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Digital three-dimensional modelling of the male pelvis and bicycle seats: impact of rider position and seat design on potential penile hypoxia and erectile dysfunction.

[Gemery JM](#), [Nangia AK](#), [Mamourian AC](#), [Reid SK](#).

Department of Radiology, Dartmouth-Hitchcock Medical Center, Lebanon, NH 03756, USA.
john.gemery@hitchcock.org

OBJECTIVE: To digitally model (three-dimensional, 3D) the course of the pudendal arteries relative to the bony pelvis in the adult male, and to identify sites of compression with different bicycle riding positions as a potential cause of penile hypoxia and erectile dysfunction. **SUBJECTS AND METHODS:** 3D models were made from computed tomography scans of one adult male pelvis (a healthy volunteer) and three bicycle seats. Models were correlated with lateral radiographs of a seated rider to determine potential vascular compression between the bony pelvis and seats at different angles of rider positioning. **RESULTS:** Pelvis/seat models suggest that the most likely site of compression of the internal pudendal artery is immediately below the pubic symphysis, especially with the rider leaning forward. For an upright rider, the internal pudendal arteries do not appear to be compressed between the seat and the bony pelvis. Leaning partly forward with arms extended, the seat/symphysis areas were reduced to 73 mm² with standard seat and 259 mm² with a grooved seat. Leaning fully forward, the seat/symphysis areas decreased (no space with standard seat; 51 mm² with a grooved seat) and both the ischial tuberosities and the pubic symphysis might be in contact with the seat. **CONCLUSION:** A grooved seat allows better preservation of the seat/symphysis space than a standard seat, but the rider's position is more important for preserving the seat-symphysis space (and reducing compression) than is seat design alone. Any factors which influence the seat-symphysis space (including an individual's anatomy, seat design and rider position) can increase the potential for penile hypoxia and erectile dysfunction/perineal numbness.

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Influence of bicycle seat pressure on compression of the perineum: a MRI analysis.

[Bressel E](#), [Reeve T](#), [Parker D](#), [Cronin J](#).

Biomechanics Laboratory, HPER Department, Utah State University, Logan, UT, USA.
ebressel@cc.usu.edu

It is a common belief that bicycle seat pressure compresses neurovascular tissues in the perineum and may lead to perineal and penile pathologies in male cyclists. The purpose of this study was to examine the effect bicycle seat pressure has on compression of the perineal cavernous spaces, which house the penile neurovascular tissues. A second purpose was to identify where peak cavernous compression occurs in relation to a bicycle seat. Five males were assessed for compression of the corpus spongiosum and corpora cavernosa with and without bicycle seat pressure using MRI.

Seat pressure was applied using a custom loading device designed to replicate seat pressure recorded during stationary bicycling. The distance between a horizontal midline of the seat and the point of peak cavernous space compression was made on sagittal plane images. Diameter measurements of the cavernous spaces at the point of peak compression were made on coronal plane images. Results revealed that peak cavernous space compression occurred below the pubic symphysis, 40.7(+/-11.4) mm anterior to the midline of the seat. Corpus spongiosum values in the unloaded condition were 148% greater than the loaded condition (p=0.008). Similarly, the left and right corpora cavernosa values for the unloaded condition were 252% and 232% greater, respectively, than the loaded condition (p=0.02-0.03). Cavernous spaces that house penile arteries and nerves were compressed maximally below the pubic symphysis. Because this location of peak compression was not different between subjects, it may be a universal impingement zone that limits blood flow and neural activity to and from the penis. This information can be used to optimize seat design and thus reduce perineal injuries.

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[J Sex Med. 2005 Sep;2\(5\):594-5.](#)

Only the nose knows: penile hemodynamic study of the perineum-saddle interface in men with erectile dysfunction utilizing bicycle saddles and seats with and without nose extensions.

[Munarriz R](#), [Huang V](#), [Uberoi J](#), [Maitland S](#), [Payton T](#), [Goldstein I](#).

Institute for Sexual Medicine, Department of Urology, Boston University School of Medicine, 720 Harrison Avenue, Suite 600, Boston, MA 02118, USA. munarriz@bu.edu

PURPOSE: To investigate the differential impact of straddles (A(ns) and B(ns)) and noseless two-cheek seats (A(ntcs) and B(ntcs)) on penile hemodynamics and perineal compressive forces in subjects who cycle in a stationary bicycle. **MATERIALS AND METHODS:** Subjects underwent cavernosal artery peak systolic velocity (CAPSV) measurements after intracavernosal injection of vasoactive agents while supine, sitting upright on an examination table, straddling a saddle, sitting on a seat, and again supine. Mean perineal compression pressures recorded while straddling the saddles were compared with those while sitting upright. **RESULTS:** No differences were found in right and left CAPSV values while supine, sitting upright on an examination table, sitting on a seat, and supine again. Right/left CAPSV (cm/second) values straddling A(ns) and saddle B(ns) (0.7 +/- 2.9/1.5 +/- 6.2 and 0/0, respectively) were significantly lower than values obtained while sitting on A(ntcs) and B(ntcs) (25.6 +/- 13.4/23.8 +/- 12.0 and 17.3 +/- 6.4/18.3 +/- 6.5, respectively) (P < 0.001). Mean perineal compression pressures (mm Hg) on A(ns) and saddle B(ns) (315.2 +/- 39 and 387.9 +/- 64.3, respectively) were significantly higher than values obtained while sitting upright on an examination table (47.6 +/- 5.2 and 46.0 +/- 8.1, respectively) (P < 0.001). **CONCLUSIONS:** We have identified an objective test to assess if an individual bicycle rider, sitting on a certain shape of bicycle saddle or seat generates sufficient compressive forces at the perineal-saddle interface to obstruct cavernosal arterial inflow. This study also demonstrated that

straddling bicycle saddles with nose extensions is associated with perineum-saddle interface compressive pressures that exceed systolic perfusion pressures, significantly diminishing penile hemodynamics.

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[J Sex Med. 2005 Sep;2\(5\):594-5.](#)

Bicycle riding and erectile dysfunction: an increase in interest (and concern).

[Huang V](#), [Munarriz R](#), [Goldstein I](#).

Institute for Sexual Medicine, Department of Urology, Boston University School of Medicine, 720 Harrison Avenue, Boston, MA 02118, USA.

INTRODUCTION: From 1999 to 2004, there had been 21 publications from multiple medical specialties (sexual medicine, urology, neurology, cardiology, biomedical engineering, sports medicine, emergency medicine, and officials from the National Institute for Safety and Occupational Health) investigating the relationship between bicycle riding and erectile dysfunction (ED). In the previous 18 years, there have been 14 such studies. **AIM:** The primary aim was to summarize accumulating data on the safety of bicycle riding based on medical evidence categorized by levels of evidence, including case reports, observational studies, case control studies, mechanistic studies, and population-based epidemiologic investigations. The secondary aim was to address the concerns of bicyclists and propose measures to minimize the risk of ED associated with bicycle riding. **METHODS:** An English-language medical literature review was made of publications in peer review journals from 1981 to 2004, including published abstract presentations at major medical meetings. **MAIN OUTCOME MEASURE:** Ranked published epidemiologic data on bicycle riding and ED. **RESULTS:** Bicycle riding more than 3 hours per week was an independent relative risk (RR = 1.72) for moderate to severe ED. In case control studies, the prevalence of moderate to severe ED in bicyclists was 4.2% and 4% vs. age-matched runners 1.1% ($P < \text{or} = 0.018$) and swimmers 2% ($P = 0.05$), respectively. Therefore, bicycle riders should take precautionary measures to minimize the risk of ED associated with bicycle riding: change the bicycle saddle with a protruding nose to a noseless seat, change the posture to a more upright/reclining position, change the material of the saddle (GEL), and tilt the saddle/seat downwards. **CONCLUSIONS:** The mechanism is hypothetically related to the rider interaction with the bicycle saddle at the perineum-saddle interface. Straddling bicycle saddles with a nose extension is associated with suprasystolic perineal compression pressures, temporarily occluding penile perfusion and potentially inducing endothelial injury and vasculogenic ED.

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Effect of bicycle racing saddle design on transcutaneous penile oxygen pressure.

[Cohen JD](#), [Gross MT](#).

Program in Human Movement Science, Department of Allied Health Sciences, School of Medicine, University of North Carolina, Chapel Hill, NC 27517, USA.

AIM: To determine the reliability of monitoring penile transcutaneous oxygen (tpO₂) during cycling, and to assess the influence of seat design and cycling position on tpO₂. **METHODS:** Experimental design: repeated measures analysis of the effects of seat design and riding position on tpO₂ values. **Participants:** 31 male cyclists between the ages of 20 and 50 years participated. **Subject inclusion criteria were:** averaged=or>80 miles of road bicycling per week during the 2 months prior to enrollment in this study; no history of vascular disease, diabetes, or sexual dysfunction; and had an erection within 15 days prior to study. **Measures:** mean tpO₂ values were calculated for seated and standing positions using 3 current bicycle seat designs. **RESULTS:** Test-retest reliability for seated cycling tpO₂ values had an ICC (3,1) of 0.76 and mean absolute difference of 5.1 mmHg. Test-retest reliability for standing cycling tpO₂ values had an ICC(3,1) of 0.88 and mean absolute difference of 7.23 mmHg. No interaction effect occurred between seat design and position. Seat design had no significant effect on tpO₂ values. Seated cycling significantly reduced tpO₂ levels compared with standing cycling (P<0.05). Mean percent decreases in tpO₂ from standing to seated cycling were; Vetta 76%, Terry 73%, and Specialized 62%. **CONCLUSION:** The data suggest that penile tpO₂ monitoring is reliable for use during cycling studies. None of the seats exhibited any significant ability to spare penile tpO₂. The implications of decreased penile tpO₂ over different time intervals on penile physiology remain to be investigated.

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The vicious cycling: bicycling related urogenital disorders.

[Leibovitch I](#), [Mor Y](#).

Department of Urology, Meir Medical Center, Affiliated to Sackler School of Medicine, Tel Aviv University, 59 Tchernichovski st., Kfar Saba, Israel. leibovitchi@clalit.org.il

PURPOSE: Bicycle riding is one of the most popular means of transportation, recreation, fitness and sports among millions of people of all ages who ride on road and off road, using a variety of bicycle types. It is also a readily available form of aerobic non-impact exercise with established cardiovascular beneficial effects. Bicycles are also a common source of significant injuries. This review focuses upon the specific bicycling related overuse injuries affecting the genitourinary tract. **MATERIALS AND METHODS:** MEDLINE search of the literature on bicycling and

genitourinary disorders was performed using multiple subject headings and additional keywords. The search yielded overall 62 pertinent articles. We focused primarily on the most prevalent related disorders such as pudendal nerve entrapment, erectile dysfunction and infertility. The potential effect of bicycling on serum PSA level was also discussed in depth in view of its recognized clinical importance. Infrequent disorders, which were reported sporadically, were still addressed, despite their rarity, for the comprehensiveness of this review. RESULTS: The reported incidence of bicycling related urogenital symptoms varies considerably. The most common bicycling associated urogenital problems are nerve entrapment syndromes presenting as genitalia numbness, which is reported in 50-91% of the cyclists, followed by erectile dysfunction reported in 13-24%. Other less common symptoms include priapism, penile thrombosis, infertility, hematuria, torsion of spermatic cord, prostatitis, perineal nodular induration and elevated serum PSA, which are reported only sporadically. CONCLUSIONS: Urologists should be aware that bicycling is a potential and not an infrequent cause of a variety of urological and andrological disorders caused by overuse injuries affecting the genitourinary system.

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Bicycle riding and its relationship to the development of erectile dysfunction.

[Taylor JA 3rd](#), [Kao TC](#), [Albertsen PC](#), [Shabsigh R](#).

Division of Urology, University of Connecticut Health Center, 263 Farmington Avenue, Farmington, CT 06030-3955, USA. jtaylor@uchc.edu

PURPOSE: Researchers have suggested that cycling is a hazard to the sexual health of men. Insufficient data have left cyclists skeptical of this claim. We explore risk factors within cycling that may put riders at risk for the development of erectile dysfunction (ED). MATERIALS AND METHODS: We performed an Internet based survey of cyclists to examine factors associated with cycling that might contribute to ED as defined by the International Index of Erectile Function. A total of 688 cyclists were included in the analysis ranging in age from 18 to 77 years. RESULTS: ED prevalence was 17% (115 of 688). Although results from univariate analysis revealed a correlation between ED and several tested variables, none proved to be statistically significant after controlling for age. CONCLUSIONS: The overall prevalence of ED in the cycling community does not appear to be greater than that of historical controls. Previously suggested alterations in riding habits may not change the prevalence of ED among cyclists.

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Erectile dysfunction after a long-distance cycling event: associations with bicycle characteristics.

J Urol. 2004 Aug; 172(2): 637-41

[Dettori JR](#), [Koepsell TD](#), [Cummings P](#), [Corman JM](#).

Department of Epidemiology, School of Public Health and Community Medicine, University of Washington and Department of Urology, Virginia Mason Medical Center, Seattle, USA.
joedettori@olympicresearch.com

PURPOSE: We conducted a prospective cohort study to examine the relationship between bicycle characteristics and the occurrence of erectile dysfunction.
MATERIALS AND METHODS: Subjects consisted of 463 cyclists completing a cycling event of at least 320 km who were free of erectile dysfunction before their event.
RESULTS: The cumulative incidence of erectile dysfunction after the ride was 4.2% (95% confidence interval [CI] 2.4%-6.8%) and 1.8% (95% CI 0.7%-3.8%) 1 week and 1 month after the event, respectively. Bicycle characteristics associated with an increased risk of erectile dysfunction included a mountain bicycle compared with a road bicycle (risk ratio [RR] 4.1, 95% CI 1.6-12.5), and the relative height of the handlebars parallel with or higher than the saddle compared with the relative handlebar height lower than the saddle (RR 3.0, 95% CI 1.1-9.3). Perineal numbness during the ride was experienced by 31% of the cyclists and was associated with erectile dysfunction (RR 4.4, 95% CI 1.6-12.7). Saddle cutouts were associated with an increased risk of erectile dysfunction among those who experienced numbness (RR 6.0, 95% CI 1.3-27.1), but the association was reversed among those who did not report numbness (RR 0.3, 95% CI 0.0-2.5).
CONCLUSIONS: If the associations described are causal, then cyclists on a long-distance ride may be able to decrease the risk of erectile dysfunction by riding a road bicycle instead of a mountain bicycle, keeping handlebar height lower than saddle height and using a saddle without a cutout if perineal numbness is experienced.

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Int J Impot Res. 2002 Dec; 14(6): 513-7

Bicycle saddle shape affects penile blood flow.

[Jeong SJ](#), [Park K](#), [Moon JD](#), [Ryu SB](#).

Research Institute of Clinical Sciences, Chonnam National University Medical School, Gwangju, Republic of Korea.

The purpose of this study was to evaluate the effect of bicycle saddle shape on penile blood flow during cycling. Penile blood flow was measured using a laser Doppler flowmeter in 20 potent male volunteers. In a counterbalanced, crossover design, measurements were taken in the standing and sitting positions, on either a narrow unpadded or wide unpadded saddle, before and after cycling for 5 min. Before cycling, penile blood flow (ml/min/100 g tissue) was significantly decreased from 1.6+/-0.7 to 1.5+/-0.7 (P=0.010) on the wide saddle and from 1.7+/-0.6 to 1.0+/-0.5 (P<0.001) on the narrow saddle. After 5 min of cycling, the changes in penile blood flow on the wide and narrow saddles were 0.34+/-0.49 and -0.38+/-0.49,

respectively ($P < 0.001$). The narrow saddle is associated with more significant reductions in penile blood flow and could be a source of blunt perineal trauma, potentially leading to erectile dysfunction.

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J Androl. 2002 Nov-Dec; 23(6):927-34

Nocturnal penile tumescence and rigidity testing in bicycling patrol officers.

[Schrader SM](#), [Breitenstein MJ](#), [Clark JC](#), [Lowe BD](#), [Turner TW](#).

National Institute for Occupational Safety and Health, Cincinnati, Ohio 45226, USA.
sms4@cdc.gov

A health assessment study was conducted in response to complaints of groin numbness in a bicycling police unit. Seventeen male cyclists were compared with 5 nonbiking men. The cyclists rode an average of 5.4 hours per day, and 91% indicated they experienced groin numbness on occasion. Each man wore the RigiScan Plus Rigidity Assessment System for one normal sleep session. Pressure measurements were also taken between the cyclist and the bicycle saddle. The percentage of sleep sessions that recorded an erectile event was significantly lower in the cyclists than it was in noncyclists (cyclists 27.1%; noncyclists 42.8%; $P = .008$). This duration percentage is negatively correlated with average hours a day that cyclists rode their bikes ($r = -.41$; $P = .05$), the number of days a week they rode ($r = -.55$; $P = .009$), and the average pressure exerted on the nose of the bike saddle ($r = -.39$; $P = .08$). The other measures of erectile quality (tumescence activity units [TAUs] and rigidity activity units [RAUs] of both the base and tip of the penis) were lower in the cyclists, but did not reach statistical significance. The number of hours cyclists rode during the day of RigiScan Plus assessment was negatively correlated with penis tip RAU ($r = -.41$; $P = .04$), and tip TAU ($r = -.45$; $P = .04$). These data suggest that prolonged bicycle riding may have negative effects on nocturnal erectile function and indicate a need for innovative bicycle saddle designs.

PMID: 12399541 [PubMed - indexed for MEDLINE]

Eur Urol. 2002 Feb; 41(2):139-43

Cycling and penile oxygen pressure: the type of saddle matters.

[Schwarzer U](#), [Sommer F](#), [Klotz T](#), [Cremer C](#), [Engelmann U](#).

Department of Urology, University Medical Center of Cologne, Germany.

OBJECTIVES: Temporary genital numbness is a common side effect of long-distance cycling; cases of impotence have even been reported. Recent reports have shown that perineal compression leads to a decrease in penile blood flow. Reduced oxygen tension leads to penile fibrosis, which works counterproductively to the achievement

of an erection. The shape of the bicycle saddle could be a factor affecting penile perfusion. The aim of this study is to find out the influence of different saddle designs on penile perfusion. MATERIAL AND METHODS: In 20 healthy athletic young men (mean age 26.8 years, range 21-31 years) without history of erectile dysfunction, transcutaneous oxygen pressure (PtcO₂), which correlates with arterial and tissue PO₂, was measured at the glans of the penis using a transcutaneous measurement device. All men were measured in a standing position before cycling, then during cycling in a seated position on a stationary bicycle. Four different bike saddle designs were used: (A) narrow heavily padded seat; (B) narrow seat with medium padding and a V-shaped groove in the saddle nose ("body geometry"); (C) wide unpadded leather seat; (D) women's special wide seat with medium padding and no saddle nose. RESULTS: During cycling in all seats a decrease in penile oxygen pressure could be observed, reflecting perineal compression. But the differences were unexpected: seat (A) mean PtcO₂ 11.8 mmHg, decrease in initial oxygen pressure 82.4%; seat (B) mean PtcO₂ 20.8 mmHg, decrease in initial oxygen pressure 72.4%; seat (C) mean PtcO₂ 25.3 mmHg, decrease in initial oxygen pressure 63.6%; seat (D) mean PtcO₂ 62.3 mmHg, decrease in initial oxygen pressure 20.3%. CONCLUSIONS: Cycling in a seated position leads to a compression of perineal arteries with a consequent significant decrease in penile perfusion. But, there are unexpected differences between different saddle types. It was possible to demonstrate that the most important factor in safeguarding penile perfusion is not the amount of padding, but rather a saddle width which prevents sufficiently the compression of the perineal arteries.

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Int J Sports Med. 2001 Aug;22(6):410-3

Impotence and genital numbness in cyclists.

[Sommer F](#), [König D](#), [Graft C](#), [Schwarzer U](#), [Bertram C](#), [Klotz T](#), [Engelmann U](#).

Department of Urology, University Medical Center of Cologne, Germany. Frank.Sommer@uni-koeln.de

Cyclists often complain of genital numbness and even of impotence. The purpose of this study was to determine if perineal compression during cycling causes changes in the penile blood supply, impotence and penile numbness. Forty healthy athletic men with a mean age of 30 +/- 5.3 years took part in the study. Transcutaneous penile oxygen pressure was obtained using a device consisting of a modified Clark pO₂ electrode, attached to the glans of the penis. All men were measured in a standing position before, in a seated and standing position during and in a standing position after cycling. Additionally, a detailed interview was carried out with each man. The penile blood supply--which correlates with the transcutaneous PO₂ at the glans--decreased significantly in over 70% of the test subjects during cycling in a seated position. Cycling in a standing position did not show any alteration in the penile blood supply as compared to the values measured before exercising. Numbness of the genital region was reported by 61% of the cyclists. 19% of cyclists who had a weekly training distance of more than 400 km complained of erectile dysfunction. The results

of the present study showed that there is a deficiency in penile perfusion due to perineal arterial compression. This could be a reason for penile numbness and impotence in long-distance cyclists. Therefore, we suggest restricting the training distance, and taking sufficient pauses during the course of prolonged and vigorous bicycle riding, in order to avoid penile numbness and impotence.

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Transcutaneous penile oxygen pressure during bicycling.

[Nayal W](#), [Schwarzer U](#), [Klotz T](#), [Heidenreich A](#), [Engelmann U](#).

Department of Urology, Medical University Centre of Cologne, Cologne, Germany.

OBJECTIVE: To evaluate the blood supply to the penis during bicycling and thus determine whether the associated perineal compression might be responsible for some cases of impotence. **SUBJECTS AND METHODS:** The transcutaneous penile oxygen partial pressure (pO₂) at the glans of the penis was measured in 25 healthy athletic men; pO₂ is readily measured by noninvasive techniques currently widely used in the management of premature infants, and which have been shown to give pO₂ levels that correlate with arterial pO₂ levels. The measurements in the healthy subjects were taken in various positions, before, during and after bicycling.

RESULTS: The mean (sd) pO₂ of the glans when standing before cycling was 61.4 (7.2) mmHg; it decreased after 3 min of cycling to 19.4 (4.7) mmHg. After 1 min of cycling in a standing position it increased significantly to 68 (7.6) mmHg; when cycling was continued in a seated position, after 3 min the pO₂ fell to 18.4 (4.2) mmHg and there was a full return to normal pO₂ values after a 10-min recovery period. **CONCLUSION:** The pO₂ seems to correlate with the blood supply to the penis. The present results support the hypothesis that as the penile arteries are compressed against the pubic bone by the saddle during bicycling, the pO₂ values decrease. Additionally, shifting from a seated to a standing position while cycling significantly improved the pO₂ value of the penis and penile blood oxygenation was then even greater. Therefore, we suggest that cyclists change their body position frequently during cycling. Correcting the handlebars or the height of the saddle, tipping the nose of the saddle to produce a more horizontal, or even downward pointing position, and attention to the design of the saddle may be the only required precautions.

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: Acta Neurol Scand. 1997 Apr; 95(4):233-40

Impotence and nerve entrapment in long distance amateur cyclists.

[Andersen KV](#), [Bovim G](#).

Laboratory of Clinical Neurophysiology, Trondheim University Hospital, Norway.

OBJECTIVES: To assess the frequency and duration of symptoms suggesting peripheral nerve compression after long distance cycling. **MATERIAL AND METHODS:** A questionnaire based cross sectional study among 260 participants in a Norwegian annual bicycle touring race of 540 km. **RESULTS:** Thirty-five of 160 responding males (22%) reported symptoms from the innervation area of the pudendal or cavernous nerves. Thirty-three had penile numbness or hypaesthesia after the tour. In 10, the numbness lasted for more than one week. Impotence was reported by 21 (13%) of the males. It lasted for more than one week in 11, and for more than one month in three. Both genital numbness and impotence were correlated with weakness in the hands after the ride, a complaint reported by 32 (19%) of all 169 respondents. Forty-six cyclists (30%) indicated paraesthesia or numbness in the fingers, half of them from the ulnar nerve area only. **CONCLUSION:** The frequency of impotence, numbness of the penis, hand weakness and sensory symptoms from the fingers in bicycle sport may be higher than hitherto recognized. It afflicts both experienced cyclists and novices. In some, the complaints may last up to eight months. Besides changing the hand and body position on the bike, restricting the training intensity, and taking ample pauses may also be necessary in prolonged and vigorous bicycle riding to prevent damage to peripheral nerves.

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Clin Exp Neurol. 1991;28:191-6.

Bicycling induced pudendal nerve pressure neuropathy.

[Silbert PL](#), [Dunne JW](#), [Edis RH](#), [Stewart-Wynne EG](#).

Department of Neurology, Royal Perth Hospital.

Pudendal neuropathies are well recognised as part of more generalised peripheral neuropathies; however, focal abnormalities of the pudendal nerve due to cycling-related injuries have been infrequently reported. We describe two patients who developed pudendal neuropathies secondary to pressure effects on the perineum from racing-bicycle saddles. Both were male competitive athletes, one of whom developed recurrent numbness of the penis and scrotum after prolonged cycling; the other developed numbness of the penis, an altered sensation of ejaculation, with disturbance of micturition and reduced awareness of defecation. Both patients improved with alterations in saddle position and riding techniques. We conclude that pudendal nerve pressure neuropathy can result from prolonged cycling, particularly when using a poor riding technique.

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Postgrad Med. 1987 Jan; 81(1):99-100, 102

Impotence and bicycling. A seldom-reported connection.

[Solomon S](#), [Cappa KG](#).

A man riding a stationary bicycle experienced transient tight sensations around the head of his penis during the exercise and progressive impairment of sexual potency over a period of more than one year. Lowering the bicycle seat terminated the bouts of impaired penile sensation, and one month after the patient discontinued the bicycle exercises, sexual potency returned. The course supported an ischemic mechanism for the abnormal penile sensation and a neural mechanism for impotence. Impotence has been associated with both vascular and neural lesions, and there is evidence for both vascular and neural compression in the perineal area during bicycle riding. A relationship between sexual dysfunction and bicycling may be more common than formerly suspected.