Journal of Korean Medical Science
Vol. 8, No. 3, 202-206 June 1993

# Corporeal Blood Gas Changes According to Duration of Drug-Induced Prolonged Erection

Sae Chul Kim, M.D., Kyeng Keun Seo, M.D., and Chung Hwan Oh, M.D.

*Department of Urology, College of Medicine, Chung-Ang University, Seoul, Korea*

***The corporeal blood gas changes in accordance with the duration of the prolonged erection which developed after intracorporeal pharmacotherapy with papaverine and phentolamine were investigated in 62 impotence patients. The picture of the corporeal blood taken from 15 psychogenic impotence patients (a control group) at 10 minutes after intracavernous injection when they showed full erections was arterial but there was $pCO_2$ rise and pH drop compared to femoral artery blood taken simultaneously. As the erection lasted longer, significant gas changes of the cavernous blood began to appear ($p<0.0001$): increase in $pCO_2$ and decrease in $pO_2$ from 4 hours, decrease in pH from 5 hours, decrease in $O_2$ saturation from 6 hours. Erections lasting for more than 16 hours showed significantly worse hypoxia ($p<0.05$). Therefore, to prevent hypoxia and metabolic acidosis, drug-induced prolonged erection would be better decompressed before it lasts for more than 4 hours.***

**Key Words:** *Corporeal blood gas, Drug-induced prolonged erection*

## INTRODUCTION

The recent introduction of intracorporeal injections of papaverine and phentolamine for the diagnosis and treatment of impotence has resulted in an increased incidence of iatrogenic priapism. The prolonged erection after intracorporeal pharmacotherapy is related usually to the initial large doses.

Cavernous blood during flaccid state is the picutre of a venous pool (low $pO_2$, high $pCO_2$), whereas the picture during erection is that of arterial blood (high $pO_2$, low $pCO_2$). In experimental study the cavernous blood after 30 minutes of sustained full erection by stimulation of the cavernous nerve was arterial even in the most peripheral part of the corpora cavernosa (Lue et al., 1983). This denotes adequate metabolic exchange during erection. However, the blood stasis in prolonged erection causes hypoxia, ischemia and trabecular edema which accounts for the initiation of erectile tissue fibrosis. Therefore, early intervention to reverse prolonged erections is recommended. Most authors agree to intervene within 3 to 6 hours of prolonged erection (Padma-Nathan et al., 1986; Lue and Tanagho, 1987; Stief et al., 1988). Sidi and Chen (1987) defined sustained erections lasting for more than 8 hours. Brindley (1986) defined priapism as an erection lasting for more than 12 hours. Lue et al (1986) demonstrated that in experimental priapism induced by intracavernosal injection of papaverine, blood gas values began to show evidence of inadequate circulation, hypoxia and accumulation of metabolic acidic products after 6 hours. They suggested that intracorporeal blood measurements should be used to document the degree of ischemia in the drug-induced priapism. To date it is uncertain after which period of time severe tissue damage may occur in men. The present study was undertaken to investigate the blood gas changes in accordance with the duration of the prolonged erection which developed after intracavernous injection therapy in impotent patients.

**Address for correspondence:** *Sae Chul Kim Department of Urology, College of Medicine, Chung-Ang University Seoul, Korea*

## MATERIALS AND METHODS

From April 1990 to February 1992, we studied 62 impotent patients who had sustained erections lasting for 1 to 57 hours after intracorporeal pharmacotherapy with papaverine and phentolamine. All of the

prolonged erections developed during the early treatment period when we determined the proper dosage of the drugs. Etiology of the impotence was psychogenic or mild arteriogenic. It was diagnosed as psychogenic impotence when rapid erectile response within 5 minutes and maintenance with rigid erection over 10 minutes were shown at papaverine (30mg) test. The patients who had not fully rigid erection within 15 minutes after papaverine injection were asked to stimulate their penis manually by themselves without ejaculation for 10 minutes. In cases the patients showed a fully rigid erection which maintained for 10 minutes by the combined manual stimulation, they were regarded as psychogenic or clinically insignificant mild arteriogenic impotence. Their ages ranged from 22 to 54 years (mean age 39.2 years). The patients with the sustained erections were classified into 1, 2, 3, 4, 5, 6, 7-10, 11-15 and 16-57 hour group according to duration of the erection. The number of the patients according to duration of the prolonged erection is in Table 1. We studied 15 pure psychogenic impotence patients without prolonged erection as a control group. The age of the control group was from 27 to 46 years (mean age 35.4 years). Corporeal blood samples of 1 ml were taken by puncture of the corpus cavernosum from the patients with the sustained erections when decompression was undertaken and from the control group at 10 minutes after intracavernous injection when they showed full erections. Blood samples were also obtained from the antecubital vein and the femoral artery simultaneously when the corporeal blood was sampled. All the patients who had pharmacotherapy were told that they should return to us or to a local hospital where arrangements for decompression were available, if full erection lasted for more than 4 hours following injection. Blood sampling from the patients whose erection lasted for 1 to 3 hours was done for the purpose of this study.

All the blood samples were placed in blood gas capillary tubes for analysis soon after being taken. The blood gas analysis (pH, $pO_2$, $pCO_2$, $O_2$ saturation) was done using the 288 Blood Gas System (CIBA-Corning Co., USA). Statistical analysis was performed using ANOVA with multiple comparison procedure (Tukey's studentized range test).

## RESULTS

The pH, $pCO_2$, $pO_2$ and $O_2$ saturation of the cavernous blood in the control group were 7.11-7.47 (7.36±0.08), 35.90-48.90 mmHg (43.91±3.34 mmHg), 67.00-129.10 mmHg (94.61±14.27 mmHg) and 93.30-98.30 %(96.61±1.33%) respectively.

The pH of the cavernous blood of the prolonged erections of 5, 7-10, 11-15 and 16-57 hours was significantly lower than that of the control group ($F=7.10$, $p<0.0001$). But there was no significant difference in pH of the cavernous blood among the sustained erection groups regardless of their duration (Fig. 1).

The $pCO_2$ of the cavernous blood of the sustained erection became to be significantly higher than that of the control group ($F=7.01$, $p<0.0001$) from 4 hours. The $pCO_2$ of the cavernous blood of 16-57 hours erections was significantly higher than those of 1, 2 and 4 hours erection ($p<0.05$). Otherwise, there was no significant difference among the sustained erections regardless of their duration (Fig. 2).

The $pO_2$ of the cavernous blood of the sustained

**Table 1.** Number of Patients According to the Duration of the Prolonged Erection.

| Duration (hours) | No. Patients | Duration (hours) | No. Patients |
|---|---|---|---|
| 1 | 5 | 11-15 | 7 |
| 2 | 5 | 11 | 2 |
| 3 | 5 | 12 | 1 |
| 4 | 14 | 14 | 2 |
| 5 | 6 | 15 | 2 |
| 6 | 7 | 16-57 | 7 |
| 7-10 | 6 | 16 | 1 |
| 7 | 1 | 17 | 1 |
| 8 | 2 | 19 | 1 |
| 9 | 1 | 30 | 1 |
| 10 | 2 | 32 | 1 |
| | | 48 | 1 |
| | | 57 | 1 |
| Total | | | 62 |

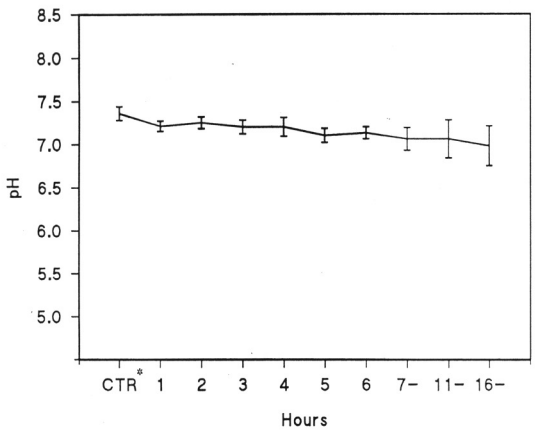


Fig. 1. Changes of pH of Cavernous Blood According to Duration of the Erection (*: Control)

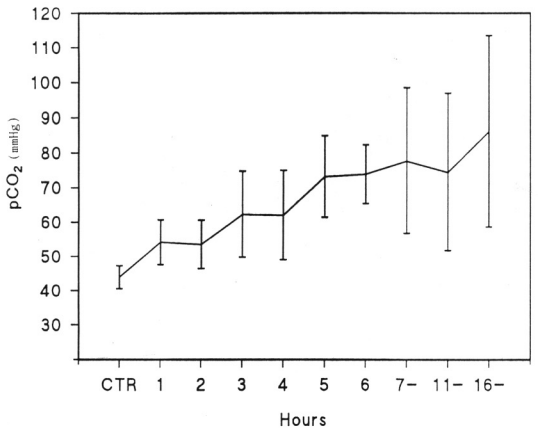


Fig. 2. Changes of $pCO_2$ of Cavernous Blood According to Duration of the Erection

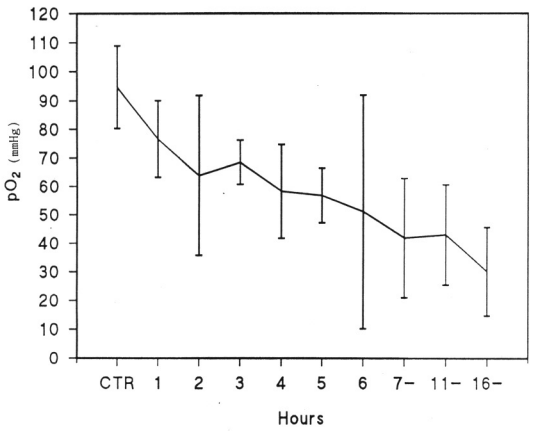


Fig. 3. Changes of $pO_2$ of Cavernous Blood According to Duration of the Erection.

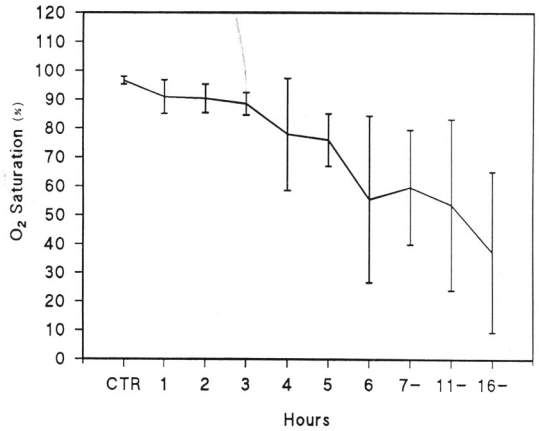


Fig. 4. Changes of $O_2$ Saturation of Cavernous Blood According to Duration of the Erection.

erection became significantly lower than that of the control group ($F=8.44$, $p<0.0001$) also from 4 hours. The $pO_2$ of 16-57 hours erection was significantly lower than those of 1 and 3 hours ($p<0.05$). Otherwise, there was no significant difference among the sustained erections regardless of their duration (Fig. 3).

The $O_2$ saturation of the cavernous blood became significantly lower from 6 hours than that of the control group ($F=8.97$, $p<0.0001$). The $O_2$ saturation of 11-15 hours erection was significantly lower than that of 2 hours ($p<0.05$). There was also a significant difference in $O_2$ saturation between 16-57 hours and 1 to 5 hours ($p<0.05$). Otherwise, there was no significant difference in $O_2$ saturation among the sustained erections regardless of their duration (Fig. 4).

In comparing the pH, $pCO_2$, $pO_2$ and $O_2$ saturation of the femoral artery blood, there was no significant difference between the control group (pH; $7.42\pm0.05$, $pCO_2$; $41.42\pm3.82$ mmHg, $pO_2$; $91.91\pm11.50$ mmHg, $O_2$ saturation: $91.15\pm0.78\%$) and the sustained erections groups regardless of their duration. There was also no significant change of blood gas in the antecubital vein between the control group (pH; $7.34\pm0.11$, $pCO_2$: $48.31\pm7.67$ mmHg, $pO_2$: $37.93\pm12.53$ mmHg, $O_2$ saturation; $64.08\pm18.64\%$) and the sustained erections groups regardless of their duration.

## DISCUSSION

Intracorporeal injection of vasoactive substance is a valuable diagnostic aid and an important tool for the treatment of erectile dysfunction. To date, three different vasoactive agents have been used on a long-term basis for intracavernous therapy; papaverine, the com-

bination of papaverine and phentolamine and prostaglandin $E_1$. The actual treatment is usually performed by the patients themselves having been trained in the intracorporeal auto-injection method. Therefore, the risk of complications during treatment is of significant importance both for the patient and the physician. The most commonly encountered side effects that have been reported are prolonged erections, hematomas or fibrosis of the corporeal tissue.

In the flaccid state, only a minimal amount of flow enters the corpora cavernosa for nutritional purpose. The pH, $pCO_2$, and $pO_2$ of blood from the corpora cavernosa are at levels maintained in venous blood. During the early phase of erection, the arterioles are dilated, the sinusoids are distended and there is an increase in the arterial blood flow into the cavernous space through the internal pudendal artery. Thus, the intracavernous blood gases reach the arterial blood gas values. In experimental study, blood samples taken from the cavernous space of sustained full erection for 30 minutes by electric stimulation of the cavernous nerve was the picture of arterial blood even in the most peripheral part of the corpora cavernosa. Druing erection, the subtunical venules are compressed by the distended sinusoids against the relatively indistensible tunica albuginea, thus effectively reducing the outflow. As the intracavernous pressure increases, the arterial flow starts to decrease. During rigid erection phase, there is almost no inflow of blood. Functionally, the corpora cavernosa becomes dead space. However, its short duration owing to skeletal muscle fatigue prevents ischemia and tissue damage. And in most cases of priapism, some degree of circulation and metabolic exchange still is maintained, so the channels do not become a dead space.

In a long term study on 615 patients, Virag et al (1991) reported prolonged erection following intracorporeal injection of papaverine/phentolamine, which was defined as an erection longer than 3 hours, in 9.75% of the patients. Our experiences of the prolonged erections lasting for more than 4 hours were mostly related to the initial large dose and those more than 7 hours were due to patients' disregard of our warning. It has been reported that pharmacologically induced priapism can be, for the most part, completely reversed if treated between 3 to 6 hours. Blood gas study in experimental priapism induced by intracorporeal injection of papaverine showed that blood gas values began to evidence hypoxia and accumulation of metabolic acidic products after 6 hours (Lue et al., 1986).

The degree of ischemia probably varies from person to person according to the numbers of emissary veins involved, the severity of the disease process and the duration of venous occlusion. If aspirated blood pH is less than 7.25, $pO_2$ less than 30 mmHg and $pCO_2$ is above 60 mmHg, ischemic priapism is highly probable (Gibel et al., 1985). In our study, the picture of cavernous blood gas druing erection at 10 minutes following intracavernous injection of papaverine (the control group) was arterial. Both effects-$pCO_2$ rise and pH drop of the cavernous blood in the control group, compared to those of the femoral artery blood-suggest that the venous outflow capacity of the penis is diminished as Juenemann et al (1986) have already mentioned. As the erection lasted longer, significant gas changes of the cavernous blood, hypoxia and acidosis, began to appear from erections lasting for 4 to 6 hours: $pCO_2$ and $pO_2$ from 4 hours, pH from 5 hours, $O_2$ saturation from 6 hours. Therefore, considering blood gas changes, it seems to be valid to decompress drug-induced prolonged erection before it lasts for more than 4 hours. Pharmacologic reversal of the drug-induced erection has been uniformly successful if the erection had not lasted for more than 14-16 hours (Sidi, 1988). Antidotes for prolonged erection, alpha-adrenergic agents, have been reported to lose their efficacy in low pH values (Padma-Nathan et al., 1987; Juenemann and Alken, 1989). In our study, there were no further more adverse effects from the prolonged erection on the blood gases up to 10 hours duration and 11-15 hours erection showed a significant difference in $O_2$ saturation compared to 2 hours erection only. However, erections lasting for more than 16 hours showed significantly worse hypoxia and higher $pCO_2$. This turning point for worse hypoxia and higher $pCO_2$ might explain why the pharmacologic reversal, when the erection does not last for more than 14-16 hours, is uniformly successful.

## REFERENCES

Brindley GS: *Maintenance treatment of erectile impotence by cavernosal unstriated muscle relaxant injection. Brit J Urol 149:210-215, 1986.*

Gibel LJ, Reiley E, Borden TA: *Intracorporeal cavernosa streptokinase as adjuvant therapy in the delayed treatment of idiopathic priapism. J Urol 133:1040-1041, 1985.*

Juenemann KP, Alken P: *Pharmacotherapy of erectile dysfunction: a review. Int J Impotence Res 1:71-93, 1989.*

Juenemann KP, Lue TF, Abozeid M, Hellstrom WJG, Tanagho EA: *Blood gas analysis in drug-induced penile erection. Urol Int 41:207-211, 1986.*

Lue TF, Hellstrom WJG, McAninch JW, Tanagho EA: *Priapism: a refined approach to diagnosis and treatment. J Urol 136:104-108, 1986.*

Lue TF, Tanagho EA: *Physiology of erection and pharmacological management of impotence. J Urol 137:829-836, 1987.*

Lue TF, Zeineh SJ, Schmidt RA, Tanagho EA: *Physiology of penile erection. World J Urol 1:194-196, 1983.*

Padma-Nathan H, Goldstein I, Krane RJ: *Treatment of prolonged or priapistic erections following intracavernosal papaverine therapy. Semin Urol 4: 236-238, 1986.*

Padma-Nathan H, Goldstein I, Payton T, Krane RJ: *Intracavernosal pharmacotherapy: the pharmacologic erection programme. World Urol 5: 160-165, 1987.*

Sidi AA: *Vasoactive intracavernous pharmacotherapy. Urol Clin North Am 15:95-101, 1988.*

Sidi AA, Chen KK: *Clinical experience with vasoactive intracavernous pharmacotherapy for the treatment of impotence. World J Urol 5:156-159, 1987.*

Stief C, Baehren W, Gall H, Schewb W: *Functional evaluation of penile hemodynamics. J Urol 139:734-737, 1988.*

Virag R, Shoukry K, Floresco J, Mollet F, Cresco E: *Intracavernous self-injection of vasoactive drugs in the treatment of impotence: 8-year experience with 615 cases. J Urol 145:287-293, 1991.*