Spinal Cord (2005) 43, 693–703

www.nature.com/sc

Review

Fertility following spinal cord injury: a systematic review

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Study design: Systematic review.
Objectives: To review systematically fertility of persons with spinal cord injuries (SCI) and their partners.
Methods: Reports from six databases (1966–2003), selected annual proceedings (1997–2002) and manufacturer's information were screened against eligibility criteria. Searches covered female obstetrical issues, and the efficacy of vibration and electroejaculation for males, as well as advanced fertility (AF) treatments for partners of SCI males. Data were pooled from case-series reports on SCI males' ejaculation, and pregnancies and live births for partners of SCI males.
Results: In all, 2127 unique reports were evaluated, of which 66 reports were included. No studies investigated fertility in SCI females. Ejaculation interventions in the last decade resulted in response rates of 95% (95% confidence intervals (CI) 91%, 99%), with 100% response rate reported in several recent publications. A total of 13 studies (1993–2001) yielded pregnancy rates of 51% (95% CI 42%, 60%) in partners of SCI males. Of these, 11 studies (1993–2003) yielded live birth rates of 41% (95% CI 33%, 49%).
Conclusions: Fertility of SCI males is extensively studied. Semen for fertility purposes can generally be obtained using vibration and electroejaculation. AF techniques are increasing pregnancy rates. Research is needed to improve sperm quality. Freezing of sperm is unlikely to significantly improve fertility rates. Fertility of SCI females is addressed only in case reports and opinion articles. The opinion that female fertility is unaffected by SCI should be further investigated using appropriate research methodology.
Sponsorship: Agency for Healthcare Research and Quality, US Department of Health and Human Services, 2101 East Jefferson Street, Rockville, MD 20852, USA.
Spinal Cord (2005) **43,** 693–703. doi:10.1038/sj.sc.3101769; published online 7 June 2005

Keywords: spinal cord injury; fertility; reproductive health; systematic reviews

Introduction

Having a child is important for many couples, and for people with spinal cord injury (SCI) it represents hope for the future and 'normalcy'. Infertility is a major issue for men with SCI, resulting from the combination of ejaculatory dysfunction and abnormal sperm quantity and quality.[1–3] Techniques to remediate erectile dysfunction and ejaculation have vastly improved the fertility potential of men with SCI.[4–8]

Women generally have unchanged hormonal status, except for a temporary period of amenorrhea following SCI.[9,10] They can carry a child safely to term and may be able to deliver a child naturally, depending on medical status and physical limitations.[10]

The Agency for Healthcare Research and Quality and a federal partner, The Consortium for Spinal Cord Medicine, commissioned the University of Ottawa's Evidence-based Practice Center to determine if there was sufficient credible literature for a comprehensive systematic review on the topic of 'Sexuality and Reproductive Health Following SCI'. Sufficient reports were identified to address the following questions pertaining to fertility:

- What is the current fertility rate for men after SCI?
- Are fertility rates changed by freezing a new patient's sperm?

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- Are there better fertility rates using electroejaculation or vibration? Does order of method influence outcome?
- To improve fertility rates, when should invasive techniques such as testicular biopsy or aspiration, or intracytoplasmic sperm injection (ICSI) be pursued?
- Are there pregnancy complications and prospective obstetric management issues for SCI females?

Methods

Search strategy

Building on the preliminary search conducted for a feasibility report (if possible, this report should be cited even as a footnote), an updated search was conducted on Medline (1966 – June Week 1, 2003), Premedline (June 13, 2003), CINAHL (1975 to June Week 1, 2003), Cochrane Central Register of Controlled Trials, (1st Quarter, 2003), SocioFile (1974 to June 2003) and PsycInfo (1887 to June Week 1, 2003) and are reported elsewhere (http://www.ahrq.gov/downloads/pub/evidence/pdf/sexlspine/sexlspine.pdf).

Additional published literature was sought through searches of relevant associations' proceedings for the years 1997–2002, and industry was contacted for ongoing and/or unpublished data.

Eligibility criteria

Published and unpublished studies of any research design or language of publication that enrolled male and/or female populations with SCI were considered for inclusion. Articles discussing fertility interventions with pre- and postintervention fertility measures, or original measurements of fertility rates were considered. Interventions or topics of interest included devices (eg for vibration, electrode ejaculation or home insemination), prescription medications (eg sympathetic agonists, physostigmine), surgical intervention (eg vas aspiration, testicular biopsy, artificial insemination, spinal cord stimulators), physical activities (eg masturbation, intercourse) or laboratory techniques (eg ICSI). Outcome measures included pregnancies, live birth rates, sperm motility, successful sperm harvesting, ejaculations, sperm count, % viable sperm, hormone levels, ovulation rates, cycle function, other measures of sperm morphology and volume of ejaculation. Single case reports and opinion articles were excluded, as were studies reporting on congenital abnormalities.

Study selection

Relevance screening, assessment of study quality and data abstraction were completed electronically. Reports were not masked for authorship and/or affiliations, given the equivocal evidence regarding the benefits of this practice.[11,12]

Calibration exercises preceded each step of the screening process. As an extension of the feasibility study where screening was directed at bibliographic records (ie title, authors, key words, abstracts), full articles were screened by two team pairings (DD and VC; JB and NL). Records were included that appeared to contain pertinent study information if there was no unequivocal reason for exclusion. Disagreements were resolved by consensus and, if necessary, third-party resolution. Excluded studies and reasons for exclusion are available elsewhere (http://www.ahrq.gov/downloads/pub/evidence/pdf/sexlspine/sexlspine.pdf).

Data abstraction

Data compiled from each report included the study design (eg randomized controlled trial (RCT), cohort study), study quality, participants (eg gender, diagnoses, control group characteristics), intervention/exposure, outcome measures and study results and conclusions.

The contents of each included study were independently abstracted by two of four reviewers (FY, VC, VM and JM). Reviewers undertook an initial calibration exercise with two studies, and checked all data abstracted by their counterpart.

Study quality

Study quality was assessed independently by two assessors. RCTs were assessed using the Jadad scale. This validated scale rates reporting of the generation of random assignments and double blinding, and descriptions of dropouts and withdrawals from each group.[13] The scoring ranges from zero to five, with higher scores indicating higher quality. In addition, allocation concealment (keeping randomization blind until participants are assigned to an intervention group) was assessed as adequate, inadequate or unclear.[14]

The Newcastle–Ottawa Scale (NOS) was used to rate cohort and case–control study reports according to the selection of the study groups, the comparability of the groups and the determination of either the exposure for case–control studies or the outcome of interest for cohort studies.[15]

Quality assessments of noncomparative case-series reports were assessed using a 19-item instrument adapted from the journal *Opthalmology*.[16]

Data synthesis

Qualitative syntheses of abstracted data were completed on a question-specific basis, with studies grouped according to research design (eg RCTs, observational studies). Tabulated information not presented here is available elsewhere (http://www.ahrq.goc/clinic/epcindex.htm).

Where quantitative data synthesis was appropriate, forest plots were constructed using Wilson score confidence intervals (CI) around individual study proportions.[17] Pooled estimates and their 95% CI were obtained using the random effects estimator of Laird and Mosteller.[18]

Results

Report identification, assessment and reasons for exclusion are summarized in Figure 1. Of 2127 reports evaluated against the eligibility criteria, 1627 were excluded after the initial relevance screening and 500 reports were retrieved. A more detailed relevance assessment revealed that 246 reports dealt with issues relating to fertility, but 180 failed to meet the inclusion criteria. All 66 reports included in this systematic review examined fertility in males with SCI.

Female fertility following SCI

We found case reports and opinion articles but no case-series studies investigating fertility issues such as pregnancy rates, live births and complications or obstetrical management issues in females after SCI.

Therefore, the systematic review was restricted to male fertility post-SCI.

Male fertility following SCI

Harvesting sperm SCI males demonstrate neurophysiologic impairment to ejaculation post-SCI, so attention was turned very early to semen harvesting followed by insemination.[19]

An initial intervention to induce ejaculation was intrathecal physostigmine injection.[20,21] Leduc *et al*[21] obtained antegrade ejaculate from 20 of 37 SCI males. Multiple medications were required to inhibit side effects, including autonomic dysreflexia, nausea, vomiting, hallucination and dizziness. Study quality was 6/19. Chapelle *et al*[22] studied 135 males injured at various neurological levels using physostigmine. Damage to the T12–L2 region of the cord (T12 metamer) correlated with testicular atrophy and poor ability to ejaculate. The high incidence of side effects limited widespread adoption of this technique.

Reports of other techniques used to harvest semen from males with SCI (Table 1) included electrical stimulation of the seminal vesicles and vas deferens,[23] vas cannulation with implanted sperm reservoirs,[24] testicular biopsy[25,26] and microsurgical aspiration of the vas deferens.[27]

The most common techniques used for semen harvesting include vibration or electroejaculation. Between 1981 and 2002, 22 case series involving 806 participants in the USA, UK and Australia were reported (Table 2).[19,28–48] These results were pooled (Figure 2), yielding an overall ejaculation response rate of 86% (95% CI 80%, 93%). Within the past decade, the success rate of these case series approached 100%, although many of these cases series lack information regarding participants that could have helped to elucidate sources of heterogeneity and bias.

Data from several electroejaculation and/or vibration studies could not be pooled because they used different outcome measures.[6,49,50]

Of the 21 studies identified that reported ejaculation rates with either technique (Figure 2), 10 reported adverse events (Table 2).[19,32,39]

Three case-series studies directly examined differences between the two techniques,[51–53] and two articles described the details of electroejaculation techniques and precautions in SCI males,[54,55] but did not specifically address any of the questions targeted by the review.

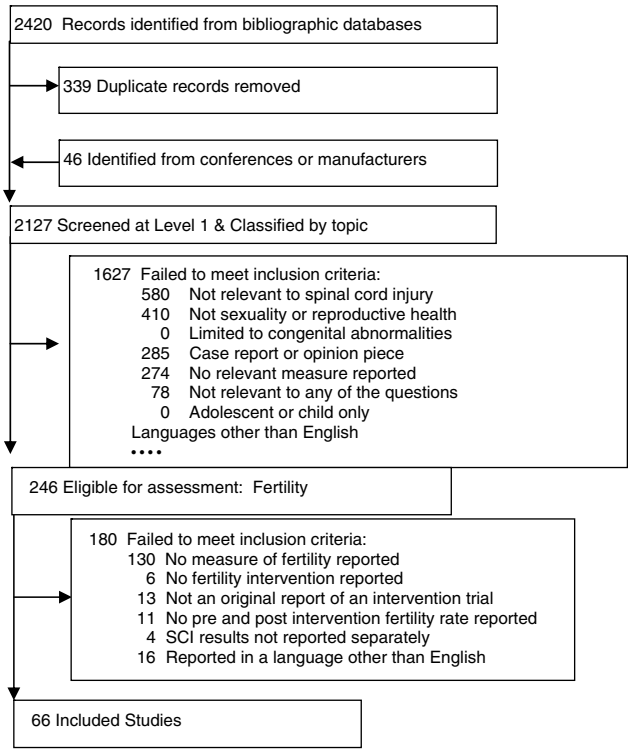

Figure 1 QUOROM Flow Chart

Pregnancies and live births In all, 17 noncomparative case series (Table 3) reported pregnancies and/or live births for partners of 400 SCI males in Canada, USA, UK and Australia.[21,31,34,37,39–41,43,44,46–48,56–60]

Not all authors presented both pregnancy and live birth data. As well, some authors reported fertility rates after vibration or electrode ejaculation and insemination, whereas other fertility studies incorporated advanced fertility (AF) techniques that can increase success four-fold.

Fertility data among couples attempting to bear a child from 1993–2003 were pooled (Figures 2 and 3), demonstrating a 51% pregnancy rate (95% CI 42%, 60%). Data suggest considerable improvement in pregnancy rates, from 0% reported in 1987[31] to the more recently reported rates of 74[46] and 73%.[47] Data from the 13 studies documenting live birth rates to 341 couples yielded a estimate of live birth rate of 40% (95% CI 33%, 48%).[56] Live birth rates have improved over time, with Lucas *et al*[34] reporting a success rate of 14% in 1991 and Elliott[61] of 62% in 1996.

Table 1 Techniques to obtain semen from men with SCI

Author (year)	*Study design*	*Number of patients*	*Technique*	*Success rates*	*Study quality*
Bensman and Kottke (1966)	Noncomparative case series	5	Electrostimulation of seminal vesicles and vas deferens	Sperm obtained in 3/5 from retrograde ejaculate; no motile sperm in 2/5; in 1/3 with 410K sperm/cm^3, 20–30% of the sperm had abnormal forms	4/19
Brackett *et al* (2000)	Case–control	12	Vas aspirated compared to ejaculated sperm	Vas aspirated sperm motility and viability plus or minus SEM were significantly higher than mean ejaculated sperm motility and viability (54.4 ± 5.0 and 74.1 ± 5.3% *versus* 14.1 ± 2.6 and 26.1 ± 4.9%, respectively)	7 (NOS)
Brindley *et al* (1986)	Noncomparative case series	12	Implanted sperm reservoir	Motile spermatozoa in eight patients (67%) were recovered; two pregnancies (17%) achieved with subsequent live births (artificial insemination at home)	6/19
Hirsch *et al* (1994)	Case–control	10	Testicular biopsy	Spermatogenesis similar between SCI men and controls	4 (NOS)
Perkash *et al* (1985)	Noncomparative case series	30	Electrical stimulator	Sperm count: in 18 men >40 million, in 22 men >20 million Normal sperm morphology: mean of 55% normal forms (range 40–75%) Sperm progressive motility: <20% in 27 of 35 specimens No motile sperm in 10 specimens and <10% motile in 13; 10–20% motile in four patients, >30% motile in five patients	7/19

NOS = Newcastle–Ottawa Scale

Intracytoplasmic sperm injection AF techniques to enhance fertility such as *in vitro* fertilization (IVF) and ICSI are becoming more available. Based on the evidence, one could assume that to achieve pregnancy and birth rates approaching 50% or greater, couples need to use an AF technique (Table 3).

Comparing fertility rates using electroejaculation or vibration SCI males have low numbers and quality of sperm compared to normal males.[2,3] Sperm quantity and quality from procedures to obtain ejaculate were examined as predictors of fertility.

In a noncomparative case series, Brackett *et al*[52] collected semen from 77 males with SCI. Although total semen volume and sperm counts were similar, the vibration-induced samples had higher percentages of motile sperm and sperm with rapid linear motion than with electroejaculation. The same trend was observed for 10 patients who had both procedures performed.

Ohl *et al*[51] conducted a crossover study, using both vibration and electroejaculation to obtain ejaculate from 11 SCI males. Antegrade vibration-induced ejaculate sperm were more motile than antegrade electroejaculate specimens. However, a higher total semen volume was obtained using electroejaculation, so that the two techniques obtained similar numbers of motile sperm. Electroejaculation caused more pain, and all patients preferred the vibration procedure.

Le Chapelain *et al*[62] found superior semen quality from vibration-induced ejaculation compared to either electroejaculation or physostigmine, from 39 SCI males. The quality of the report was 11/19, with concealment reported.

Finally, Park *et al*[53] reported a case–control study examining electroejaculation and vibration in 17 males with SCI. Although sperm quality was superior using vibration, this technique was unsuccessful for those with lesions at and below T10, requiring electroejaculation to be used with the lesions at or below the thoracolumbar sympathetic center.

Freezing a new patient's sperm

It is not uncommon that patients of a family ask about the feasibility and utility of freezing a new SCI male's sperm to be used at a later date for fertility. The literature provides some guidance.

Mallidus *et al*[35] demonstrated that after the acute patient comes out of spinal shock, sperm motility and

Table 2 Ejaculation success rates and complications observed with electroejaculation and/or vibration

Author (year)	*Procedure*	*Ejaculation success*	*Complications (number of patients)*	*Study quality*
Sarkarati *et al* (1987)	Vibration Electroejaculation	29/34	Pain with electroejaculation (4) Minor headache and/or 20–40 mmHg increase in systolic blood pressure occurred in a few patients (autonomic dysreflexia)	10/19
Pryor *et al* (1995)	Vibration Case 1: Ephedrine, imipramine, sodium bicarbonate Case 2: Ephedrine and sodium bicarbonate, imipramine and sodium bicarbonate Case 3: No medication Case 4: Ephedrine and sodium bicarb Case 5: No medication Case 6: Intrauterine insemination	6/6	Case 1: Headaches and spasticity due to ephedrine – switched to imipramine Cases 2/3/4/5/6: Not reported	5/19
Lim *et al* (1994)	Electroejaculation Vibration	12/12	No incidence of severe hypertension due to autonomic dysreflexia Postelectroejaculation proctoscopy showed no damage to the rectal mucosa of any patient Significant problems with recurrent urinary tract infections (1) Severe stomach cramps during electroejaculation (1)	10/19
Beretta *et al* (1989)	Vibration	78/102	Headache (2) Increased blood pressure (2)	11/19
VerVoort *et al* (1988)	Electroejaculation	7/7	Headache/blurred vision/sweating/flushing and increased blood pressure without nifedipine (all) Autonomic hyper-reflexia – effects reduced with nifedipine	10/19
Sonksen *et al* (1994)	Vibration Population I: (25) Vibrator A, no nifedipine Population II – (41) Vibrator B, nifedipine sublingual prophylactically	58/66	Population I: Light headache/no increase in blood pressure (4) glycerine nitrate sublingual required (1) Population II: No discomfort	9/19
Heruti *et al* (2001)	Electroejaculation	14/14	Abdominal pain or spasm (17 stimulations) Blood pressure elevated (15) Increased spasm (3) Syncope – untreated, no further complications (1)	11/19
Brindley (1981)	Electroejaculation	50/82	Intolerable pain – procedure stopped (7)	5/19
Halstead *et al* (1987)	Electroejaculation	10/12	Mild dysreflexia (3) Disruption of normal bowel program (1)	NA
Rawicki and Hill (1991)	Electroejaculation Vibration Subcutaneous physostigmine Notes: •Three patients had electroejaculation under general anaesthetic due to pain •Patients with lesions above C7 treated with labetolol 100 mg or nifedipine 10 mg	24/38	Electroejaculation: Autonomic hyper-reflexia in patients with high lesions Pain in patients with low lesions Vibration: Autonomic hyper-reflexia in patients with high lesions Superficial ulcer (1) Superficial trauma to the glans resulting in bruising (2) Subcutaneous physostigmine: Blurring vision (4) Nausea and vomiting (2) Marijuana-like highs (2)	7/19

NA = not assessed

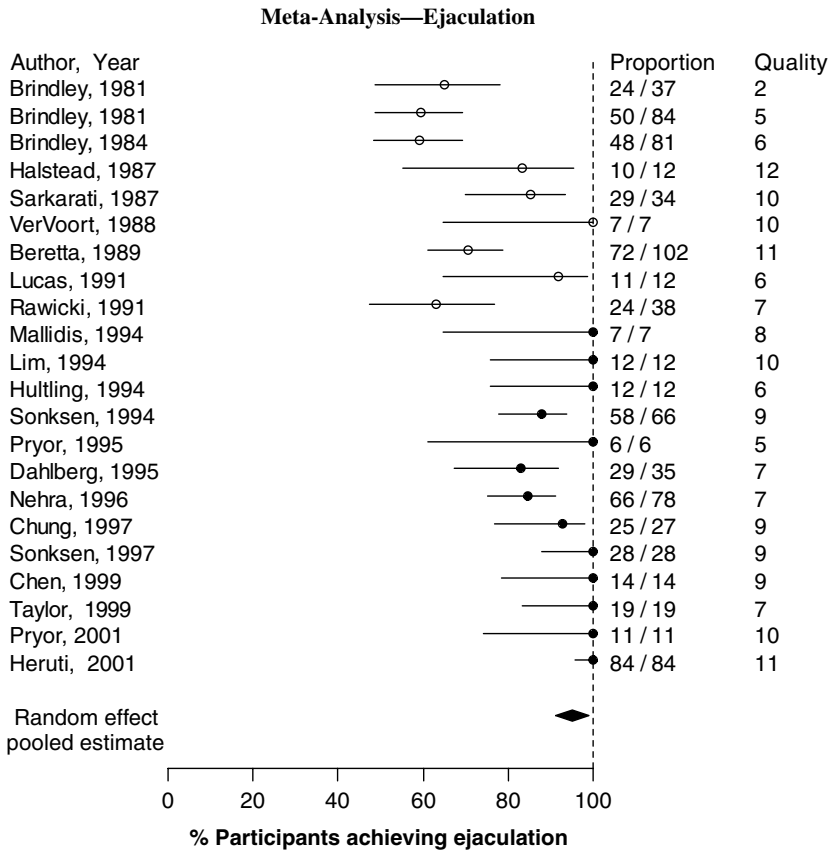

Figure 2 Forest plot of the success rate of vibration and/or electrode stimulation in noncomparative case-series studies that reported ejaculation as an outcome. Data were pooled and the overall estimate and its CI were calculated using the random effects estimator of Laird and Mosteller.[18] Estimates from studies prior to 1993 are denoted by open circles. Only results from the past 10 years (1993–2003) were pooled to account for changes in techniques and technology. Quality scores are out of a possible 19

viability improve temporarily and then rapidly deteriorate, reaching the levels observed in males with chronic SCI 16 days following injury. In the chronically spinal cord-injured individual (>1 year), there is no relationship between duration of injury and sperm quality.[26,27,63–65]

Padron *et al*[65] found that sperm from nine SCI males was cryopreserved as reliably as semen obtained from controls, but that sperm motility was consistently reduced by approximately 65%. Green *et al*[66] found similar results. Thus, unless carried out in the first 1 or 2 weeks after SCI, there is no utility in freezing the sperm. Further, even if frozen earlier, the reduction in sperm quality may be equivalent to the improvement in results of using current techniques; hence, this intervention is unlikely to significantly improve SCI males' fertility rates.

Sperm quality Reproductive success was limited by the prevailing low semen quality in SCI males. Abnormal sperm in the ejaculate of SCI males has been discussed in terms of decreased sperm counts,[26] decreased sperm motility,[24,26,56] increased reactive oxygen species formation,[56] sperm autoimmunity,[67] necrospermia,[68] the inhibitive effect of seminal plasma in SCI males[69] and the presence of antisperm antibodies.[70] Methods used to counteract these negative effects include retrieving the semen more proximally through testicular biopsy or aspiration.[27,71]

Physical factors may be optimized to improve sperm quality. Men managing their bladders with high-pressure reflex voiding had lower sperm quality than men using intermittent catheterization.[63,64,72] Chen *et al*[45,73] found in a small study that there was a nonstatistical trend towards better sperm counts in antegrade ejaculate specimens, although retrograde ejaculation occurred more frequently. Bracket *et al*[71,74] found that the sperm of SCI males lost motility faster than the sperm of normal males, but that scrotal temperature and gonadotropin levels did not contribute to poor semen quality in SCI males. Repeated ejaculation may improve sperm quality to a plateau, but too-frequent ejaculation (once per week) causes sperm quality to fall off.[64,75]

Table 3 Pregnancy and live birth rates for studies with and without AF techniques

Study	*N*	*Intervention*	*Pregnancies*	*Live births*	*Study quality*
Brackett *et al* (1995)	23	AF	11/23 (48%)	8/23	10/19
Brinsden *et al* (1997)	35	AF	18/35 (51%)	14/35	9/19
Dahlberg *et al* (1995)	35	AF	18/35 (51%)	14/35	7/19
Elliott *et al* (2002)	73	AF	NR	45/73	NA
Heruti *et al* (2001)	33	AF	18/33 (55%)	18/33	11/19
Hultling *et al* (1997)	25	AF	16/25 (64%)	11/25	9/19
Nehra *et al* (1996)	33	AF	17/33 (52%)	17/33	7/19
Pryor *et al* (1995)	6	AF	5/6 (83%)	NR	5/19
Pryor *et al* (2001)	11	AF	8/11 (73%)	NR	10/19
Taylor *et al* (1999)	19	AF	14/19 (74%)	NR	7/19
Beretta *et al* (1989)	6	Non-AF	3/6 (50%)	NR	11/19
Buch *et al* (1993)	6	Non-AF	NR	2/6	8/19
Chung *et al* (1997)	27	Non-AF	7/27 (26%)	4/27	9/19
Halstead *et al* (1987)	12	Non-AF	0/12 (0%)	0	12/19
Hultling *et al* (1994)	12	Non-AF	6/12 (50%)	3/12	6/19
Leduc *et al* (1992)	6	Non-AF	3/6 (50%)	3/6	6/19
Lucas *et al* (1991)	12	Non-AF	1/12 (10%)	1/7	6/19
Sonksen *et al* (1997)	28	Non-AF	10/28 (36%)	9/28 (including one set of twins)	9/19

AF = advanced fertility techniques; NR = not reported; NA = not assessed

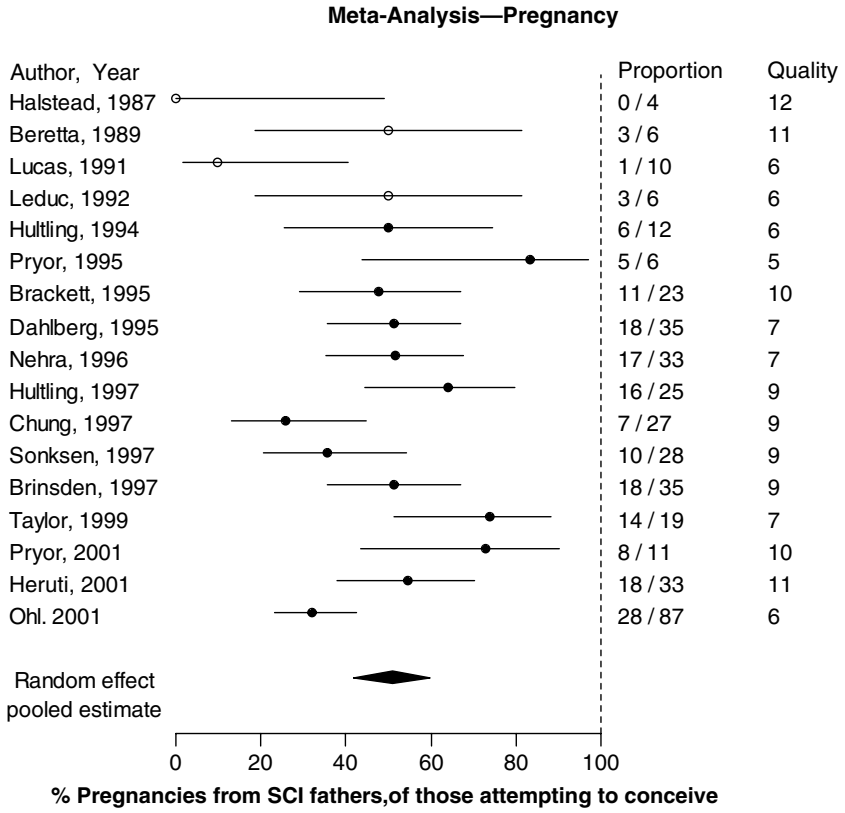

Figure 3 Forest plot of the pregnancy rate in the noncomparative case-series studies that reported pregnancy as an outcome. Data were pooled and the overall estimate and its CI were calculated using the random effects estimator of Laird and Mosteller.[18] Estimates from studies prior to 1993 are denoted by open circles. Only results from 1993 to 2003 were pooled, due to changes in techniques and technology. Quality scores are out of a possible 19

Thus, procedures should be synchronized with the female partner's monthly cycle. It is unknown whether prolonged immobility and sitting contribute to the problem.

Discussion and conclusions

Much of the literature describes individual centers' experiences with treatment techniques in case-series

format. Although such descriptions are interesting, many were excluded from this systematic review because of incomplete reporting. Included reports presented results in variable formats with unique outcome measures, so not all studies could not be statistically compared or compiled. As researchers comply with emerging international reporting standards for medical research, trials will be more readily combined statistically, to build expertise and to inform best practices.[76,77] The quality of many of the case-series studies could have been improved with simple reporting of complete methodology, including preintervention measures, how missing data were dealt with, dropouts and follow-up efforts, and reporting of side effects.

Specific questions

Are there pregnancy complications and prospective obstetric management issues for SCI females? The paucity of literature regarding SCI female fertility and pregnancy-related complications is disturbing. It is often stated, both in review articles and by clinician teachers at the bedside, that although there is an initial acute delay in the return of ovulation cycles in females following SCI, ultimately there is no impact on female fertility by the injury *per se*. Although this may be true, it is not supported by studies comparing fertility of SCI women with an uninjured cohort to examine effects of SCI on the rate of miscarriages, live births, birth defects and pregnancy complications. Rigorous, prospective case-series or cohort studies, potentially involving multiple centers, could provide valuable natural history information to inform practice or policy regarding this important health issue.

What is the current fertility rate for men after SCI? The vast majority of SCIs occur in men (approximately 80% of injured persons are male in western nations) and male reproduction is most obviously affected, so not surprisingly the majority of fertility literature focuses on male reproduction post-SCI. The reasons for male infertility after SCI are complex, and 12 articles reported on semen characteristics and examination techniques, often to further delineate reasons for infertility and discuss possible treatments of SCI males.[67–70,73,74,78–83]

Initial interventions were to harvest sperm from the SCI male and to inseminate the female partner, either using self-insemination at home or intrauterine insemination in a clinic. In 1960, Bors and Comarr[84] reported that SCI males had a fertility rate of <10%, citing difficulties with ejaculation (sperm harvesting) and sperm quality. Although pooled fertility data in this systematic review reveals a pregnancy rate of 51% and a live birth rate of 40%, the most recent studies show the highest success rates with the use of AF techniques.

Problems are two-fold, of harvesting sperm and of poor semen quality.

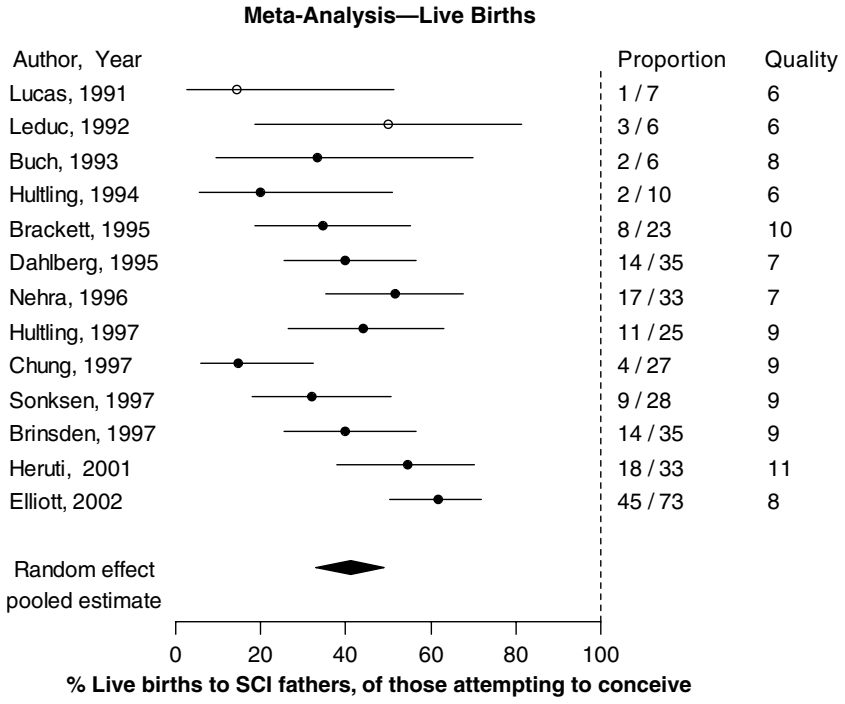

Figure 4 Forest plot of the rates of live births in noncomparative case-series studies that reported live birth as an outcome. Data were pooled and the overall estimate and its CI were calculated using the random effects estimator of Laird and Mosteller.[18] Estimates from studies prior to 1993 are denoted by open circles. Only results from 1993 to 2003 were pooled, due to changes in techniques and technology. Quality scores are out of a possible 19

Are there better fertility rates using electroejaculation or vibration? Does order of method influence outcome? Although both techniques have similar success rates, vibration is less likely to be successful for lower motor neuron (areflexic) injuries than with spastic injuries, but is less likely than electroejaculation to cause autonomic dysreflexia in patients with spastic injuries.[31,33] Electroejaculation causes stimulation pain[19,30,36,51] in incompletely injured patients, and inflammation to the rectal mucosa.[36] Therefore, vibration is usually tried first, followed by electroejaculation in the areflexic subjects. Thus, semen can be harvested in at least 80% of cases, with recent series reporting 100% success rates. Testicular biopsy or vas deferens aspiration techniques, although expensive and invasive, are usually successful in any remaining patients, and for those whose sperm was of very low quality when harvested by other techniques.

Are fertility rates changed by freezing a new patient's sperm? Sperm freezing would probably not enhance fertility unless the sperm were to be frozen almost immediately after injury. Any advantage of early freezing (within the first 2 weeks postinjury) would probably be outweighed by the loss of sperm motility during the procedure, since with modern techniques one is likely to obtain fresh sperm from the SCI male when he is ready to conceive a child in later years.

To improve fertility rates, when should invasive AF techniques such as testicular biopsy or aspiration, or ICSI be pursued? Using IVF and ICSI techniques to compensate for poor semen quality, the rates of live birth climbed to over 50% of couples attempting to have children. The proportion of successful pregnancies may be lower because multiple births are common with AF techniques. Clinicians often prescribe a graduated approach, starting with the most natural and least invasive methods, to increasingly invasive and expensive options in a fertility clinic. Although these risks and expenses mirror those of other infertile couples, those living with SCI have additional lifelong equipment and care expenses, as well as reduced employment opportunities. This financial situation constitutes a new limitation on pregnancy success. Research is needed to improve semen quality in SCI men so that pregnancy may be achieved with simpler techniques.

As in many scientific fields, evolving technology confounded estimates of interventions' effectiveness. Although studies were pooled only from a 10-year period, statistically significant heterogeneity in the meta-analyses broadened the confidence intervals for ejaculatory success, pregnancy rates and live births (Figure 4). Heterogeneity in such data will inevitably exist even as AF options are refined, not only due to variations in the population but also due to invasiveness and accessibility to user-pay techniques.

Acknowledgements

This document was prepared by the *University of Ottawa Evidence-based Practice Center*, Ottawa, Canada. We gratefully acknowledge the following individuals who served on our Technical Expert Panel (acknowledgment does not reflect endorsement of this report): Drs David Chen, Stanley Ducharme, Stacy Elliott, Arthur Leader, Todd Linsenmeyer and Shawn Marshall. We would also like to thank Dr Meg Sears who helped in the drafting and editing of this manuscript.

Note: Appendices and additional Tables cited in this report are available at http://www.ahrq.gov/downloads/pub/evidence/pdf/sexlspine/sexlspine.pdf.

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