Male reproductive health effects of bicycle saddles: The contribution of ergonomics and design

B.D. Lowe[a], S.M. Schrader[a], M.J. Breitenstein[a]

[a]*National Institute for Occupational Safety and Health, Cincinnati, OH, USA*

Abstract

Bicycle saddle use has been implicated as a risk factor for male reproductive health disorders in numerous anecdotal reports and a growing number of scientific studies. The U.S. National Institute for Occupational Safety and Health (NIOSH) has been investigating this issue as an occupational health concern that originated from complaints of groin numbness and sexual function problems from members of a security bicycle patrol unit. To date, two studies addressing this issue have been conducted. The first study demonstrated an inverse relationship between the duration and magnitude of pressure on the perineum (groin) from the bicycle saddle and measures of male erectile function. The second study confirmed the hypothesis that bicycle saddle designs without a narrow protruding nose reduce the pressure in the perineum of the cyclist. A third study is being conducted to determine whether this reduction in perineal pressure will reduce symptoms of erectile dysfunction and whether no-nose saddles can be effectively incorporated in police and security patrol cycling . These studies highlight the contribution and importance of ergonomic design in reducing soft tissue trauma that may impair male sexual and reproductive function.

Keywords: product design, product comfort, physiology

1. Background

Our interdisciplinary group began investigating the effects of occupational bicycling on male reproductive/sexual function in 2000 when complaints of groin numbness were received from officers in a California bicycle patrol unit. NIOSH responded to a request for a Health Hazard Evaluation on this topic by conducting an initial study of this bicycle patrol unit. This study [1,2] and those that have followed combine expertise in the areas of reproductive health assessment and human factors/ergonomics.

As the mission of NIOSH is to promote the safety and health of U.S. workers our focus has been on police officers, security officers, and emergency medical personnel who use bicycles in their work, rather than on recreational and/or sport bicyclists. There are approximately 50,000 police, emergency response, and security officers who are members of bicycle patrol units in the United States. Many of these individuals also bicycle recreationally while off duty. Thus, male police and security patrol officers and emergency medical personnel who ride a bicycle as part of their occupation may be at particularly high risk for groin numbness or erectile dysfunction because of their high duration of exposure to perineal pressure from the bicycle saddle.

To date, we have conducted two studies on security, police, and emergency response cyclists. Both of these studies have included the measurement of pressure at the interface between the cyclist's perineum (groin) and the bicycle saddle. Our aims in these

studies have been (1) to confirm that a health hazard may exist among individuals who ride a bicycle as part of their occupation, and, (2) to identify an intervention(s) that will reduce or eliminate the problem. These aims are being pursued through collaboration between researchers in the reproductive health assessment and human factors/ergonomics areas. The purpose of this paper is to summarize the findings of these studies and to highlight the contribution of ergonomics in addressing this reproductive/sexual function health problem.

2. Summary of completed studies

2.1 Study 1

The first study conducted by NIOSH on this topic was published in the form of a Health Hazard Evaluation report [1] and a scientific paper published in the *Journal of Andrology* [2]. Using a device called the Rigiscan Plus Rigidity Assessment System (Timm Medical Technologies, Eden Prairie, MN), described by Schrader et al. [2], measures of nocturnal erectile quality (including the number of, duration of, and rigidity of erections during sleep) were obtained from 17 male police officers from a bicycle patrol unit and 5 non-bicycling men as a small control group.

Measures of contact pressure at the bicycle saddle/perineum interface for these officers were made with a thin profile pressure sensitive mat placed over the bicycle saddle. Each officer pedaled his personal bicycle while it was mounted in a stationary magnetic resistance cycling trainer. Pedaling resistance and cadence were self selected by the participant who was instructed to choose a "comfortable" gear ratio and cadence that was comparable to the conditions of his normal patrol "beat".

While none of the men evaluated were determined to be clinically impotent, 91% reported experiencing occasional numbness in the groin and genitals after long periods on the bicycle. Results from the Rigiscan assessments of nocturnal erectile quality among these officers indicated that the bicycle patrol officers had an erection for a lower percentage of sleep time than members of the control group ($p=0.01$). In addition, an inverse correlation was observed between cycling hours/day and duration percentage of sleep time with an erection ($r= -0.41$, $p<0.05$). The average pressure measured on the nose of the bicycle saddle was also negatively correlated with duration percentage, though statistical significance did not reach an $\alpha = 0.05$ level ($r=-0.43$; $p =0.08$). This study added to a growing body of literature to support the validity of complaints of groin numbness and sexual function problems in association with long periods of use of a bicycle saddle.

2.2 Study 2

Some urologists have speculated that bicycle saddles without a protruding nose will reduce pressure on the pudendal nerves and vasculature thereby decreasing the likelihood of cycling-related erectile dysfunction and impotence [3, 4]. Therefore, a second study was conducted in 2003 to examine the effect of saddle design on perineal pressure of the bicyclist [5]. The aim of this study was to examine the distribution of pressure on the perineum of the cyclist associated with bicycle saddles that do not incorporate a narrow protruding nose. Increasing awareness of a relationship between bicycle use and impaired sexual function has led to the appearance of many saddles that share the design concept of removing the narrow protruding saddle nose. We hypothesized that saddles designed without the narrow protruding nose would be associated with less pressure on the perineum of the cyclist than the traditional racing/sport saddle with a narrow protruding nose.

This study was conducted with cooperation from the International Police Mountain Bike Association (IPMBA) at their 2003 annual meeting. Saddle pressure was recorded from 32 participants assigned to one of four bicycle saddles ($n = 8$ participants per saddle) during controlled pedaling on a stationary bicycle ergometer (Tunturi Oy Ltd., Turku, Finland) modified with a seatpost to accept the saddles that were tested. Saddle height on this ergometer was adjustable and participants self-selected the saddle height based on personal preference. Hand position was also adjustable within a limited range. Pedalling cadence and resistance were held constant (70 rpm, 150 Watts). Using a custom-fabricated pressure sensing mat (Pliance, Novel Electronics, St. Paul, MN) contact pressure between the cyclist and saddle was characterized over each saddle as a whole and over a spatial region of each saddle corresponding to the cyclist's perineum. Saddle pressure was measured for approximately one minute of stationary cycling on the ergometer.

The pressure sensing mat was constructed with 234 sensors (a 16 x 16 matrix with tapered corners) of

1.875 cm x 1.875 cm dimensions. The perineal region was identified along the centerline of the segment running perpendicularly between the clearly identifiable pressure maxima under the ischial tuberosities (see Figure 1). Pressure in the region corresponding to the perineum of the cyclist was compared among four saddle designs. A traditional sport/racing saddle with a narrow protruding nose was compared to three saddles which did not have the traditional narrow protruding nose.

The traditional racing/sport saddle (Figure 2 saddle A) was associated with more than two times the pressure on the perineal region than saddles B,C, and D (see Figure 2) which did not have a protruding nose ($p < 0.01$). Pressure in the perineal region averaged 37.2 kPa for saddle A and 19.0, 19.4, and 16.4 kPa for the "no-nose" saddles (B,C, and D, respectively). There were no significant differences in perineal pressure among the no-nose saddles.

Bicycle saddle designs without a narrow protruding nose were associated with significantly less pressure distributed in the perineal region of the cyclist during controlled stationary cycling. Based on results of our first study, suggesting an inverse relationship between pressure on the saddle nose and the quality of nocturnal erections, we hypothesized that use of saddles designed without the narrow protruding nose will result in fewer symptoms of groin numbness and reduced risk of male erectile problems associated with occupational cycling.

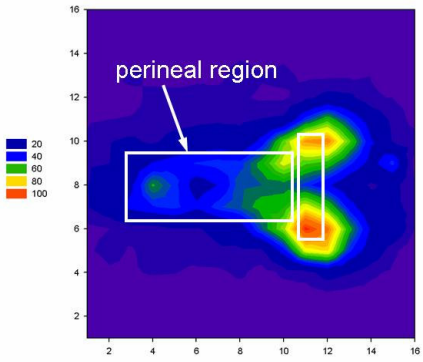

Fig. 1: Pressure contour map showing the identification of the perineal region for the purpose of perineal pressure calculation. The local pressure maxima under the ischial tuberosities were used as anatomical landmarks.

3. Study 3

Our group is conducting a third study to test this hypothesis. This study is a prospective interven-tion study to evaluate "no-nose" saddles when used by police and security patrol bicycle officers over a six-month study period. The aim of this study is to evaluate the effectiveness of saddles without protruding noses in preventing and/or alleviating symptoms of groin numbness and erectile dysfunction.

In spite of the abundance of no-nose saddles available commercially and well-publicized recommendations against traditional protruding-nosed racing/sport saddles these no-nose saddle designs have not been universally embraced by cyclists. Anecdotal feedback from police and security patrol cyclists has suggested some skepticism of bicycle saddles that do not incorporate a traditional narrow protruding nose [6]. Some cyclists believe that the absence of the saddle nose compromises stability, maneuverability, and handling of the bicycle. These are not issues that can be evaluated in a study based on pedaling a stationary cycling trainer for a few minutes. Thus, the third study is also including an evaluation of the usability and acceptance of no-nose saddles to determine whether bicycle handling and maneuverability are compromised by the absence of the saddle nose.

Bicycle patrol officers have been recruited in four major U.S. cities to participate in the six month prospective study. These men were measured at baseline for a number of factors including measures of nocturnal erectile quality, penile vibrotactile sensation threshold, and measures of perineal pressure at the cyclist-saddle interface. These officers then selected a no-nose saddle to use for a six month period, after which time the measurements are being repeated. From these four metropolitan police departments 105 participants have been recruited.

Preliminary data suggest that the no-nose saddles have been generally well accepted by police bicycle patrol officers. To date approximately 85% of the bicycle patrol officers participating in the study continued using their no-nose saddle through the six-month study period. A few cases of saddle failure and breakage have been observed within the first six months of use. These cases highlight the importance of durable design if no-nose saddles are to be used for police patrol cycling.

4. Discussion

Pressure to the groin of the bicyclist is a function of numerous variables that can not be comprehensively investigated in any single study. These variables are related to the anthropometrics and riding position of the cyclist, the physical characteristics of the saddle, and the type of cycling. Physical characteristics of the saddle that influence the distribution of pressure on the cyclist are the geometry/shape and the cushion compliance. The traditional saddle evaluated in this work (saddle A) was associated with an average pressure of 19.5 kPa over the full saddle and an average pressure over the perineal region of 37.2 kPa. Qualitatively, the traditional saddle (saddle A) was fairly hard with relatively little cushion compliance compared to many saddles used by bicycle patrol officers. However, saddle A was associated with an average full saddle pressure that was significantly higher than that of only one of the non-protruding nose saddles (saddle D). Thus, we conclude that the significantly higher pressure in the perineal region associated with saddle A is more likely influenced by the saddle geometry and shape than by its cushion properties.

The present findings in regard to the relationship between the protrusion of the saddle nose and perineal pressure are in agreement with recent studies of Schwarzer et al. [4] and Jeong et al [7]. The latter of these studies revealed an 82.4% reduction in transcutaneous penile oxygen pressure with a traditional racing saddle design and only a 20.3% reduction with a wide saddle without a protruding nose. Jeong et al [7] revealed a substantially greater decrease in penile blood flow associated with sitting on a saddle with a long narrow nose than with a wide saddle with a lesser protruding nose. These studies and the present study implicate the shape and protrusion of the bicycle saddle nose and the resulting distribution of pressure on the perineum in the compression of the vasculature supplying the penis.

It is important to emphasize that the generalizability of the findings of the studies reported to recreational and sport cyclists is unknown. The police and security patrol officers who have participated in our studies report spending an average of over five hours per work day riding a bicycle. Several reported spending over 50 hours per week on the bicycle when combining off duty cycling time with cycling time during work hours. Casual recreational cyclists and amateur competitive cyclists are likely to receive only a fraction of the exposure duration of an individual bicycling as part of their occupation. However, more studies are needed to investigate the dose-response relationship between perineal pressure from bicycle saddle use and sexual health effects.

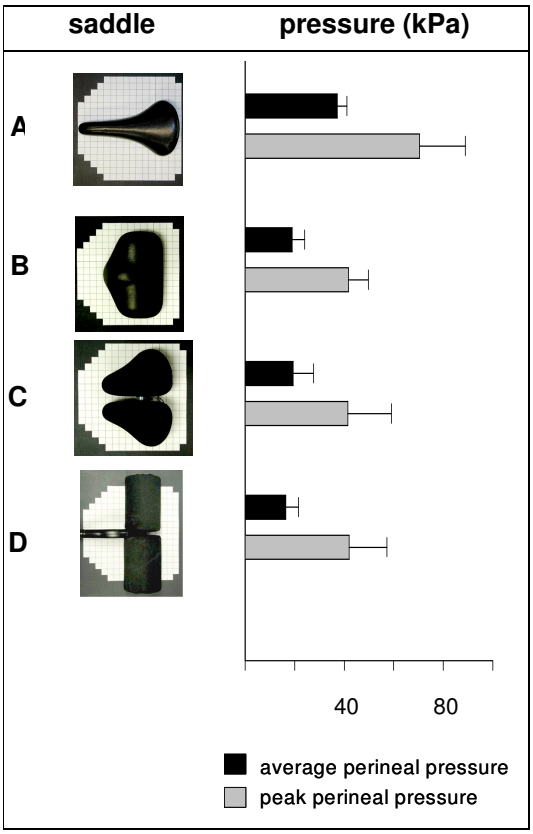

Fig. 2: Perineal pressure associated with four bicycle saddle designs. Saddle A represents a traditional racing/sport saddle with a narrow protruding "nose". Saddles B, C, and D are representative of designs without a narrow protruding nose. Each saddle is shown over a paper replica of the pressure sensing mat. Saddle D consists of two padded cylindrical surfaces T-mounted to a seat post which projects to the left in the figure.

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Note: The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.