

Author Year; Country Score Research Design Total Sample Size	Methods	Outcome
<p>Raviv et al. 2013; Israel Case control Level 3 N=32 (couples)</p>	<p>Population: 32 couples with male partner with SCI referred to IVF after repeated trials of electroejaculation (EEJ) or penile vibratory stimulation (PVS) and full andrological evaluation; mean(SD) time since injury until assisted reproductive procedure 7.6(2.1) yrs, range 5–16; Patient subgroups: obstructive azoospermia (n=19), non-obstructive azoospermia (n=6), severe oligozoospermia (n=7). Treatment: Testicular sperm aspiration (TESA) for sperm extraction. Open testicular sperm extraction (TESE) was performed only after a negative TESA attempt. Outcome measures: clinical pregnancy and live birth rates.</p>	<ol style="list-style-type: none"> 1. A total of 106 testicular procedures were performed. Sperm was found in 95 cycles (89.6%). 2. Average metaphase II (MII) oocyte number was 11.0(4.2), an average of 5.1(2.3) oocytes became normally fertilized after Intra Cytoplasmic Sperm Injection (ICSI) (fertilization rate 57.1%). 3. On average, 2.7(1.2) embryos were replaced. The clinical pregnancy rate was 32/106 (30.2%) per cycle and 19/32 (59.3%) per couple. The live birth rate was 62.5% (20/32).
<p>Kathiresan et al. 2012; USA Case series Level 4 N SCI=444 N controls=61</p>	<p>Population: 444 men with SCI with no known causes of infertility other than SCI; level of injury: 176 cervical, 193 T1-T10, 70 T11-caudal; 115 complete, 126 incomplete. Controls: 61 able-bodied (AB) men, healthy with no history of infertility. Treatment: Retrospective chart review of Male Fertility Research Program participants from 1991 to 2011. Sperm retrieval methods included masturbation, penile vibratory stimulation (PVS), and electroejaculation (EEJ). Outcome measures: sperm retrieval method (masturbation, PVS, EEJ), semen volume, sperm concentration, sperm motility, total sperm count.</p>	<ol style="list-style-type: none"> 1. Sperm retrieval method in SCI participants: masturbation (n=43), PVS (n=243), EEJ (n=158). Sperm retrieval method in AB control group: masturbation (n=61). 2. 8.1% (43 of 528 SCI participants) retained ability to ejaculate by masturbation. 3. Sperm motility was significantly higher in the SCI-masturbation group (36.9%) than the PVS group (25.9%) or EEJ group (15.0%), but lower compared with a control group of 61 non-SCI healthy men who collected their semen by masturbation (58.0%). 4. The SCI-masturbation group had similar antegrade sperm concentration as the PVS group, and control group, but significantly higher than the EEJ group.
<p>Qiu et al. 2012; China Pre-post Level 4 N SCI=26 N controls=16</p>	<p>Population: 26 infertile men with SCI (primary infertility present in 9), mean(SD) age 33.8(2.9) yrs, mean(SD) DOI 8.6(3.0) yrs (range 1-11 yrs), level of injury: C5-C6 (n=4), T2-T12 (n=22), mean(SD) yrs of infertility 6.8(4.2) yrs; Controls: 16 non-SCI fertile donors (all had previously fathered at least one child), mean(SD) age 32.9(2.1) yrs. Treatment: Collection of semen samples in SCI men using penile vibratory stimulation (PVS) (n=14), percutaneous vasal sperm aspiration (PVSA) (n=12); collection of semen samples in non-SCI donors all by masturbation (n=16). Outcome measures: sperm vitality and DNA integrity, sperm chromosomal aneuploidy.</p>	<ol style="list-style-type: none"> 1. The rate of sperm DNA fragmentation was higher in the PVS group than in the percutaneous vassal sperm aspiration (PVSA) group. 2. Aneuploidy rates for SCI patients were 1.5 to 1.6-fold higher for chromosomes 13, 18, and 21, and were 2.3- to 2.4-fold higher for chromosomes X and Y than for the control group.

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<p>Sonksen et al. 2012; Denmark Case control Level 3 N=140</p>	<p>Population: 140 SCI men with anejaculation and their healthy female partners (presenting for infertility treatment between 1988 and 2008); Age: SCI men (median 30 yrs, range 22–44), female partners (median 28 yrs, range 19–39 yrs); DOI: median 7 yrs (range 1–22), Level of lesion: C2 to T9. Treatment: Men who obtained antegrade ejaculation by penile vibratory stimulation (PVS) and had motile sperm in the ejaculate were offered the possibility of PVS combined with vaginal self-insemination at home. Couples were instructed to perform PVS and to instill the ejaculate intravaginally. Outcome measures: Pregnancy rate per couple, number of live births, total motile sperm count and time to pregnancies.</p>	<ol style="list-style-type: none"> 1. Median total motile sperm count: 29 million (range 1–92 million). 2. 60 of the 140 couples (43% pregnancy rate) achieved 82 pregnancies. 3. 72 of the pregnancies resulted in live births with delivery of 73 healthy babies. 4. Median time to first pregnancy was 22.8 months (range 6.0–98.4). No complications were reported.
<p>Brackett et al. 2009; USA Case series Level 4 N=500</p>	<p>Population: 500 men with SCI (3,152 semen retrieval procedures); mean(SD) age 34.1(0.4) yrs (range 17-63); mean (SD) DOI: 10.0(0.3) yrs; Level of injury: 203 cervical, 123 T1-T6, 150 T7-T12, 20 ≤ L1,4 unknown. Treatment: review of research data from Jan 1991 to Apr 2009 from SCI participants in a male fertility research program. Semen retrieval methods were performed according to ability: masturbation, if not then penile vibratory stimulation (PVS), if not then electroejaculation (EEJ). Outcome measures: semen retrieval methods: masturbation, PVS, EEJ; semen analysis: total sperm count, motility.</p>	<ol style="list-style-type: none"> 1. Of the 500 men 9% could ejaculate by masturbation. 2. Penile vibratory stimulation (PVS) was successful in 86% of patients with a T10 or rostral injury level. 3. Electroejaculation (EEJ) was successful in most cases of failed PVS (91.9% responded to EEJ). 4. Sperm obtained without surgical sperm retrieval, in 97% of patients completing the treatment algorithm. 5. Total motile sperm counts exceeded 5 million in 63% of cases.
<p>Hibi et al. 2008; Japan Post-test Level 4 N=8</p>	<p>Population: 8 participants with cervical SCI and neurogenic anejaculation (age 26-46 yrs, mean 35.6). Treatment: Retrograde vasal sperm aspiration (ReVSA). Outcome Measures: Presence of motile sperm.</p>	<ol style="list-style-type: none"> 1. Motile sperm was recovered in all participants who underwent ReVSA (11 procedures total). 2. The retrieved sperm concentration was $109.4(64.7) \times 10^6$ /mL (range 31.2-156.3 $\times 10^6$ /mL). 3. The retrieved motility of sperm was 69.8% (16.8) (range 50-91%). 4. Clinical pregnancies were achieved in 8 cases (7 couples).
<p>Kanto et al. 2008; Japan Case control Level 3 N = 56</p>	<p>Population: 22 men with SCI (age 21-41); data on 34 men with obstructive azoospermia was obtained retrospectively as control Treatment: Testicular sperm extraction (TESE); if unsuccessful, microdissection TESE was performed, followed by intracytoplasmic injection (ICSI) Outcome Measures: Fertilization; pregnancy</p>	<ol style="list-style-type: none"> 1. TESE successfully retrieved sperm in 19 participants with SCI. 2. ICSI resulted in a fertilization rate of 236 of 364 (64.8%) in SCI couples and 14/19 achieved pregnancy. 3. In couples with obstructive azoospermia, ICSI resulted in a fertilization rate of 435 of 567 (77%) and 29/34 achieved pregnancy. 4. Pregnancy rate was significantly higher for couples with SCI using fresh testicular

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		sperm-ICSI compared to frozen-thawed sperm-ICSI
Arafa et al. 2007; Egypt Post-test Level 4 N=69	<p>Population: Men with SCI; Age: mean 36.6 yrs, SD=18.34; Injury level: at or below T10 (n=34), above T10 (n=35); Time since injury: mean 11.03 yrs, SD=7.80; anejaculatory.</p> <p>Treatment: Prostatic massage thru the rectum to push the sperm out through the ejaculatory ductal system.</p> <p>Outcome Measures: Semen retrieval.</p>	<ol style="list-style-type: none"> 1. Semen retrieval by prostatic massage was successful in 22 men (31.9%). 2. Semen retrieval by prostatic massage was higher for men with a SCI above T10 than below T10 (81.8% vs 18.2%).
Brackett et al. 2007; USA Pre-post Level 4 N=297	<p>Population: Men with SCI; Age: range 17-60 yrs; Injury level: cervical (n=109), T1-T10 (n=131), T11 or below (n=45), unknown (n=12); Time since injury: range 0.2-44.6 yrs.</p> <p>Treatment: Penile vibratory stimulation using 1 vibrator, or if this failed, 2 vibrators applied to glans penis using sandwich method.</p> <p>Outcome Measures: Semen retrieval.</p>	<ol style="list-style-type: none"> 1. 49% of all men ejaculate with 1 vibrator; 57% of men whose injury level was at or above T10 responded to 1 penile vibratory stimulation vs. only 15% with a level of injury at or below T11. 2. Of failures with 1 vibrator, 22 % responded to penile stimulation with 2 vibrators.
Soler et al. 2007; France Pre-post Level 4 N=158	<p>Population: Men with SCI; Age: mean 29.5-33.2 yrs; Level of injury: tetraplegia (group 1, n=55), paraplegia at or above T6 (group 2, n=52), paraplegia T7-T10 (group 3, n=23), paraplegia T11 and below (group 4, n=28); anejaculation, failed to respond to penile vibratory stimulation (PVS).</p> <p>Treatment: PVS and midodrine 7.5-30mg (tetraplegia) or 15-30mg (paraplegia) 30 to 120 mins before stimulation, ED was treated with PDE5i or intracavernosal prostaglandin injection.</p> <p>Outcome Measures: Number of ejaculations, blood pressure (BP), average dose for success.</p>	<ol style="list-style-type: none"> 1. Percentage successful ejaculation following midodrine was 64.6% (62%, 69%, 46%, and 79% in groups 1 to 4 respectively). 2. Individuals with upper motor lesions above T10 and complete lesions had more success. 3. Average dose required was 18.6mg. 4. Midodrine induced mild increase in mean arterial BP (max. 10mmHg) and reduced heart rate with PVS in all patients. 5. Individuals with tetraplegia have highest increase in SBP (more than 200mmHg in 20% of cases).
Kolettis et al. 2002; USA Post-test Level 4 N=27	<p>Population: Men with SCI (n=27), 9 couples; Injury level: cervical (n=10), thoracic (n=16), lumbar (n=1).</p> <p>Treatment: Electrical stimulation (12-18V, 400-600mA for 30 second bursts) followed by intrauterine insemination or IVF.</p> <p>Outcome Measures: Seminal parameters, ejaculation rates, cycle function, pregnancy</p>	<ol style="list-style-type: none"> 1. Ejaculation rates: 43/112 were antegrade ejaculations (38%), 24/112 were retrograde ejaculations, 45/112 were both antegrade and retrograde ejaculations (40%) and 2/112 were not able to ejaculate (2%). 2. Pregnancy rate: 3/9 couples achieved pregnancy, 2 of which resulted in live births and both were twins.

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Le Chapelain et al. 1998; France Case series Level 4 N=44	<p>Population: Men with SCI; Age: mean 28.5 yrs, range: 19-49 yrs; Injury level: C4-L2, tetraplegia (n=17), paraplegia (n=22); Impairment: 8 complete, 9 incomplete.</p> <p>Treatment: Retrospective analysis of vibratory stimulation, electroejaculation or subcutaneous physostigmine (a reversible acetylcholine esterase antagonist) (at least 2 sessions).</p> <p>Outcome Measures: Ejaculation, conception, sperm count, motility.</p>	<ol style="list-style-type: none"> 30/39 patients produced an ejaculation. Greater success rate among participants with tetraplegia (96%), then T1-T10 (73%), then T11-L2 (42%). Vibratory stimulation produced significantly higher volumes of sperm than electroejaculation, and better sperm quality. Among 10 couples who wanted children, 3 pregnancies resulted and 2 births of healthy children.
Lochner-Ernst et al. 1997; Germany Post-test Level 4 N=219	<p>Population: 219 men; 51 participants with tetraplegia, 161 with paraplegia; Mean time since injury: 11.9 yrs.</p> <p>Treatment: Supranuclear patients were treated by vibrostimulation. When this failed, further treatment was applied: physostigmine medication and vibrostimulation, electroejaculation, physostigmine with electroejaculation (EE), surgical approaches. Infranuclear patients were treated by EE.</p> <p>Outcome Measures: Semen retrieval and pregnancy success.</p>	<ol style="list-style-type: none"> Vibrostimulation in supranuclear lesions was successful in 133 patients, and in 5 more after physostigmine injection. EE was successful in all 7 infranuclear lesions and in 4 supranuclear patients failing with vibrostimulation. 8 more supranuclear patients responded to EE and physostigmine. Surgical retrieval was applied in 27 patients. In 109 patients who wanted children, 73 pregnancies in 46 couples, leading to 54 births and 16 abortions.
Lim et al. 1994; Australia Post test Level 4 N=12	<p>Population: Men with SCI; Age: mean 31 yrs, range 21-36; Injury level: C4-L2; Time since injury: mean 8 yrs, range 1-24</p> <p>Treatment: Assisted ejaculation (electroejaculation (EE) or penile vibratory stimulation (PVS)) using balloon catheter to tamponade the bladder neck.</p> <p>Outcome measures: Antegrade ejaculation, semen analysis including volume, sperm concentration, morphology, percentage of motile sperm, adverse events, impact of catheter and lubrications on sperm.</p>	<ol style="list-style-type: none"> Antegrade ejaculations were collected on all occasions. No urine contamination of sperm and no sperm were found in post-ejaculate urine. Silicone catheters had minimal effect on sperm motility and viability. Lubricant gels adversely affect sperm quality.
Sonksen et al. 1994; Denmark Post-test Level 4 N=66	<p>Population: Men with SCI and erectile dysfunction; Age: range 18-44 yrs; Time since injury: 0.6-39 yrs, Level of injury: C2-L1.</p> <p>Treatment: Vibrator (multicept ApS) and Relax (Nordic Light) vibrators. Different amplitudes were tested.</p> <p>Outcome Measures: Ejaculation responses.</p>	<ol style="list-style-type: none"> Similar ejaculation responses when using frequencies of 80-100Hz and amplitude of 1mm. At 100Hz and 2.5mm amplitude there were significantly higher ejaculation rates than amplitude of 1mm. Ejaculation occurred in 58/66 men (88%).
Leduc et al. 1992; Canada Post-test Level 4	<p>Population: 37 men with SCI; Age: mean 29.5 yrs, range 19-61; 15 cervical (9 complete, 6 incomplete), 22 thoracic (20</p>	<ol style="list-style-type: none"> 54% of cases resulted in antegrade ejaculation.

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N=37	complete, 2 incomplete), Time since injury: range 3 months-23 yrs. Treatment: 10mg nifedipine for autonomic dysreflexia, 40mg butylbromure hyoscine subcutaneously to limit some of the parasympathetic side effects of physostigmine, and then 2-4mg physostigmine subcutaneously 30 mins later and followed by masturbation by female partner. Outcome Measures: Ejaculation responses, pregnancies.	<ol style="list-style-type: none"> 2. 46 samples showed mean normal count but low motility rate (28%). 3. Fresh unwashed sperm artificial insemination performed in 6 couples with 3 successful pregnancies.
Rawicki & Hill 1991; Australia Post-test Level 4 N=39	Population: 39 men; Injury level: C4-L5. Treatment: Electroejaculation (EE), vibration ejaculation (VE), and subcutaneous physostigmine (PS). Outcome Measures: Seminal emission, pregnancies, conception.	<ol style="list-style-type: none"> 1. Semen obtained from 21 of 24 men with a lesion at T8 or above, and from 4 of 11 men with lesions below T10. 2. 8 pregnancies from 6 couples.
Beretta et al. 1989; Italy Post-test Level 4 N=102	Population: 102 men; Age: mean 25.6 yrs; Injury level: cervical-sacral lesions, above T11 (n=58), thoracolumbar lesions (n=36), sacral (n=8); Mean time since injury 6.1yrs. Treatment: Simple vibrator applied to the penis for ejaculatory response. 15 patients who wanted to conceive a child, received instruction in home use of vibrator. Outcome Measures: Ejaculation frequency, sperm quality.	<ol style="list-style-type: none"> 1. Penile vibrators triggered ejaculation in 72 patients (70.5%). 2. 11 other patients showed 'weak' ejaculation with poor contractions of perineal muscles. 3. Stimulation ranged from 30 sec-20 min. Of 15 'home-use' patients, increase in sperm concentration and steep decrease in abnormal spermatozoa over 3 months. 4. 6 couples had homologous artificial insemination, 3 pregnancies resulted.
Brindley et al. 1989; UK Post-test Level 4 N=8	Population: 7 SCI, 1 primary anorgasmia, Age: range 27-37 yrs; Level of injury: C5-T9, 5 complete; Time since injury: 2-15 yrs. Treatment: Implantation of radio-linked hypogastric plexus stimulator device. Outcome Measures: Seminal emission and erection (with use of implant).	<ol style="list-style-type: none"> 1. Post-implant, all patients achieved external emission of semen, volume between 1-5ml in 4 patients, only a drop or two drops in 3 patients (but good quantities obtained later). 2. 5 pregnancies (2 live births) in the partners of 4 patients. Implants functioned for years without deterioration in performance.
Ohl et al. 1989; USA Post-test Level 4 N=48	Population: 48 men with SCI; mean age 31yrs, range 20-53 yrs; 15 cervical, 29 thoracic, 4 lumbar; YPI 4 months-34 yrs; 56% complete, 44% incomplete. Treatment: Rectal probe electroejaculation (EE). Outcome Measures: Semen retrieval and sperm quality.	<ol style="list-style-type: none"> 1. 10 million sperm obtained in 71% of participants (n=34). 2. Age and interval since injury had no effect on outcome. 3. Higher success among participants with paraplegia (90% ejaculated successfully) and in those using intermittent catheterization for bladder management compared to cervical or lumbar patients (successful ejaculation in 60% and 50%, respectively). 4. Indwelling urethral catheters and high pressure reflex voiding had a negative impact on EE results.

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Halstead et al. 1987; USA Post-test Level 4 N=12	<p>Population: 12 men with SCI; Age: range: 23-38 yrs; Injury level: C5-C6 (n=4), T3-T12 (n=7), L1 (n=1); paraplegia (n=8), tetraplegia (n=4); Impairment grade: AIS A (n=7), b (n=1), C (n=3), D (n=1). Time since injury: range 0.5-18 yrs.</p> <p>Treatment: Rectal probe electroejaculation on 38 occasions.</p> <p>Outcome Measures: Ejaculation response and sperm quality.</p>	<ol style="list-style-type: none"> 1. Antegrade ejaculation occurred in 9 patients with improvement in % motility and total live sperm count on repeated stimulations in 5 patients. 2. Significant retrograde ejaculation occurred in 1 patient. 3. Sperm acceptable for artificial insemination from 4 patients.
Brindley 1984; England Post-test Level 4 N=81	<p>Population: 81 men with SCI, mostly complete.</p> <p>Treatment: Application of a vibrator of 80 Hz and 2.5mm amplitude to the lower surface of the glans penis, electroejaculation (EE).</p> <p>Outcome Measures: Semen retrieval.</p>	<ol style="list-style-type: none"> 1. Required duration <20min (usually <3min) in 48/81 men with SCI. 2. Vibrator failed in 19/81 who lacked reflex hip flexion on scratching soles of feet and in 14 others. Vibrator failed in 11/12 men with injuries <6 months duration. 3. From 21/34 men for whom the vibrator failed, semen could be obtained by electroejaculation (EE). 4. 11 pregnancies reported. 9 healthy children born.
Chapelle et al. 1983; France Post-test Level 4 N=20	<p>Population: Injury level: T6-L4; Time since injury: >6 months.</p> <p>Treatment: Physostigmine (PS) followed by intraspinal injection of neostigmine (ISN) (0.25-0.5mg) or PSC (2mg physostigmine sulfate injected 30min after 40mg N-buthylhyocine) several weeks later.</p> <p>Outcome Measures: Ejaculation.</p>	<ol style="list-style-type: none"> 1. Initial PS application successful in 5/20 patients. 3 patients successful in subsequent tests. 12 not successful. 2. Only successful if T12-L2 segments are intact.
Brindley 1981; UK Post-test Level 4 N=89	<p>Population: Men with SCI (n=84); Injury level: C6-L1 or below; ejaculatory failure.</p> <p>Treatment: Electro-ejaculation (EE) technique with glove-finger electrode.</p> <p>Outcome measures: Successful EE defined as: external success (liquid containing spermatozoa trickled from meatus), retrograde success (no external spermatozoa but at least 5×10^6 spermatozoa in urine), definite failure (no liquid at meatus or no external spermatozoa or $< 5 \times 10^6$ spermatozoa in urine), external failure (no semen externally and no urine specimen provided), pain prevented (at the only attempt at EE, stimulation was less than strength needed for success due to pain).</p>	<ol style="list-style-type: none"> 1. EE technique resulted in external success in 43% of men, retrograde success in 17% of men, and definite failure in 24% of men, with remaining 16% uncertain due to external failure without urine confirmation or being prevented by pain.
	<p>Population: 20 males (mean age=30.8 years old, age range=20-44 years old); level of injury 13 cervical and 7 thoracic; average time since injury to PVS= 64 months; 7 patients had PVS for more than 3.5 years and 13 patients had PVS less than 3.5 years.</p>	<ol style="list-style-type: none"> 1. Ejaculation was achieved in 11 (55%) patients [9 (82%) of patients with cervical SCI & 2 (18%) patients with thoracic SCI] 2. Success rate of PVS in patients less than 3.5 years since injury was 77% in comparison with 14% in patients over 3.5 years since injury.

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Cechova et al. 2014 Czech Republic Post Test Level 4 N=20	<p>Treatment: Participants were divided into two groups: Group 1 had 7 patients who were more than 3.5 years since their injuries and Group 2 had 13 patients who were less than 3.5 years since injury. PVS was performed using the Ferticare Multicept.</p> <p>Outcome Measures: Evaluate the effectiveness and safety of penile vibrostimulation (PVS), semen quality, sperm count, sperm motility, and further utilization of the ejaculate in men with SCI.</p>	<ol style="list-style-type: none"> 3. When comparing semen quality in first and second PVS, total sperm count and number of sperm with progressive motility increased. 4. Fertilization was not successful despite high sperm concentration (213 x 10⁶/ml). The plan is to use it in vitro fertilization. In 1 patient the ejaculate was successfully used for fertilization. 5. Autonomic dysreflexia during PVS occurred in 7 patients, in 6 with cervical and 1 patient with thoracic SCI. Symptoms of autonomic dysreflexia resolved within three minutes.
Chehenesse et al. 2016 France Case Series Level 4 N=384	<p>Population: 384 participants with SCI; level of injury C5-L4.</p> <p>Treatment: None. A retrospective analysis of a cohort of men with complete SCI.</p> <p>Outcome Measures: Successful ejaculation with PVS</p>	<ol style="list-style-type: none"> 1. Successful ejaculation with PVS was reported in 47.4% of patients 2. Ejaculation success with PVS was high when any of the C5–T6 spinal segments was injured (50-67% success). 3. Ejaculation success with PVS decreased when lesions were more caudal, reaching a minimum for the subsample with complete L4 injury of 2.6% versus a minimum of 12% when any of the sacral segments was injured.