide), 1.29 (3H, s, Me-acetonide); ^{13}C \text{ NMR (50 MHz, CDCl}_{3} \delta 138.9, 138.5, 134.4, 129.8, 128.7, 128.4, 127.3,
To a stirred solution of isoxazolidine 2c (49.60 mg, 0.15 mmol) in CHCl₃ (2.60 mL) was added dropwise AllylBr (14 µL, 0.15 mmol) and heated at 60°C. The solution was stirred at 60°C for 20 h. Then it was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 12b (32.9 mg, 60%). [α]D₂⁰ = -31.7 (c=0.6, CHCl₃); IR (film): 3068.75, 2981.95, 2931.80, 2860.43, 1446.61, 1305 cm⁻¹;¹H NMR (200 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.2 Hz, Horno), 7.70-7.52 (3H, m, Hpara and Hmeta), 5.75-5.58 (1H, m, H-2'), 5.31 (1H, dd, J = 1.8 and 13.6 Hz, H₈-3'), 5.14 (1H, dd, J = 1.8 and 13.6 Hz, H₈-3'), 4.70 (1H, s, H-1), 4.62 (1H, d, J = 5.4 Hz, H-6), 4.51 (1H, d, J = 5.4 Hz, H-7), 4.20-4.09 (2H, m, 2H-3), 4.05 (1H, s, H-5), 3.80-3.55 (2H, m, H-4 and H₈-1'), 3.07-3.01 (1H, m, H₈-1'), 1.48 (3H, s, Me-acetone), 1.26 (3H, s, Me-acetone);¹³C NMR (50 MHz, CDCl₃) δ 138.7, 135.3, 134.3, 129.7, 128.8, 117.3, 113.4, 90.3, 84.7, 83.5, 62.3, 59.8, 58.4, 51.9, 26.1, 25.0; HRMS (EI) calcd for C₂₂H₂₃NO₃S requires (M+H)+ 416.1538; found 416.1538.

To a stirred solution of isoxazolidine 3a (28.30 mg, 0.09 mmol) in CHCl₃ (1.30 mL) was added dropwise BnBr (10 µL, 0.09 mmol) and heated at 60°C. The solution was stirred at 60°C for 20 h. Then it was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 13a (24 mg, 67%). [α]D₂⁰ = -28.3 (c=0.7, CHCl₃); IR (film): 3387, 2978, 2864, 1589, 1397, 1140 cm⁻¹;¹H NMR (200 MHz, CDCl₃) δ 7.84-7.52 (10H, m, HAr), 5.34 (1H, d, J = 5.8 Hz, H-6), 4.72 (1H, d, J = 5.8 Hz, H-7), 4.50 (1H, s, H-1), 4.14-3.97 (3H, m, CH₂-Bn and 1H-3), 3.84 (1H, t, J= 14.8 Hz, H-3), 3.73 (1H. ddd, J = 2.6, 6.2 and 8.8 Hz, H-4), 3.56 (1H, s, H-5), 1.52 (3H, s, Me-acetone), 1.37 (3H, s, Me acetone);¹³C NMR (50 MHz, CDCl₃) δ 138.1, 137.3, 134.4, 129.8, 128.7, 128.3, 127.5, 112.5, 89.6, 81.4, 77.4, 59.9, 59.8, 54.1, 48.3, 26.4, 25.4; HRMS (EI) calcd for C₂₃H₂₅NO₃SNa requires (M+Na) 438.1345; found 438.1349.

To a stirred solution of isoxazolidine 2d (49.60 mg, 0.15 mmol) in CHCl₃ (2.60 mL) was added dropwise AllylBr (14 µL, 0.15 mmol) and heated at 60°C. The solution was stirred at 60°C for 20 h. Then it was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 13b (32.9 mg, 60%). [α]D₂⁰ = -31.7 (c=0.6, CHCl₃); IR (film): 3068.75, 2981.95, 2931.80, 2860.43, 1446.61, 1305 cm⁻¹;¹H NMR (200 MHz, CDCl₃) δ 7.84 (2H, d, J = 8.2 Hz, Horno), 7.70-7.52 (3H, m, Hpara and Hmeta), 5.75-5.58 (1H, m, H-2'), 5.31 (1H, dd, J = 1.8 and 13.6 Hz, H₈-3'), 5.14 (1H, dd, J = 1.8 and 13.6 Hz, H₈-3'), 4.70 (1H, s, H-1), 4.62 (1H, d, J = 5.4 Hz, H-6), 4.51 (1H, d, J = 5.4 Hz, H-7), 4.20-4.09 (2H, m, 2H-3), 4.05 (1H, s, H-5), 3.80-3.55 (2H, m, H-4 and H₈-1'), 3.07-3.01 (1H, m, H₈-1'), 1.48 (3H, s, Me-acetone), 1.26 (3H, s, Me-acetone);¹³C NMR (50 MHz, CDCl₃) δ 138.7, 135.3, 134.3, 129.7, 128.8, 117.3, 113.4, 90.3, 84.7, 83.5, 62.3, 59.8, 58.4, 51.9, 26.1, 25.0; HRMS (EI) calcd for C₂₃H₂₅NO₃S requires (M+H)+ 416.1538; found 416.1538.
To a stirred solution of isoxazolidine 3c (74 mg, 0.23 mmol) in CHCl₃ (4 mL) was added dropwise AllylBr (20 μL, 0.23 mmol) and heated at 60°C. The solution was stirred at 60 °C for 20 h. Then it was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo. The resulting crude residue was purified by flash chromatography (silica gel, hexane/EtOAc 8:2) to obtain 13b (113 mg, 74%). [α]₀°Ds = -13.7 (c=0.6, CHCl₃); IR (film): 3066.82, 2981.95, 2935.66, 1309.67, 1246.02, 1101.35, 902.69, 866.04, 731.02, 603.72 cm⁻¹;¹H NMR (200 MHz, CDCl₃) δ 7.85 (2H, d, J= 8.0 Hz, Horro), 7.72-7.52 (3H, m, Hpara and Hmeta), 5.71-5.63 (1H, m, H-2'), 5.33 (1H, d, J= 5.4 Hz, H-6), 5.20 (1H, dd, J = 1.8 and 7.2 Hz, H₃-C'), 5.02 (1H, dd, J = 1.8 and 7.2 Hz, H₃-B'), 4.70 (1H, d, J = 5.4 Hz, H-7), 4.51 (1H, s, H-1'), 4.02-3.87 (2H, m, 2H-3), 3.60 (1H, s, H-5), 3.59-3.42 (2H, m, H-4 and H₂-1'), 3.29-3.19 (1H, m, H₃-1'), 1.45 (3H, s, Me-acetoneide), 1.36 (3H, s, Me-acetoneide).¹³C NMR (50 MHz, CDCl₃) δ 138.1, 134.3, 129.9, 117.6, 112.6, 89.5, 81.5, 77.9, 59.9, 53.9, 46.9, 26.4, 25.5; HRMS (EI) calcd for C₁₈H₂₃NO₂S requires (M+H)⁺ 366.1369; found 366.1372.

(1'R,2R,3S,4R,5R)-1-Benzyl-5-methyl-2-(1-phenylsulfonyl-2-hidroxyethyl)-3,4-isopropylidenedioxypryrolidine 14a.

To a stirred solution of 12a (10 mg, 0.023 mmol) in Et₂O (1.0 mL) was added dropwise a 3.0 M Et₂O solution of MeMgBr (0.10 mL) at -60°C. The solution was stirred at -60 °C for 2 h. Then the mixture was allowed to warm slowly to room temperature. It was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo to afford 14a (8.50 mg, 85%). [α]₀°Ds = -4.3 (c=0.4, CHCl₃); IR (film): 2958.80, 2920.23, 2850.79, 1143.79, 1051.20, 806.46, 584.43 cm⁻¹;¹H NMR (200 MHz, CDCl₃) δ 7.92-7.25 (10H, m, HAr), 5.04 (1H, dd, J = 2.6 and 6.0 Hz, H-3), 4.35 (1H, dd, J = 3.2 and 6.0 Hz, H-4), 4.01 (1H, dd, J = 4.4 and 12.0 Hz, H₃-C'), 3.89 (1H, d, J = 13.2 Hz, H₃-CH₂Bn), 3.66-3.56 (2H, m, H-2 and H-21), 3.64 (1H, d, J = 13.2 Hz, H₃-CH₂Bn), 3.42-3.36 (1H, m, H-1'), 3.12 (1H, dq, J = 3.2 and 7.0 Hz, H-5), 1.45 (3H, s, Me-acetoneide), 1.30 (3H, s, Me-acetoneide), 1.20 (3H, d, J = 7.0 Hz, Me-C-5);¹³C NMR (50 MHz, CDCl₃) δ 138.0, 135.7, 134.2, 129.8, 129.4, 128.8, 128.7, 127.8, 112.5, 86.4, 84.2, 69.0, 66.9, 64.1, 60.0, 59.4, 27.6, 25.3, 19.8;HRMS (EI) calcd for C₁₈H₂₃NO₂SNa requires (M+Na⁺) 454.1658; found 454.1640.

(1'S,2R,3S,4R,5R)-1-Benzyl-5-methyl-2-(1-phenylsulfonyl-2-hidroxyethyl)-3,4-isopropylidenedioxypryrolidine 15a.

To a stirred solution of 13a (50 mg, 0.12 mmol) in Et₂O (1.50 mL) was added dropwise a 3.0 M Et₂O solution of MeMgBr (0.40 mL) at -60°C. The solution was stirred at -60 °C for 2 h. Then the mixture was allowed to warm slowly to room temperature. It was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo to afford 15a (49 mg, 98%). [α]₀°Ds = +5.8 (c=0.7, CHCl₃);IR (film): 3473.80, 2985.81, 2964.59, 2933.73, 1448.54, 1381.03, 1307.74, 1043.49, 690.52 cm⁻¹;¹H NMR (400 MHz, CDCl₃) δ 7.94-7.55 (10H, m, HAr), 4.76 (1H, d, J= 6.0 Hz, H-3'), 4.09 (1H, t, J= 6.5 Hz, H-4), 4.06 (1H, ddd, J = 1.0, 4.7 and 11.6 Hz, H₃-C'), 3.96 (1H, dd, J = 7.5 and 11.6 Hz, H₃-B'), 3.82 (1H, d, J = 13.6 Hz, H₃-CH₂Bn), 3.59 (1H, s, H-2'), 3.49 (1H, d, J = 13.6 Hz, H₃-CH₂Bn), 3.03-2.99(1H, m, H-1'), 2.70-2.67
To a stirred solution of 13a (61.50 mg, 0.15 mmol) in Et₂O (2.20 mL) was added dropwise a 1.0 M Et₂O solution of AllylMgBr (1.50 mL) at -60°C. The solution was stirred at -60°C for 2 h. Then the mixture was allowed to warm slowly to room temperature. It was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo to afford 15e (58 mg, 85%). [α]D₂⁰ = +4.3 (c=0.5, CHCl₃); IR (film): 3502.73, 2981.95, 2916.37, 2848.46, 1448.54, 1149.57, 1070.49, 736.81, 590.22 cm⁻¹; ¹H NMR (200 MHz, CDCl₃) δ 7.91-7.24 (10H, m, Ar), 5.90-5.76 (1H, m, H-2’), 5.20-5.03 (2H, m, H-3’), 4.78 (1H, dd, J = 2.0 and 6.2 Hz, H-3), 4.31 (1H, t, J = 6.2 Hz, H-4), 4.09-3.98 (2H, m, H-2’), 3.91 (1H, d, J = 13.2 Hz, H₋ CH₂-Bn), 3.58 (1H, s, H-2), 3.56 (1H, d, J = 13.2 Hz, H₋ CH₂-Bn), 3.09-2.95 (1H, m, H-1’), 2.48-2.16 (3H, m, H-5, H-1”), 1.42 (3H, m, Me-acetamide), 1.29 (3H, m, Me-acetamide). ¹³C NMR (50 MHz, CDCl₃) δ 138.8, 138.3, 136.2, 135.7, 134.3, 129.7, 129.4, 129.3, 128.5, 127.3, 118.4, 112.7, 82.4, 79.0, 67.6, 65.4, 64.1, 58.4, 57.1, 56.2, 28.1, 26.0; HRMS (El) calced for C₂₅H₂₃NO₃S requires (M+H)+, 432.1815; found 432.1824.

(1’S,2R,3S,4R,5R)-1-Benzyl-2-(1-phenylsulfonfonyl-2-hydroxyethyl)-5-propenyl-3,4-isopropylidenedioxypyrrrolidine 15e.

To a stirred solution of 13a (42 mg, 0.10 mmol) in Et₂O (1.5 mL) was added dropwise a 1.0 M THF solution of VinylMgBr (20 mL) at -60°C. The solution was stirred at -60°C for 2 h. Then the mixture was allowed to warm slowly to room temperature. It was quenched with saturated aqueous solution of NH₄Cl and the product was extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated in vacuo to afford 15h (24 mg, 54%). [α]D₂⁰ = +40 (c=0.3, CHCl₃); IR (film): 2983.88, 2920.23, 2848.80, 1448.54, 1215.15, 1070.44, 690.52 cm⁻¹; ¹H NMR (200 MHz, CDCl₃) δ 7.97-6.95 (10H, m, Ar), 5.79-5.61 (1H, m, H-1”), 5.40-5.29 (2H, m, H-2”), 4.79 (1H, dd, J = 1.2 and 5.6 Hz, H-3), 4.26 (1H, t, J = 7.0 Hz, H-4), 4.07 (1H, dd, J = 4.2 and 11.8 Hz, H₋2”), 3.93 (1H, dd, J = 5.8 and 11.8 Hz, H₋2”), 3.89 (1H, d, J = 13.2 Hz, H₋ CH₂-Bn), 3.60 (1H, s, H-2), 3.35 (1H, d, J = 13.2 Hz, H₋ CH₂-Bn), 3.08 (1H, t, J = 7.8 Hz, H-1”), 2.93-2.95 (1H, m, H-1”), 1.46 (3H, s, Me-acetamide), 1.30 (3H, s, Me-acetamide). ¹³C NMR (50 MHz, CDCl₃) δ 138.2, 137.3, 135.8, 134.4, 129.9, 129.5, 129.2, 128.8, 128.1, 120.1 112.8, 83.2, 79.3, 72.4 64.9, 63.7, 58.5, 56.1, 28.2, 26.1; HRMS (El) calced for C₂₅H₂₃NO₃S (M+Na)+, 466.1658.; found 466.1660.

(1’S,2R,3S,4R,5R)-1-Benzyl-2-(1-phenylsulfonfonyl-2-hydroxyethyl)-5-vinyl-3,4-isopropylidenedioxypyrrrolidine 15h.

(2S,3S,4R,5R)-1-Benzyl-3,4-isopropylidenedioxo-5-methyl-2-vinylpyrrrolidine 16.

a) To a solution of pyrrrolidine 15a (40 mg, 0.09 mmol) in MeOH (1.5 mL) was added 128 mg (0.28 mmol) of 5% Na (Hg) amalgam at r.t. The mixture was stirred for 2 h at this temperature under an
argon atmosphere. Next, it was filtered to eliminate the Hg residue and diluted with DCM, 30mL. The mixture was washed with brine, dried (Na₂SO₄), filtered, and concentrated. The resulting crude residue was purified by flash chromatography (silica gel, n-hexane/EtOAc 6:4) to obtain 16 (25 mg, 100%). [α]D²⁰ = -5.0 (c=0.5, CH₂Cl₂); IR (film): 2980.02, 2964.59, 1448.04, 1070.49, 866.04 cm⁻¹; ¹H NMR (200 MHz, CDCl₃) δ 7.31-7.21 (5H, m, HAr), 5.84-5.66 (1H, m, H-1’), 5.39-5.20 (2H, m, H-2’), 4.29 (1H, dd, J= 5.0 and 6.8 Hz, H-3), 4.16 (1H, dd, J= 4.8 and 6.8 Hz, H-4), 3.84 (1H, d, J = 14.6 Hz, H₅-CH₂-Bn), 3.57 (1H, d, J = 14.6 Hz, H₆-CH₂-Bn), 3.09 (1H, dd, J= 5.0 and 8.4 Hz, H-2), 2.70-2.64 (1H, m, H-5), 1.43 (3H, s, Me-acetone), 1.29 (3H, s, Me-acetone), 1.22 (3H, d, J = 5.6 Hz, Me-C-5); ¹³C NMR (50 MHz, CDCl₃) δ 138.8, 137.6, 129.5, 128.2, 127.1, 118.9, 113.5, 85.4, 83.5, 72.9, 63.9, 53.4, 27.5, 25.6, 18.5; HRMS (EI) calcd for C₁₇H₂₃NO₂ requires (M+H)+ 274.1801; found 274.1800.

b) To a solution of pyrrolidine 14a (10 mg, 0.02 mmol) in MeOH (1 mL) was added 48 mg (0.06 mmol) of 5% Na (Hg) amalgam at r.t. The mixture was stirred for 2 h at this temperature under an argon atmosphere. Next, it was filtered to eliminate the Hg residue and diluted with DCM, 30mL. The mixture was washed with brine, dried (Na₂SO₄), filtered, and concentrated. The resulting crude residue was purified by flash chromatography (silica gel, n-hexane/EtOAc 6:4) to obtain 16 (6 mg, 100%).

(2S,3S,4R,5R)-1-Benzyl-2,5-divinyl-3,4-isopropylidenedioxypyrrolidine 17.

To a solution of pyrrolidine 15h (24 mg, 0.06 mmol) in MeOH (1 mL) was added 75 mg (0.16 mmol) of 5% Na (Hg) amalgam at r.t. The mixture was stirred for 2 h at this temperature under an argon atmosphere. Next, it was filtered to eliminate the Hg residue and diluted with DCM, 30mL. The mixture was washed with brine, dried (Na₂SO₄), filtered, and concentrated. The resulting crude residue was purified by flash chromatography (silica gel, n-hexane/EtOAc 6:4) to obtain 17 (17 mg, 100%). IR (film): 2981.95, 2924.09, 1375.25, 1367.23, 1072.42, 921.97, 866.04, 704.20 cm⁻¹; ¹H NMR (200 MHz, CDCl₃) δ 7.26-7.21 (5H, m, HAr), 5.82-5.84 (2H, m, H-1’), 5.38 (2H, d, J= 1.8 Hz, H₅-2’), 5.20 (2H, dd, J= 5.0 and 6.8 Hz, H₆-2’), 4.30 (2H, dd, J= 1.2 and 3.0 Hz, H-3 and H-4), 3.70 (2H, bs, CH₂-Bn), 3.12 (2H, dd, J= 1.8 and 7.8 Hz, H-2 and H-5), 1.42 (3H, s, Me-acetone), 1.27 (3H, s, Me-acetone); ¹³C NMR (50 MHz, CDCl₃) δ 138.5, 136.5, 130.1, 128.1, 127.1, 118.9, 113.7, 83.7, 77.3, 71.7, 52.6, 27.4, 25.6; HRMS (EI) calcd for C₁₇H₂₃NO₂ requires (M+H)+ 286.1803; found 286.1801.

(2S,3S,4R,5R)-1-Benzyl-3,4-isopropylidenedioxy-5-methylpyrrolidine-2-ethanol 18.

9-BBN (1.8 ml, 0.9 mmol) was added to a solution of vinylypyrrolidine 16 (50 mg, 0.18 mmol) in THF (1.50 mL) at 0°C. The reaction mixture was stirred at r.t. for 4h. a saturated aqueous solution of NaBO₃ was added and the resulting mixture was stirred at r.t. for 18h. The reaction product was then extracted with DCM (3x15 mL). The combined organic layers were washed with brine, dried (Na₂SO₄), filtered, and concentrated. The resulting crude residue was purified by flash chromatography (silica gel, n-hexane/EtOAc 6:4) to obtain 18 (15 mg, 30%). [α]D²⁰ = -12.8 (c=0.8, CH₂Cl₂); IR (film): 3396.7, 2980.02, 2931.80, 2866.22, 1452.40, 1340.53, 1028.06, 732.95, 702.09 cm⁻¹; ¹H NMR (200 MHz, CDCl₃) δ 7.33-7.17 (5H, m, HAr), 4.29 (1H, dd, J= 5.0 and 6.8 Hz, H-3), 4.16 (1H, dd, J= 4.6 and 6.8 Hz, H-4), 4.05-3.99 (1H, m, H-2’), 3.84 (1H, d, J = 14.3 Hz, H₅-CH₂-Bn), 3.59 (1H, d, J = 14.3 Hz, H₆-CH₂-Bn), 3.54-3.40 (1H, m, H-2’), 3.12-3.05 (1H, m,
H-2), 2.70-2.64 (1H, m, H-5), 1.95-1.85 (1H, m, H-6), 1.83-1.75 (1H, m, H-1’), 1.44 (3H, s, Me-acetonide), 1.29 (3H, s, Me-acetonide), 1.17 (3H, d, J = 5.6 Hz, Me-C-5); $^{13}$C NMR (50 MHz, CDCl$_3$) δ 135.2, 132.3, 130.4, 128.6, 113.2, 83.5, 81.2, 72.7, 68.663.5, 54.4, 27.6, 24.3, 17.6; HRMS (EI) calcd for C$_{17}$H$_{26}$NO$_3$ requires (M+H)$^+$ 292.1907; found 292.1911.
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[Chemical structures and spectra images]

Pulse Sequence: [details]
Crystal data for 13a: \( \text{C}_{22}\text{H}_{25}\text{NO}_{5}\text{S}, \text{CH}_{2}\text{Cl}_2, \; M = 500.42, \) monoclinic, space group \( P2_1, \)
\( a = 6.0659(2) \; \AA, \; b = 15.5656(6) \; \AA, \; c = 12.9608(5) \; \AA, \; \alpha = \gamma = 90^\circ, \; \beta = 99.791(3)^\circ, \; V = 1205.93(8) \; \AA^3, \; Z = 2, \; D_c = 1.378 \; \text{Mg/m}^3, \; \mu(\text{Cu-K} \alpha) = 3.521 \; \text{mm}^{-1}, \; F(000) = 524. \)

Reflections were collected at 4.48 \( \leq 2\theta \leq 67.01 \) and merged to give 3318 unique reflections \( (R_{int} = 0.0254) \), of which 3132 with \( I > 2\sigma(I) \) were considered to be observed. Final values are \( R_1 = 0.0379, \; wR_2 = 0.1017, \; \text{GOF} = 1.039, \) max/min residual electron density 0.355 and -0.352 e. \( \text{Å}^{-3} \).

A suitable single crystal of the 13a compound was mounted on glass fibre for data collection on a Bruker Kappa APEX II CCD (charge coupled device) diffractometer. Data were collected at 298 K using Cu K\( \alpha \) radiation \( (\lambda = 1.54178 \; \text{Å}) \) and \( \omega \) scan technique, and were corrected for Lorentz and polarization effects. Structure solution, refinement and data output were carried out with the SHELXTL\textsuperscript{TM} program package. The structure was solved by direct methods combined with difference Fourier synthesis and refined by full-matrix least-squares procedures, with anisotropic thermal parameters in the last cycles of refinement for all non-hydrogen atoms. Hydrogen atom positions were calculated by geometrical methods and refined as a riding model. CCDC 888605. See https://www.ccdc.cam.ac.uk/services/structure_deposit/ for crystallographic data in .cif or other electronic format.

**ORTEP of 13a.**

The crystal contains an unique molecule of 13a compound and a molecule of solvent in the asymmetric unit. The title compound consists of a pyrrolidine-oxazine bicyclic ring with an isopropylidenediroyx group, a benzyl group and a phenylsulfone group as substituents. All the bond lengths and angles are within the normal ranges. The C-S-C and O-S-O angles are 104.7(1)º and 118.2(2)º, respectively. The large O-S-O angle and its deviation from the optimal 109.5º angle can be explained by the repulsion of the lone pairs of the oxygen placing the oxygen atoms as far away from each other as possible and thus minimizing the C-S-C angle. The molecule is twisted at the C-S bond being the C13-C7-S1-C6 torsion angle of 155.6(2)º.

In the crystal structure, each solvent molecule is involved in two type of intermolecular C-H-···O and C-H-···Cl interactions with different molecule of 13a compound, which lead to infinite molecular chains running along [010] directions (Fig. 1). The first one occurs between the carbon atom (C8) of the oxazine group and the chlorine atom (Cl1) with \( d(\text{C8-H8-···Cl1}) = 3.590(4) \) Å and \( < \text{C8-H8-···Cl1} > = 134.7(2)^\circ \). The other exists between the carbon atom of solvent and the oxygen atom (O5) of the isopropylidenediroyx group with \( d(\text{C23-H23-···O5}) = 3.363(6) \) Å and \( < \text{C8-H8-···Cl1} > = 157.1(3)^\circ \). A view of intermolecular C-H-···O (dotted light blue lines) and C-H-···Cl (dotted violet lines) interactions is shown in Fig. 2.

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**Fig. 1** Crystal packing of 13a·view along a-axis, showing intermolecular hydrogen bonding.
Fig. 2 Perspective view of intermolecular interactions for 13a

Fig. 3 X-ray crystal structure of 13a compound. Displacement ellipsoids are drawn at the 30 % probability level. Hydrogen atoms are shown as spheres of arbitrary radius.