Development of a New Geometric Bicycle Saddle for the Maintenance of Genital–Perineal Vascular Perfusion

G. Breda, MD,* N. Piazza, MD,† V. Bernardi, MD,‡ E. Lunardon, MD,* and Adara Caruso, MD*

*Department of Urology, S. Bassiano Hospital, Bassano of the Grappa (VI); †Department of Urology, SS. Giovanni and Paul Hospital, Venice; ‡Department of Anaesthesia, S. Bassiano Hospital, Bassano of the Grappa (VI), Italy

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ABSTRACT

Objective. To identify a bicycle saddle model for cyclists who cover long distances, to minimally reduce the compression on the structures of the pelvic floor, thereby protecting blood perfusion of the penis and avoiding possible consequences on penile erection.

Materials and Methods. A comparison between a new geometric development of a bicycle saddle model (SMP) and one of the more frequently used models by professional cyclists was made. The measurement of the partial pressure of penile transcutaneous oxygen ($PtcO_2$) in 29 healthy voluntary cyclists was recorded to investigate the differences of compression from two different saddles on the vascular structures of the perineum. The $PtcO_2$ was recorded at 3 and 10 minutes in conditions of static sitting. Then, the values of $PtcO_2$ were recorded for 15 minutes while the cyclists were in a 60-degree position and in stable hemodynamic conditions.

Results. A *t*-test was performed to measure the level of confidence. The clear superiority of the SMP saddle in preventing vascular compression of the perineal structures was demonstrated to be statistically significant.

Conclusion. The experiment validated the effectiveness of the SMP saddle in limiting the compression on the pelvic floor. In addition, the SMP saddle introduces compatible seat dimensions that cyclists prefer to cover long distances. **Breda G, Piazza N, Bernardi V, Lunardon E, and Caruso A. Development of a new geometric bicycle saddle for the maintenance of genital–perineal vascular perfusion. J Sex Med 2005;2:605–611.**

Key Words. Bicycle Saddle; Genital–Perineal Vascular Perfusion; Pelvic Floor

Introduction

The professional world of sports takes advantage of medical science contributions to obtain more efficient equipment for athletes. The ultimate objective of athletes is to perform at their best while maintaining minimal harmful side effects from strenuous physical activity. Studies show that cyclists who cover long distances have an increased incidence of erectile dysfunction compared with the normal population [1–4]. In particular, this incidence was found to be 13.1% vs. 3.9% in a Cologne University study [5]. There are two theories. Some authors suggest that the compression on the pudendal nerve results in an increase of erectile dysfunction [6,7]. According to other authors, erectile dysfunction results from penile blood hypoperfusion [4,6–8] and this would cause fibrosis of corpora cavernosa [9–11]. Despite the differences between the two theories, they agree that the compression on the perineal region is the most critical point. Therefore, our research has been directed toward the development of a saddle model for bicycles that could prevent excessive perineal compression. Schwarzer et al. (2002) [5] made an important contribution on this perspective. They have demonstrated that in order to protect the blood perfusion of the penis, the width of the seat is more important than the texture of the seat. The absence of the nose of the saddle prevents a hard compression on the blood vessels. A saddle with these characteristics is not well suited for professional cyclists, which our attention addresses to. The objective of our study has identified a product that contains the characteristics for preserving blood perfusion of the penis and at the same time has a compatible geometry that cyclists prefer. The SMP saddle possesses many of the

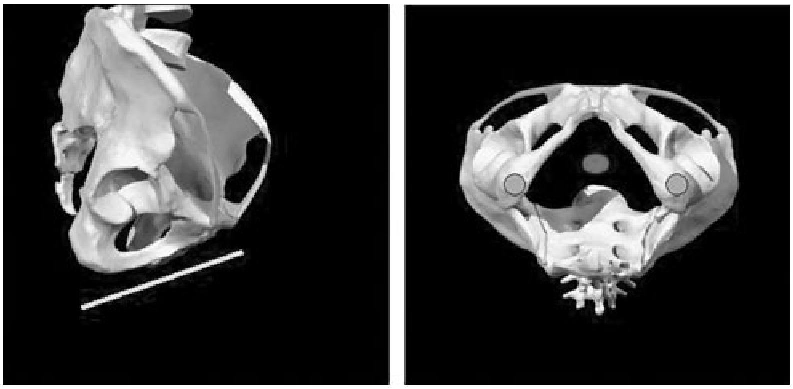

Figure 1 Anatomical areas of concern: △ ischiatic bone; △ ischiatic tuberosity; ▲ perineal area.

requirements that uniformly distribute the pressure on the gluteus, ischiatic tuberosity, and ischial muscles and maintain perineal area free from compression (Figures 1–3). The tip of the SMP saddle resembles the beak of an eagle, which relieves compression on external genitalia (Figure 4). The athletes appreciate the advantages of the SMP saddle. This model has a posterior width of 140 mm that converges to 45 mm in the front, where its structure inclines 60 degrees forward. The central width of the seat is 75 mm. The geometric shape of the saddle conforms to the shape of the thigh muscles. These characteristics prevent gracile muscle from rubbing with the adductor muscle that could annoyingly disturb the legs during cycling. Typically, professional cyclists pedal with their knees medially toward the chassis of the bicycle to increase their power. The effectiveness of this new ergometric conception has been tested by comparing the SMP saddle with one of the models more frequently used by professional cyclists, similar to the thin type, already tested by Schwarzer et al. [5]. In order to test our hypotheses, we chose to evaluate the modifications of blood perfusion of the penis caused by the compression on the perineal structures in the two saddle models. This was performed through the measurement of the partial pressure of oxygen in the penis through the transcutaneous way ($PtcO_2$) [8]. The methods proved to be noninvasive and effective [4–8]. It has been proven that the $PtcO_2$ reflects the changes of blood flow [12,13]. Its values correlate to the values of arterial pressure of oxygen (PaO_2) [14] and there is a close relationship between the levels of

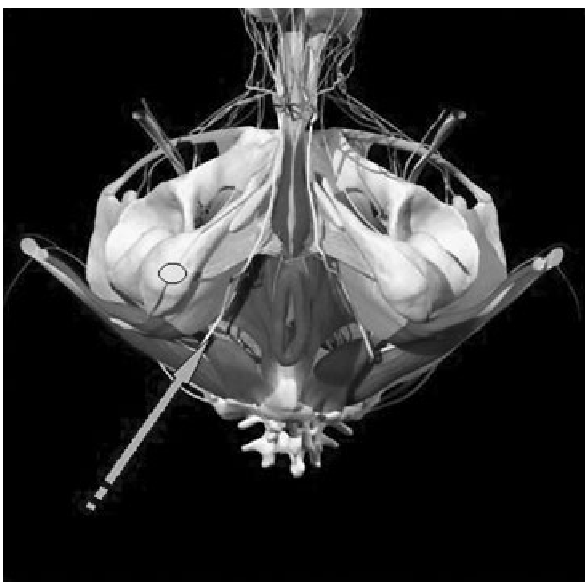

Figure 2 Anatomical areas of concern: △ ischiatic tuberosity; △ pudendal nerve and vessel.

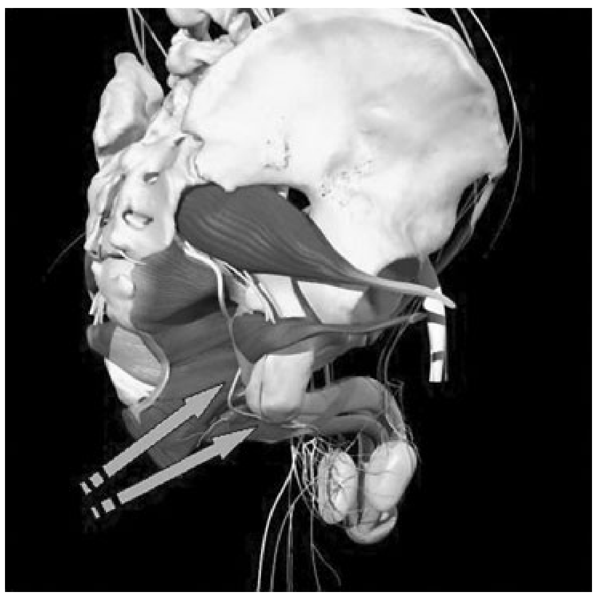

Figure 3 Anatomical areas of concern: △ pudendal nerve and vessel.

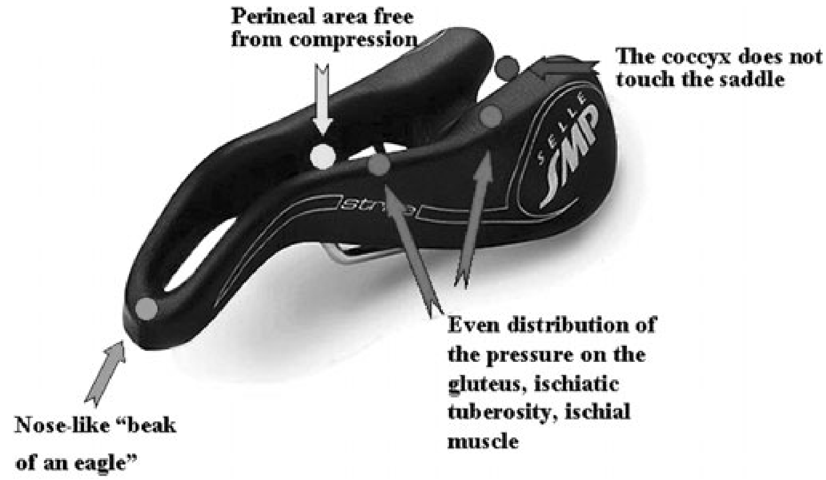

Figure 4 SMP saddle.

PaO_2 obtained from the blood in the cavernous bodies and the $PtcO_2$ of the glans penis [5].

Materials and Methods

Thirty-five healthy voluntary cyclists were recruited, but 29 were considered for our study. We obtained informed consent from all subjects and a score greater than 21 to a modified International Index of Erectile Function questionnaire was considered. The subjects' average age was 25.14 years (range 18–35 years); weight: 68.58 kg (range 58.8–80 kg); and height: 177.2 cm (range 162–188 cm). All the subjects were dependent on constant monitoring of cardiac frequency and saturation of oxygen, while the arterial pressure was recorded every 3 minutes (Diana MP400N, Mek, Korea). We used TCM 400 equipment (Radiometer Copenhagen, Denmark), with a Clark electrode that measures the $PtcO_2$. This apparatus contains a microcathode in platinum and an anode in silver dipped in an electrolytic solution isolated from a membrane permeable to oxygen. Oxygen crosses this membrane and is then reduced from the cathode, producing ions and freeing electrons that generate a recordable electrical current. The electrode was applied through an adhesive ring to the glans of the cyclists interposing a special electrolytic solution between membrane and glans. As a general principle, we have to remember that the $PtcO_2$ depends on the content in oxygen of the superficial capillaries of the penis and from the oxygen spread through the epidermis. The oxygen content of cutaneous capillaries depends on the local blood perfusion. In order to obtain the PaO_2 from the $PtcO_2$, the capillaries oxygen content has to be independent from the local blood flow. The increase in the local temperature is an essential factor that increases the cutaneous blood flow. The maximum flow is attended for a value of 45°C. The temperature is routinely qualified to 43–44°C to avoid burning risks; therefore, we set up our machine to 44°C. The experiment was performed in a room with fresh air.

We asked the athletes to use their own bicycle, in order to respect their personal anatomical characteristics. All of the athletes wore shorts without padding to show the direct compressive effect of the saddle. The subjects were randomly selected into two groups (A and B). Group A was evaluated, using saddle SMP, while group B was evaluated with the compared saddle (Figure 5). Subsequently, the experiment was repeated with the exchange of saddles that came alternatively mounted on the static bicycles, in respect to the typical measures in height of the examined subject. Every cyclist was evaluated singularly. After calibration of the instrument and application of the electrode on the glans, the measurement of the $PtcO_2$ was recorded with the subject in static and erect position for a time of 20 minutes, which is necessary for the stabilization of the values. The data were updated every 2 seconds. The cyclist was asked to sit on the saddle that was mounted on the bicycle, while maintaining a position of 60 degrees without pedaling. The relative $PtcO_2$ was recorded after 3 minutes to evaluate the acute impact with the saddle. Then, a continuous recording for 10 minutes was obtained with the subjects in a position at 60 degrees without pedaling. Finally, the athletes began to pedal with a constant pushing (a constant gear ratio of 53 : 19), until they reached their stabilized maximum training heart rate. With

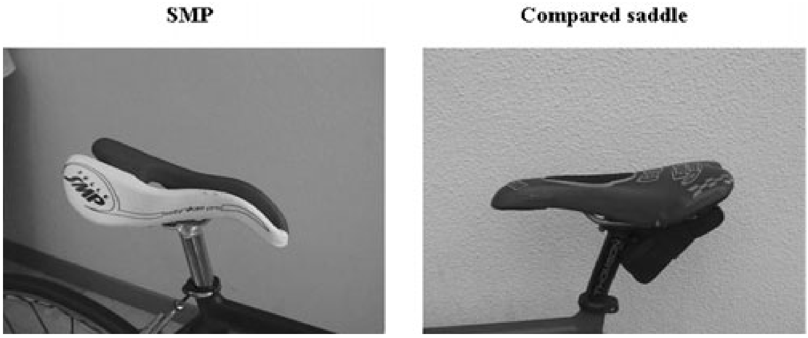

Figure 5 SMP saddle and the compared saddle (one of the more frequently used models by professional cyclists).

the athlete maintaining the 60-degree position, the $PtcO_2$ was measured for 15 minutes further. Every test required a total $PtcO_2$ recording time of 45 minutes (stabilization period included).

The study calculated the averages of the values of $PtcO_2$ of the penis, obtained from the two saddle models in our experiment, which were measured at 3 minutes, 10 minutes later at the stabilization of values, and 15 minutes thereafter. The statistics were carried out with the *t*-test. We examined the confidence interval (CI) associated to the measures.

Results

The analysis of the data obtained from the three series of measurements shows a statistically significant difference between the two saddle models, with a net advantage for the SMP saddle (Figure 6). In particular, after 3 minutes, the medium value of $PtcO_2$ with the SMP saddle (49.38 mm Hg) is approximately twice as much as the value with the compared saddle (25.34 mm Hg) (Figure 7). The *t*-test ($P = 0.00089$) and the *t*-value obtained (–3.5096) from the confidence interval (CI = –38.24690; –10.44966) marked statistically the superiority of the SMP saddle. The data suggest that the SMP saddle was also better than the other saddle, after 10 minutes of recording (compared saddle = 32.61 mm Hg; SMP saddle = 50.63 mm Hg), with a difference of 35% and a *P* value of 0.00674 and *t*-value of –2.8136 (CI = –30.851306; –5.190073) (Figure 8). The recordings after foot thrust of 15 minutes matched the results reported already: 52.17 mean value of mm Hg was measured from the SMP saddle and 28.50 mm Hg was measured for the compared saddle, with a *P* value of 0.00015 and *t*-value of –4.0598 (CI = –35.34455; –11.98786) (Figure 9).

Discussion

The real innovation of the SMP saddle is its ability not to affect the blood perfusion of the penis while maintaining desirable dimensions, mainly in width, which is the essential factor in the protection against compression on the perineal structures [5]. The geometry of the SMP saddle avoids crushing the neurovascular structures that pass medially to the ischiatic tuberosity, redistributes

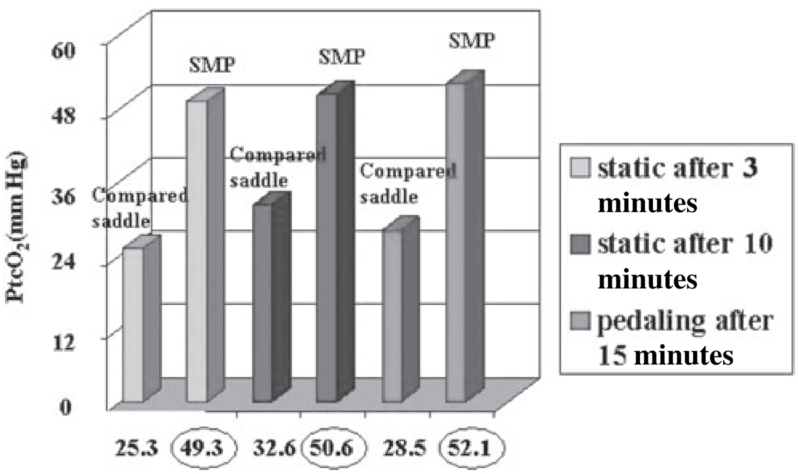

Figure 6 Global results of the comparison between the two saddles after 3, 10, and 15 minutes.

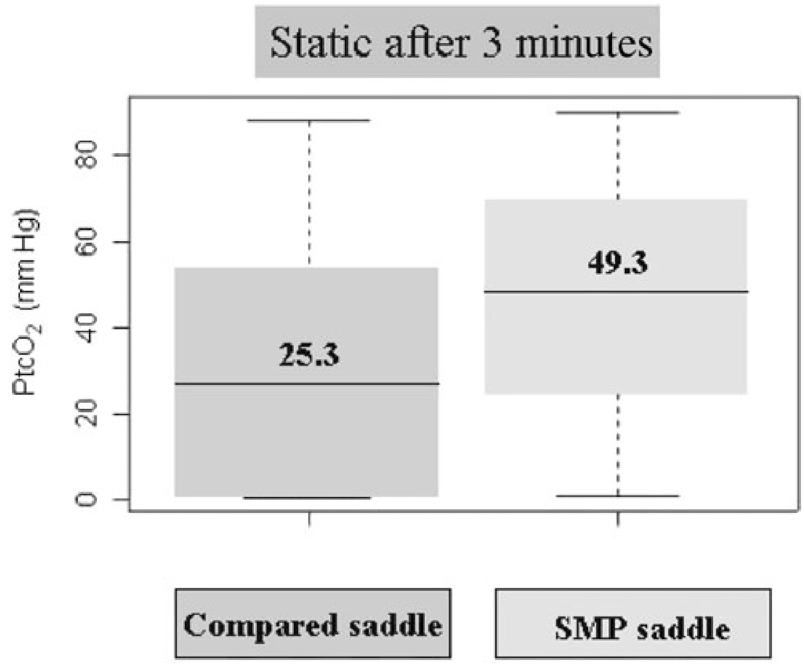

Figure 7 Comparison of the two saddles after 3 minutes in standby ($P = 0.00089$).

the body weight on the gluteus, ischiatic tuberosity, and ischial muscles, and allows the freedom of the perineal floor. Furthermore, because of the sinking quality of the posterior part of the saddle, the coccyx does not touch the saddle, which avoids repercussions caused from the roughness of the land that could apply stress to the rachid. In our study, the SMP saddle was found to be more efficient for the protection of the blood perfusion of the penis compared with one that is more frequently used by professional cyclists. It is interesting to note that the medium values of $PtcO_2$ with the SMP during foot thrust for 15 minutes are considerably better than the findings of Schwarzer et al. [5]. Their findings with their wide saddle model were 25.3 mm Hg at a 60-degree angle, while $PtcO_2$ with SMP saddle was the same, at 52.17 mm Hg at the same angle. Even a saddle

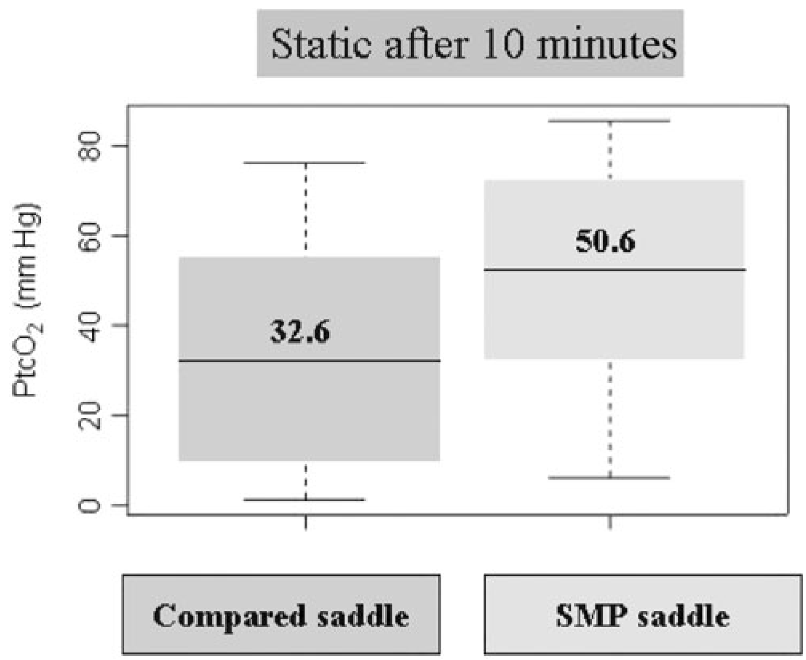

Figure 8 Comparison of the two saddles after 10 minutes in standby ($P = 0.0067$).

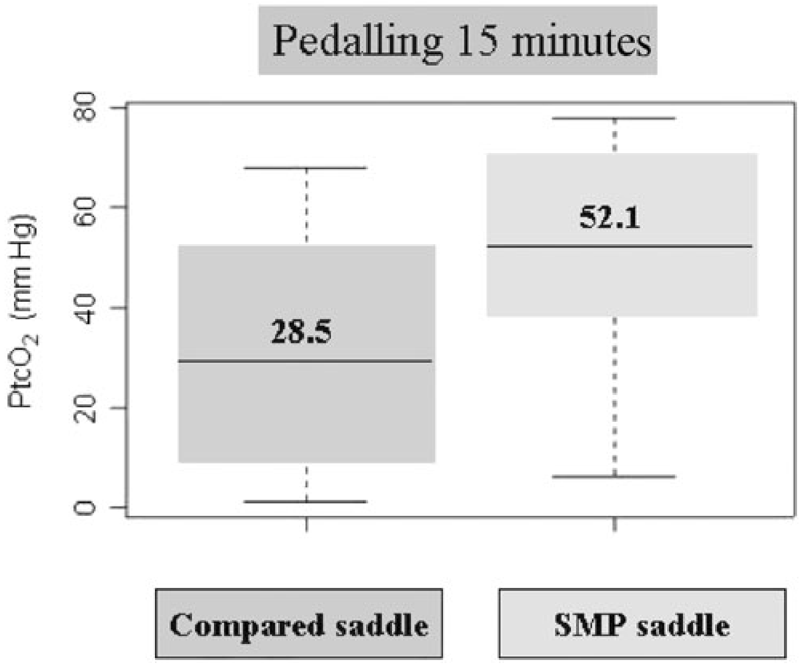

Figure 9 Comparison of the two saddles after 15 minutes pedaling ($P = 0.00015$).

having a gel padding, although revealing its efficiency in reducing the perineal compression, produced $PtcO_2$ average values of 42 mm Hg during pedaling with the cyclist at a 60-degree angle [15].

However, it has to be underlined that the methodology used in our study is, for various aspects, different from the one already published by Schwarzer and Sommer. Therefore, any direct comparison of the results may be unreliable.

Our main purpose was to compare a new sport saddle with the usual sport saddle used by the population under study.

Conclusion

The compression on the perineal floor causes a decrement of the vascular perfusion of the penis with possible consequences on penile erection. The geometry of a bicycle saddle is an important parameter to consider in the attempt to reduce compression on the neurovascular structures of the pelvic floor. In this regard, the SMP saddle represents a true innovation for cyclists who cover long distances every year.

Corresponding Author: N. Piazza, MD, Department of Urology, SS. Giovanni and Paul Hospital, Venice 30100, Italy. Tel: 0424-888416; Fax: 0424-888417; E-mail: monvi_disco@libero.it

Conflict of Interest: None.

References

1 Solomon S, Cappa KG. Impotence and bicycling. A seldom-reported connection. Postgrad Med 1987; 81:99–100,102.
2 Desai KM, Gingell JC. Hazard of long distance cycling. BMJ 1989;298:1072–3.
3 Schwarzer U, Wiegand W, Bin-Saleh A, Loetzerich H, Kahrmann G, Klotz T, Elgelmann U. Genital numbness and impotence rate in long distance cyclists. J Urol 1999;161(4 suppl):178.
4 Sommer F, Konig D, Graft C, Schwarzer U, Bertram C, Klotz T, Engelmann U. Impotence and genital numbness in cyclists. Int J Sports Med 2001;22:410–3.
5 Schwarzer U, Sommer F, Klotz T, Cremer C, Engelmann U. Cycling and penile pressure: The type of saddle matters. Eur Urol 2002;41:139–43.
6 Silbert PL, Dunne JW, Edis RH, Stewart-Wynne EG. Bicycling induced pudendal nerve pressure neuropathy. Clin Exp Neurol 1991;28:191–6.
7 Andersen KV, Bovim G. Impotence and nerve entrapment in long distance amateur cyclists. Acta Neurol Scand 1997;95:233–40.
8 Nayal W, Schwarzer U, Klotz T, Heidenreich A, Engelmann U. Transcutaneous penile oxygen pressure during bicycling. BJU Int 1999;83:623–5.
9 Kerstein MD, Gould SA, French-Sherry E, Pirma C. Perineal trauma and vasculogenic impotence. J Urol 1982;127:57.
10 Nehra A, Goldstein I, Pabby A, Nugent M, Huang YH, de las Morenas A, Krane RJ, Udelson D, Saenz de Tejada I, Moreland RB. Mechanism of venous

leakage: A prospective clinicopathological correlation of corporeal function and structure. J Urol 1996;156:1320–9.

11 Moreland RB. Is there a role of hypoxemia in penile fibrosis: A viewpoint presented to the Society for the Study of Impotence. Int J Impot Res 1998;10:113–20.

12 Moosa HH, Makaroun MS, Peitzmann AB, Steed DL, Webster MW. $TcPO_2$ values in limb ischemia: Effects of blood flow and arterial oxygen tension. J Surg Res 1986;40:482–7.

13 Eickhoff JH, Jacobsen E. Is transcutaneous oxygen tension independent of variations in blood flow and in arterial blood pressure? Biotelem Patient Monit 1982;9:175–84.

14 McDowell JW, Thiede WH. Usefulness of transcutaneous PO_2 monitor during exercise testing in adults. Chest 1980;78:853–5.

15 Sommer F. Type of saddle and sitting position influence penile oxygen pressure while cycling. Cologne March 2003. http://www.selleroyal.com/news/Study_Sommer_2003–03.pdf.