Author Year Country PEDro Score Research Design Total Sample Size	Methods	Outcome
Leaning and Push-Up		
Hobson 1992 USA Prospective Controlled Trial N=22	**Population:** *SCI group:* Mean age:40.9 yr; Gender: males=10, females=2; Mean weight: 59.8 kg; Level of injury: paraplegia=7, tetraplegia=5; Severity of injury: complete=12; Mean time since injury: 19.5 yr; Chronicity=chronic; *Able-bodied group:* Mean age: 39.3 yr; Gender: males=6, females=4. **Intervention:** Comparison of Pressure mapping and shear measurements from midline neutral posture to eight typical wheelchair-sitting postures (trunk bending left and right, forward trunk flexion 30° and 50°, back recline 110° and 120° and body recline or tilt 10° and 20°). **Outcome Measures:** Tangentially induced shear measuring shear forces; Pressure distribution-Oxford Pressure Monitor Device measuring average and maximum pressure and peak pressures gradient.	1. Mean maximum pressure was on average 26% higher in the SCI group versus the able-bodied group. 2. Maximum reduction of TIS occurred with forward trunk flexion of 50° (-133%) and full body tilt of 20° (-85%). Backward recline to 120° caused increase in TIS of 25%. 3. Forward trunk flexion reduced the average pressure for both groups; however, SCI group encountered a 10% increase in pressure at the initial 30° of forward flex before a reduction occurred. 4. SCI subjects had a mean peak pressure gradient that was 1.5-2.5 greater than able-bodied subjects. Maximum decrease of pressure gradient from a neutral position happened after the backrest reclined to 120° (18%). 5. When a sitting position change occurred, a similar shift to the anterior/posterior midline location of maximum pressure was experienced in both groups. From neutral, a forward trunk flexion at 30° and 50° produced a 2.4 and 2.7 cm posterior shift. When the backrest reclined to 120°, the greatest posterior shift occurred at 6 cm.
Makhsous et al. 2007a USA Case Control N=60	**Population:** *Paraplegia (n=20):* Mean age: 35.1 yr; Gender: males=20, females=0; Mean weight: 87.2 kg; Mean time since injury: 8.4 yr. *Tetraplegia (n=20):* Mean age: 36.5 yr; Gender: males=15, females=5; Mean weight: 81.8 kg; Mean time since injury: 9.2 yr; *Non-SCI (n=20)*: Mean age: 39.3 yr; Gender: males=10, females=10; Mean weight: 71.3 kg. **Intervention:** 2-one hr sitting protocols: 1) Dynamic protocol: alternating every 10 min between normal sitting (sitting upright with full seat support and no added lumbar support) and an off-loading sitting (sitting upright with position in seat section tilted down 20° with pressure to IT and coccyx) configuration; 2) Wheelchair push-up protocol: one wheelchair push-up every 20 min, while in normal sitting configuration.	1. In normal sitting, mean T_cPO_2 at IT was <10mmHg and mean T_cPCO_2 was >60mmHg, for all groups. During off-loading sitting configuration, IT T_cPCO_2 was maintained >50mm Hg and $T_cPCO_2$at<45 mm Hg for all groups. During push-up protocol (mean=49 sec), IT T_cPCO_2 increased and $T_cPCO_2$reduced only slightly. 2. With pressure release (off-loading configuration) average perfusion recovery time for T_cPCO_2 was 200-250 sec for all groups. 3. T_cPO_2 perfusion recovery time was significantly shorter for control group than SCI groups, p<0.001.

	Outcome Measures: Transcutaneous partial pressure of oxygen (T_cPO_2) and carbon dioxide (T_cPCO_2).	
Lin et al. 2014 USA Pre-Post N=23	**Population:** Mean age: 46.0 yr; Gender: males=22, females=1; Injury etiology: SCI=16, multiple sclerosis=3, unilateral transfemoral amputation=1, bilateral transtibial amputations=3; Mean time since injury: 15.0 yr. **Intervention:** Participants performed repetitive weight-relief raises (WR) and shoulder external rotation (ER). Ultrasound imaging of the non-dominant shoulder in an unloaded baseline position and while holding a WR position before and after the WR/ER tasks. **Outcome Measures:** Acromiohumeral distance (AHD), Wheelchairs Users Shoulder Pain Index (WUSPI), OMNI pain scale (OMNI).	1. There were no significant differences in the AHD before and after WR (p=0.89) and ER (p=0.81). 2. The AHD in the pre-WR and pre-ER were significantly smaller than the AHD in the baseline shoulder neutral position (p<0.001). 3. Participants with a narrower AHD at baseline had smaller shoulder circumferences (p=0.044). 4. Participants with increased years of disability had greater AHD percentage narrowing after the WR task (p=0.008). 5. More shoulder pain on WUSPI had a greater percentage narrowing after the ER task (p=0.007). 6. Participants with higher scores on the OMNI after ER had greater percentage narrowing of AHD after ER (p=0.003).
Wu & Bogie 2014 USA Pre-Post N=13	**Population:** Mean age: 42 yr; Gender: males=10, females=3; Level of injury: C2-T12; Mean time since injury: 8 yr. **Intervention:** Participants were provided with alternating-pressure air cushion (APAC) to compare with their own independent pressure relief (IPR) methods. Outcomes were assessed at baseline and every 3 mo over an 18 mo period. **Outcome Measures:** Transcutaneous oxygen tension (T_CPO_2), blood flow components (cardiac, respiratory, neurogenic) and ischial interface pressure (IP).	1. IPR significantly decreased IP (p<0.05), and significantly increased T_CPO_2 (p<0.05) from baseline to post-assessment. 2. The cardiac component of blood flow increased significantly (p<0.05) using IPR post-intervention. 3. APACs significantly decreased IP (p<0.05) from baseline to post-assessment. 4. There was no significant difference between using IPR or APACs in T_CPO_2 post-assessment. 5. APACs produced significantly higher neurogenic (p<0.05) and respiratory (p<0.01) components post-assessment. 6. Following APAC use, the cardiac component of blood flow was significantly lower (p<0.001).
Sonenblum et al. 2014 USA Pre-Post N=17	**Population:** Median age: 45.0 yr; Gender: males=3, females=14; Level of injury: cervical=3, thoracic=12, lumbar=1, unknown=1; Level of severity: complete=8, incomplete=8, unknown=1; Median time since injury: 7 yr. **Intervention:** Participants received a randomized order of three forward leans (small, intermediate and full) and two sideward leans (intermediate and full) while seated on each of three different wheelchair cushions (Matrix Vi, Jay J2, and ROHO). Leans were maintained for one minute, with 8 min of erect sitting in between different leans.	1. All leans except for the small forward lean significantly reduced IP (p<0.001). 2. The full frontward and sideward leans significantly reduced IP more than all other leans (p<0.001), but were not significantly different from each other (p=0.12). 3. Across all leans, IP was significantly higher when participants were sitting on the Matrix Vi compared to the other two cushions (p<0.001).

	Outcome Measures: Ischial interface pressure (IP), Blood flow.	4. The Jay J2 and ROHO cushions had no significant differences between them (p=0.90). 5. The ROHO cushion had the lowest IP value in erect sitting (p<0.001). 6. Blood flow during erect sitting and small forward leans was significantly lower than blood flow during the full and intermediate leans in both forward and sideward directions (p<0.001). 7. There was no significant effect of cushion (p=0.89) or cushion and posture (p=0.67) on blood flow.
Smit et al. 2013 Netherlands Pre-Post N=12	**Population:** Mean age: 38.1 yr; Gender: males=12, females=0; Level of injury: paraplegia=3; tetraplegia=9; Level of severity: AIS A=9, B=3; Mean BMI: 82.2 kg; Mean time since injury: 173 mo; Cushion type: air cushions=10, gel=2. **Intervention:** Participants using their own wheelchairs and cushions were asked to perform a series of pressure relief movements in order: bending forward, leaning sideways to right and push up, for as long as possible to a maximum of 2 min. A 30 sec rest to gain baseline values, occurred before each test and then a 30 min rest after the movement. **Outcome Measures:** Interface pressure mapping to gather mean pressure values under both ITs (defined as the 3x3 sensors under each IT). Oxygenation data was obtained using a rigid probe attached to the left IT, to measure oxygen saturation of hemoglobin, and velocity of blood flow captured as mean and peak blood flow. Electrical stimulation with two surface probes at the upper part of the gluteal muscle above the sitting area and one halfway of the hamstring area with stimulation increasing in increments of 5-10 mA to a maximum without discomfort or excessive muscle contraction disrupting normal sitting (mean=87±18.5 m). Blood flow, oxygenation and IT pressure were compared during all test conditions.	1. Interface Pressure: Compared to rest, IT pressure was significantly lower during all movements; push-ups=19±44 mmHg (p<0.001), bending forward 56±33 mmHg (p<0.001), leaning sideways=44±38mmHg (p<0.001). Electrical stimulation of gluteal and hamstring muscle reduced IT pressure (p=0.003); no significant differences between ES condition and Pressure relief movements. 2. Oxygenation: Data from only nine participants was reliable due to technical issues with testing equipment. Compared to rest, significant increase in mean oxygenation for bending forward (p=0.01), leaning sideways (p=0.01), and push up (p=0.01). No significant differences in mean oxygenation for electrical stimulation (p=0.57). No significant difference was found between pressure relief movements. Significant correlation between oxygenation and electrical stimulation (r=0.7), but not for oxygenation change and mean IT pressure. 3. Blood flow: Compared to rest, significant increase in blood flow for bending forward (p=0.02), leaning sideways (p=0.03) and push-up (p=0.02). No significant change in mean blood flow with electrical stimulation (p=0.75). There was a significant difference in peak blood flow for electrical stimulation (p=0.007) and bending forward (p=0.006) compared to rest.
Henderson et al. 1994 USA Pre-Post N=10	**Population:** Mean age: 33.5 yr; Gender: males=9, females=1; Level of injury: paraplegia=7, tetraplegia=3; Mean weight: 77.7 kg; Time since injury range: 1 mo-7 yr. **Intervention:** Three different postures: 35° tilt backward, 65° tip/ tilt backward, 45° lean forward.	1. There was no significant decrease in pressure at a 35° tilt. 2. A significant decrease occurred in maximum point pressure (100mmHg) and circumscribed area pressure (71mmHg) at a 65° tip/tilt (p<0.05).

	Outcome Measures: Pressure distribution- Tekscan F-Scan System measuring the average of maximum pressure at the ITs and an average of the area around the ITs.	3. The greatest decrease in pressure occurred when leaning 45° forward. When leaning forward, a 70% decrease in area pressure (33mmHg) and a 78% decrease in maximum pressure (34mmHg) were experienced ($p<0.05$).
Coggrave & Rose 2003 UK Case Series N=50	**Population:** Age Range: 20-83 yr; Gender: males=33, females=13; Injury etiology: SCI=50; Severity of injury: Frankel grade A-D; Time since injury range: 5 wk-50 yr. **Intervention:** Retrospective chart review. **Outcome Measures:** Effect of pressure relief on transcutaneous oxygen tension (TCPO2).	1. Mean duration of pressure relief required to raise tissue oxygen to unloaded levels was 1 min 51 sec (range 42 sec-3½ min). 2. Leaning forward with elbows or chest on knees, leaning from side to side or tipping/tilting the wheelchair back to >65º were all effective for pressure relief (raising TCPO2 to unloaded levels) and more easily sustained for most individuals than a pressure relief lift. 3. Resulted in a change in practice at the seating clinic.
Effects of Wheelchair Frame Set-Up		
Makhsous et al. 2007b USA Case Control N=60	**Population:** Mean age:37 yr; Gender: males=45, females=15; Level of injury: paraplegia=20, tetraplegia=20, able-bodied=20. **Intervention:** Two 1-hr protocols. 1) Alternative protocol-sitting position was altered every 10 min between normal and WO-BPS (partially removed support at ischial area). 2) Normal protocol-normal posture and push-ups or Hoyer lifts every 20 min. **Outcome Measures:** XSensor pressure mapping system measuring Interface pressure measures of total contact area, average pressure and peak pressure on backrest and anterior middle and posterior sections of the seat.	1. Those with tetraplegia had a larger contact area at the anterior portion of the cushion, as compared to the other groups. 2. The mean pressure over the whole cushion was significantly different for each group ($p<0.001$). 3. Those with tetraplegia had the highest mean pressure during the WO-BPS posture, as compared to the other groups ($p<0.001$). 4. The contact area of the posterior portion of the cushion and the peak interface pressure decreased in all groups, with the largest decrease in those with tetraplegia for the latter. The mean pressure of the anterior and middle portions of the cushion increased in all groups. 5. At the posterior portion of the seat where ischial tuberosities are usually positioned, average pressure was higher for those with paraplegia (88.9 mmHg). 6. Average push up time was 49 sec for those with paraplegia.
Maurer & Sprigle 2004 USA Pre-Post N=14	**Population:** Mean age: 37 yr; Gender: males=9, females=5; Level of injury: paraplegia=14; Chronicity: chronic. **Intervention:** Seat angle decrease at 0, 2, 3, 4 inches. **Outcome Measures:** Force Sensing Array pressure mapping system measuring Total force, Contact area, Peak pressure index, Dispersion index, Seat pressure index.	1. Total force increased with decreasing seat angle from 751.5 N (baseline) to 774.5 N (4 in). 2. Contact area varied as the seat dropped ($p=0.03$). Contact area was highest at baseline and after a 2 in decrease. 3. No differences in peak pressure occurred. 4. As the seat dropped, less pressure was concentrated under the ischial tuberosities ($p<0.001$).The dispersion index was higher at

		baseline than when seat decreased. 5. Seat pressure index was higher at baseline than when seat decreased (p=0.008).
Position Change: Recline Only		
Hobson 1992 USA Prospective Controlled Trial N=22	**Population:** *SCI group:* Mean age: 40.9 yr; Gender: males=10, females=2; Mean weight: 59.8 kg; Level of injury: paraplegia=7, tetraplegia=5; Severity of injury: complete=12; Mean time since injury: 19.5 yr; Chronicity: chronic. *Able-bodied group:* Mean age: 39.3 yr; Gender: males=6, females=4. **Intervention:** Comparison of Pressure mapping and shear measurements from midline neutral posture to eight typical wheelchair-sitting postures (trunk bending left and right, forward trunk flexion 30° and 50°, back recline 110° and 120° and body recline or tilt 10° and 20°). **Outcome Measures:** Tangentially induced shear measuring shear forces; Pressure distribution-Oxford Pressure Monitor Device measuring average and maximum pressure and peak pressures gradient.	1. Mean maximum pressure was on average 26% higher in the SCI group versus the able-bodied group. 2. Maximum reduction of TIS occurred with forward trunk flexion of 50° (-133%) and full body tilt of 20° (-85%). Backward recline to 120° caused increase in TIS of 25%. 3. Forward trunk flexion reduced the average pressure for both groups; however, SCI group encountered a 10% increase in pressure at the initial 30° of forward flex before a reduction occurred. 4. SCI subjects had a mean peak pressure gradient that was 1.5-2.5 greater than able-bodied subjects. Maximum decrease of pressure gradient from a neutral position happened after the backrest reclined to 120° (18%). 5. When a sitting position change occurred, a similar shift to the anterior/posterior midline location of maximum pressure was experienced in both groups. From neutral, a forward trunk flexion at 30° and 50° produced a 2.4 and 2.7cm posterior shift. When the backrest reclined to 120°, the greatest posterior shift occurred at 6cm.
Position Change: Tilt Only		
Sonenblum & Sprigle 2011c USA RCT Crossover PEDro=4 N=11	**Population:** Mean age: 45.5 yr; Gender: males=9, females=2; Level of injury: incomplete=6, complete=5; Chronicity: sub-acute, chronic; Mean weight: 80 kg; Mean duration of w/c use: 9.4 yr. **Intervention:** A randomization of four tilt sequences in 15° increments, separated by 5 min reperfusion periods. **Outcome Measures:** Blood flow, Interface pressure.	1. Small tilts (15°) resulted in a significant increase in blood flow (p=0.016); magnitude was small and highly varied. 2. An increase in blood flow at 15° did not correspond with a decrease in loading when compared to upright (peak p=0.085, mean pressure p=0.131). 3. 15° tilt from upright resulted in significant increase in blood flow with no significant decrease in pressure. 4. Peak and mean pressures at 30° were significantly different than at preceding 15° tilt (p<0.001); blood flow did not increase further (p=0.118). 5. There were no statistical differences in pressure and flow in upright-to-30° tilts compared to 15° to 30° tilts.

		6. Pressure reduction required tilts >30°; blood flow increased with all tilts beyond upright but no further increase when going from 15° to 30°. 7. Most participants (9/11) required maximum tilt (45°-60°) to increase blood flow >/=10%.
Hobson 1992 USA Prospective Controlled Trial N=22	**Population:** *SCI group:* Mean age: 40.9 yr; Gender: males=10, females=2; Mean weight: 59.8 kg; Level of injury: paraplegia=7, tetraplegia=5; Severity of injury: complete=12; Mean time since injury: 19.5 yr; Chronicity: chronic; *Able-bodied group:* Mean age: 39.3 yr; Gender: males=6, females=4. **Intervention:** Comparison of Pressure mapping and shear measurements from midline neutral posture to eight typical wheelchair-sitting postures (trunk bending left and right, forward trunk flexion 30° and 50°, back recline 110° and 120° and body recline or tilt 10° and 20°). **Outcome Measures:** Tangentially induced shear measuring shear forces, Pressure distribution-Oxford Pressure Monitor Device measuring average and maximum pressure and peak pressures gradient.	1. Mean maximum pressure was on average 26% higher in the SCI group versus the able-bodied group. 2. Maximum reduction of TIS occurred with forward trunk flexion of 50° (-133%) and full body tilt of 20° (-85%). Backward recline to 120° caused increase in TIS of 25%. 3. Forward trunk flexion reduced the average pressure for both groups; however, SCI group encountered a 10% increase in pressure at the initial 30° of forward flex before a reduction occurred. 4. SCI subjects had a mean peak pressure gradient that was 1.5-2.5 greater than able-bodied subjects. Maximum decrease of pressure gradient from a neutral position happened after the backrest reclined to 120° (18%). 5. When a sitting position change occurred, a similar shift to the anterior/posterior midline location of maximum pressure was experienced in both groups. From neutral, a forward trunk flexion at 30° and 50° produced a 2.4 and 2.7cm posterior shift. When the backrest reclined to 120°, the greatest posterior shift occurred at 6cm.
Giesbrecht et al. 2011 Canada Pre-Post N=18	**Population:** Mean age: 42.6 yr; Gender: males=17, females=1; Level of injury: tetraplegia=10, paraplegia=8; Mean time since injury: 18.2 yr; Mean weight: 74.7 kg; Mean BMI=24.1 kg/m^2. **Intervention:** Forced Sensing Array (FSA) interface pressure mapping system, 6 min settling period; test wheelchair-Quickie Iris with Jay 2 cushion, seat to back angle set at 100°, sitting pressure at tilt angles measured at 10° increments to a maximum of 50°. **Outcome Measures:** Peak pressure index readings on the ischial tuberosities and sacrum.	1. No statistically significant difference in pressure between right and left ischial tuberosities (IT) at each angle of tilt. 2. No significant reduction in IT IP at 10° tilt compared to baseline; modestly significant change at 20° (right, p=0.034; left, p=0.001); all other angles showed highly significant change (p=0.000) compared to baseline. 3. No significant differences between those with paraplegia versus tetraplegia. 4. Mean sacral IP did not change significantly at 10° or 20°; statistically significant reduction at 30° (p=0.002), 40° (p=0.000) and 50° (p=0.000). 5. Compared to paraplegia group, mean sacral pressure values were

		significantly higher in tetraplegia group at 0° (p=0.036), 10° (p=0.025), 30° (p=0.044) and approached significance at 20° (0.067).
Spijkerman et al. 1995 Netherlands Pre-Post N=18	**Population:** Mean age: 37.7 yr; Gender: males=15, females=3; Level of injury: C2-L2; Severity of injury: complete=18. **Intervention:** Interface pressure was assessed on SCI patients using various seat inclinations. **Outcome Measures:** Mean pressure.	1. Body tilt had a significant effect on the mean pressure, p=0.003. 2. At seat inclination of 5°, 15° and 25°, overall mean pressure was 86.79, 86.90 and 82.91, respectively.
Henderson et al. 1994 USA Pre-Post N=10	**Population:** Mean age: 33.5 yr; Gender: males=9, females=1; Mean weight: 77.7 kg; Level of injury: paraplegia=7, tetraplegia=3; Time since injury range: 1 mo-7 yr. **Intervention:** Three different postures: 35° tilt backward, 65° tip/ tilt backward, 45° lean forward. **Outcome Measures:** Pressure distribution- Tekscan F-Scan System measuring the average of maximum pressure at the ITs and an average of the area around the ITs.	1. There was no significant decrease in pressure at a 35° tilt. 2. A significant decrease occurred in maximum point pressure (100mmHg) and circumscribed area pressure (71mmHg) at a 65° tip/tilt (p<0.05). 3. The greatest decrease in pressure occurred when leaning 45° forward. When leaning forward, a 70% decrease in area pressure (33mmHg) and a 78% decrease in maximum pressure (34mmHg) were experienced (p<0.05).
Position Change: Combinations of Tilt, Recline and Stand		
Jan et al. 2013a USA RCT Crossover PEDro=4 N=20	**Population:** Mean age: 38 yr; Gender: males=18, females=2; Level of injury: C4-T5; Mean BMI: 24.5±2.3 kg/m^2. **Intervention:** Participants used the same study power wheelchair with tilt and recline and high density contoured foam cushion. All participants completed a protocol of: baseline-5 min in 0° tilt and recline (sitting induced ischemia period); 5 min one of six randomly assigned test; 5 min in washout period (35° tilt and 120° recline). The tilt and recline positions were randomly assigned (15°, 25° and 35° tilt each with 100° and 120° recline). **Outcome Measures:** Laser Doppler Flowmetry used to measure skin perfusion over the left ischial tuberosity; Near-infrared Spectroscopy used to measure muscle tissue oxygen saturation (muscle perfusion) to a depth of 0-14 mm on right IT. Muscle and skin perfusion during the tilt/reclined position was normalized to skin perfusion in upright sitting.	1. Muscle perfusion significantly increased from baseline to both 25° tilt and 120° recline and 35° tilt and 120° (p<0.05); other test positions did not show significant differences. 2. Normalized skin perfusion showed significant increase (p<0.05) from baseline to 35° tilt and 100° recline and all tilt angles and 120° recline; other test positions did not show significant differences. 3. Normalized skin perfusion in 120° recline with all three tilt angles, showed significant increase compared to muscle perfusion in these test positions (p<0.05); other combinations did not show a significant difference between muscle and skin perfusion.
Jan et al. 2013b USA PEDro=5 RCT Crossover N=9	**Population:** Mean age: 38 yr; Gender: males=8, females=1; Level of injury: C4-T5; AIS A=1, B=1, C=7; Mean BMI=24.5 kg.m^2; Mean time since injury: 6 yr. **Intervention:** Participants used the same study power wheelchair with tilt and recline and cushion and back support. All participants completed a protocol of: baseline of 15 min in 0 tilt	During the recovery period: 1. Mean perfusion of all 3 protocols showed significant increase in skin perfusion than baseline sitting skin perfusion (p<0.05) 2. Normalized mean skin perfusion was significantly higher at the 3 min duration (1.92±0.28) than the 1 min

	and recline (sitting induced ischemia period), followed by the testing period, a second ischemia period and then 15 min recovery period (35° tilt and 120° recline). The test positions were randomly assigned; 3 min in 35° tilt and 120° recline, 1 min in same tilt-recline and 0 min in tilt and recline. **Outcome Measures:** Laser Doppler Flowmetry used to measure mean and peak skin perfusion over the right ischial tuberosity. Normalized individual skin perfusion response to baseline sitting skin perfusion.	duration (1.35±0.05; p<0.017) but not significantly higher than the 0 min duration (1.57±0.21). 3. Normalized mean skin perfusion was not significantly different between the 1 min and 0 min durations. 4. The peak skin perfusion of the reactive hyperemic response did not show significant difference for any test protocol while peak skin perfusion was higher the 3 (4.1±1.1) and 0 (3.7±1.5) min durations but not in the 1 min protocol (2.15±0.15). 5. During the second ischemic sitting period, significantly higher normalized skin perfusion occurred at the 3 min (1.15±1.5) compared to the 1 min (0.96±0.06; p<0.017) and compared to the 0 min (0.98±0.03; p<0.017).
Jan & Crane 2013c USA RCT Crossover PEDro=4 N=11	**Population:** Mean age: 37.7 yr; Gender: males=9, females=2; Mean BMI: 24.7±2.6 kg/m^2; Level of injury: AIS A=4, B=2, C=5. **Intervention:** Participants all used the same study power wheelchair with tilt and recline and back support. All participants completed a protocol of: baseline - 5 min in 0° tilt and recline (sitting induced ischemia period); 5 min 1 of 6 randomly assigned test; 5 min in washout period (35° tilt and 120° recline). The tilt and recline positions were randomly assigned (15°, 25° and 35° tilt each with 100° and 120° recline). **Outcome Measures:** Laser Doppler Flowmetry used to measure skin perfusion over the right ischial tuberosity and sacrum (midpoint between the PSIS and adjacent vertebrae spinous process).	1. Sacral skin perfusion did not show a significant difference in the six test positions (p>0.05). 2. Skin perfusion at the ischial tuberosity showed significant increase at all tilt positions combined with 120° recline (p<0.01) and 35° tilt with 100° recline (p<0.008).
Sonenblum & Sprigle 2011c USA RCT Crossover PEDro=4 N=11	**Population:** Mean age: 45.5 yr; Gender: males=9, females=2; Level of injury: incomplete=6, complete=5; Chronicity: sub-acute, chronic; Mean weight: 80 kg; Mean duration of w/c use: 9.4 yr. **Intervention:** A randomization of four tilt sequences in 15° increments, separated by 5 min reperfusion periods. **Outcome Measures:** Blood flow, Interface pressure.	1. Small tilts (15°) resulted in a significant increase in blood flow (p=0.016); magnitude was small and highly varied. 2. An increase in blood flow at 15° did not correspond with a decrease in loading when compared to upright (peak p=0.085, mean pressure p=0.131). 3. 15° tilt from upright resulted in significant increase in blood flow with no significant decrease in pressure. 4. Peak and mean pressures at 30° were significantly different than at preceding 15° tilt (p<0.001); blood flow did not increase further (p=0.118).

		5. There were no statistical differences in pressure and flow in upright-to-30° tilts compared to 15° to 30° tilts. 6. Pressure reduction required tilts >30°; blood flow increased with all tilts beyond upright but no further increase when going from 15° - 30°. 7. Most participants (9/11) required maximum tilt (45°-60°) to increase blood flow ≥10%.
Jan et al. 2010 USA RCT Crossover PEDro=4 N=11	**Population:** Mean age: 37.7 yr; Gender: males=9, females=2; Injury etiology: traumatic SCI=11; Level of severity: AIS A=4, B=2, C/D=5; Mean time since injury: 8.1 yr; Mean BMI: 24.7 kg/m^2 . **Intervention:** All participants completed six protocols randomly assigned (15°, 25°, 35°, each with 100° and 120° recline; 5 min sitting-induced ischemic period (no tilt/recline) followed by 5 min wheelchair tilt and recline pressure-relieving period; 5 min washout period between each test position. **Outcome Measures:** Laser Doppler Flowmetry used to measure skin perfusion over the ischial tuberosity and normalized to skin perfusion in upright sitting.	Tilt-in-Space Angle Effect: 1. Combined with 100° recline, tilt at 35° resulted in a significant increase in skin perfusion ($p<0.05$) as compared to upright; no significant increase occurred at 15° and 25°. 2. Combined with 120° recline, all tilt angles (15°, 25°, 35°) showed a significant increase in skin perfusion compared to upright sitting ($p<0.05$) and 35° resulted in significant increase compared with 15° tilt ($p<0.05$). Recline Angle Effect: 1. Combined with 15° tilt, 120° recline did not induce a significant increase in skin perfusion compared with 100° recline. 2. Combined with 25° tilt or 35° tilt, 120° recline induced a significant increase in skin perfusion compared to 100° recline ($p<0.05$ for both tilt angles).
Sprigle et al. 2010 USA RCT PEDro=4 N=16	**Population:** Mean age: 36.9 yr; Injury etiology: SCI=16; C4-T12 (AIS A to D); Level of injury: paraplegia, tetraplegia; Mean time since injury: 12.9yr ± 14.5mo). **Intervention:** Randomization of five different angles of tilt, recline, and stand positions performed for 1 min each. **Outcome Measures:** Normalized seat and backrest forces (% of max load) Rate of loading change.	1. Normalized seat loads were linearly related to angles of tilt, recline and standing (increase angle, decrease % maximum load). 2. Full stand (75º seat angle) and recline (90º backrest angle) resulted in greater unloading than full tilt (55º seat angle). 3. Maximum unloading occurred in full stand and recline. 4. Rate of change in force was different for each. configuration ($p=0.000$); loads decreased on the seat with increasing amounts of tilt, recline and standing; rate of increased loading on the backrest was higher with tilt than recline; standing was the only configuration that decreased load off seat and backrest simultaneously. 5. Reduced seat load is greater with full recline and full stand (61%) versus full tilt (46%).

		6. There is no threshold point for drop in load (linear relationship), therefore, an "effective" tilt, recline or stand angle cannot be defined.
Inskip et al. 2017 USA Prospective Controlled Trial N=29	**Population:** *Autonomically-incomplete SCI (n=12):* Mean age= 42.6 yr; Gender: males=6, females=6; Level of injury: C1-T12; Mean time since injury= 18.9 yr. *Autonomically-complete SCI (n=7):* Mean age= 37.0 yr; Gender: males=5, females=2; Level of injury: C1-T12; Mean time since injury= 16.6 yr. *Healthy Controls (n=10):* Mean age= 31.9 yr; Gender: males=6, females=4. **Intervention:** Participants were tested in supine and seated positions (neutral, lowered, and elevated) in the Elevation wheelchair. **Outcome Measures:** Blood pressure (BP); Heart rate (HR); Middle cerebral artery blood flow velocy (MCAv). All variables were measured using a of five-beat moving average. Additional variables measured were minimum blood pressure, timing of minimum blood pressure and overall orthostatic burden	1. Test group comparisons: autonomically-complete SCI group had significantly lower systolic and diastolic arterial pressure, MCA diastolic and MCA mean cerebral blood flow velocities comared to the incomplete group (all $p<0.05$) 2. Test groups to controls comparison: MCAdiastolic was significanty lower in autonomically-complete group ($p<0.05$).; Dastolic arterial pressure and mean arterial pressure were significantly higer ($p=0.0015$ and $p=0.035$) 3. Movement from supine to seated position increased Systolic arterial pressure in controls ($p< 0.001$) and autonomically incomplete ($p=0.024$) 4. Movement from seate to elevated postitions the mean systolic arterial pressure changed for the complete group only compared to supine ($p=0.037$) 5. Movement to the lowered seated position increased systolic arterial pressure compared to standard seating and elevated for the complete group ($p=0.029$) 6. Calculated cumulative orthostaic burden was not significantly different in the seated position, but was greater for the complete group in the elevated position compared to seated and lowered positions and compared to incomplete and control groups. (all $p<0.05$) 7. HR increased from supine values during seated, elevated and lowered positions in all three groups (all $p<0.05$). In the autonomically-complete SCI group only, the HR in the elevated position was higher than in the seated and lowered positions.
Lung et al. 2014 USA Pre-Post N=13	**Population:** Mean age: 36.2 yr; Gender: males=9, females=4; Level of severity: AIS A=4, AIS B=2, AIS C=7; Mean time since injury: 5.8 yr. **Intervention:** Participants received a randomized order of six combinations of wheelchair tilt (15º, 25º, 35º) and recline (10º and 30º) angles. Participants were tested for each combination for 5 min, with an additional 5 min for both a	1. Peak pressure displacement was not significantly different for any of the tilt-recline angle combinations ($p>0.05$). 2. For center of pressure displacement there were significant differences for 10º and 30º recline for the following tilt angles: 15º versus 35º and 25º versus 35º ($p<0.05$). 3. At 15º, 25º and 35º, center of pressure was significantly different

	baseline and recovery period before and after testing. **Outcome Measures:** Peak pressure displacement, Center of pressure displacement.	between 10º and 30º recline ($p<0.05$).