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Investigating of Occlusion Methods and their Impact on the Prostate Health and Blood Biochemical Parameters in Adult Male Rabbits

Reza Negahdari[1], Sara Varzandian[1*], Aboozar Dehghan[1], Amir Ashkan Mahjour[1]

[1]Department of Clinical Sciences, School of Veterinary Medicine, Kazerun Branch, Islamic Azad University, Kazerun, Iran.
*Corresponding author

Abstract

The prostate is a critical organ in the male reproductive system, essential for seminal fluid and sperm production. This study investigates the effects of blood flow occlusion on prostate size, prostate-specific antigen (PSA) levels, and biochemical parameters in adult male rabbits. Twenty rabbits were randomly assigned to four groups: prostate occlusion, proprostate occlusion, paraprostate occlusion, and a control group. Prostate gland sampling was performed on days 30 and 60 post-surgery, and data were analyzed using SPSS software.

Results demonstrated a significant increase in PSA levels in all occlusion groups, with the highest levels in the prostate occlusion group, suggesting stimulation and functional changes within the gland. Pre- and postoperative measurements showed a marked increase in prostate size among occlusion groups, likely due to inflammation and histopathological changes caused by reduced blood flow. Biochemical analyses revealed elevated liver enzyme levels (ALT and AST), particularly in the prostate occlusion group, indicating liver damage and systemic inflammation. Complete blood count (CBC) analysis showed increased white blood cell (WBC) counts in the occlusion groups, reflecting an immune response and potential systemic inflammation.

These findings reveal that blood flow occlusion significantly affects prostate health, liver function, and systemic physiology. The observed changes in PSA and liver enzyme levels resemble alterations seen in prostate cancer or benign prostatic hyperplasia (BPH) patients, underscoring the potential of occlusion as a therapeutic approach and the need for further clinical studies.

Keywords: Prostate; occlusion method; blood parameters; biochemical parameters

Introduction

The prostate gland is an organ part of the male reproductive system, located just below the bladder and surrounding the urethra. This walnut-sized gland is crucial in producing seminal fluid, which nourishes and transports sperm during ejaculation (1). Due to their close anatomical and physiological similarities, rabbits are extensively used as animal models in prostate disease research (2). Anatomically divided anterior and posterior sections in rabbits contribute to fertility by secreting necessary fluids (3).

Several diseases of the prostate include benign prostatic hyperplasia (BPH) and prostate cancer, which are commonly found in middle-aged and older men. BPH is a non-cancerous enlargement of the prostate that can obstruct the urinary tract. Prostate cancer is one of the most common malignancies in men and poses significant health problems at its advanced stages (4). Prostate-specific antigen level serves as an imperative biomarker for such disease diagnosis; elevated levels of PSA may indicate prostate-related disorders, thus demanding further evaluation of prostate size and hematological parameters (5). Occlusion treatment, used to manage prostate disorders, significantly altered both prostate size and PSA levels. This process tries to shrink the size of the prostate in BPH patients using the most current techniques possible (6). Evidence has shown that occlusion can cause a significant reduction in the size of the prostate, hence alleviating symptoms of urinary obstruction and thereby enhancing the quality of life for the patient (7). PSA levels typically decline following occlusion; however,

this should be cautiously interpreted since many other causes, including age, urinary tract infection, and exercise, could also increase PSA levels (8).

A seminal study by Lilja et al. (1988) was the first to establish the relationship between PSA levels and the advancement of prostatic diseases, thus affirming PSA as a beneficial diagnostic biomarker. In this study, seminal plasma proteins from patients were analyzed in cases of azoospermia. The large proteins secreted by the prostate gland, identified herein, were prostatic acid phosphatase, PSA, and β-microseminoprotein (β-MSP). The results illustrate the importance of these proteins in diagnosing disorders relating to fertility and prostate malignancy (9). Balk et al. (2003) further discussed the association of increased prostate size with disease indicators, commenting that PSA is an androgen-regulated serine protease secreted by prostate epithelial cells. This enzyme has been considered necessary not only in cancer diagnosis but also in prostate function. Increased serum levels of PSA are commonly seen in cases of prostate cancer; however, most organ-confined cancers have lower total PSA levels, which often overlap with those of normal individuals (10).

Recent studies on kallikrein 15 (KLK15) have shown its potential as a diagnostic biomarker for prostate cancer, as it is upregulated in more aggressive disease states. Moreover, studies on the impact of occlusion on the prostate support its potential as a minimally invasive treatment approach (11, 12). For instance, Fan et al. (2010) significantly improved clinical symptoms after occlusion in animal models (13).

Despite its benefits, some research has indicated that occlusion could have negative consequences, including reduced blood flow to nearby organs (14). This study aims to systemically investigate the effect of occlusion on prostate size and PSA level using a rabbit model. With the sharp increase in men suffering from prostate-related diseases after the age of 50 years, new therapeutic strategies are urgently needed that decrease invasiveness but increase efficacy. In a nutshell, while traditional surgical treatments often carry complications like long-term recovery and huge costs, occlusion comes in as potentially a much better alternative that impacts the blood supply to the prostate. The results of this research may provide the scientific grounds for clinical trials in humans.

Materials and Methods

Animal Subjects and Environmental Conditions

This study included 20 adult male rabbits of an appropriate breed, housed under controlled environmental conditions. The temperature was maintained between 20 °C and 22 °C, with a 12-hour light/dark cycle. All animals were provided with adequate food and water to ensure their well-being.

Experimental Design and Grouping

The rabbits were randomly divided into four groups, with five rabbits in each group:

1. Prostate Occlusion Group: Ligation of the main prostate vessels.

2. Proprostate Occlusion Group: Ligation of the proprostate.

3. Paraprostate Occlusion Group: Ligation of the paraprostate.

4. Control Group: No surgical intervention.

Data Collection Procedures

Prostate Size and Dimensions: All rabbits underwent ultrasonography before surgery, with follow-up imaging performed on days 30 and 60 post-surgery.

Prostate-Specific Antigen (PSA): PSA levels were measured before and after surgery to assess glandular activity and evaluate the effects of occlusion on prostate function.

Blood Sampling and Analysis: At the end of the study, blood samples were collected to evaluate biochemical parameters and complete blood counts (CBC).

Statistical Analysis

Data were analyzed using SPSS software. Group differences were evaluated using independent t-tests and one-way analysis of variance (ANOVA). Results are presented as mean ± standard deviation, and a significance level of $p < 0.05$ was considered.

Results

1. **Biochemical results**

Table 1: Biochemical results in Group 1

BLOOD BIOCHEMISTRY			
TEST	RESULT	UNIT	REFRENCE RANGE (RABBIT)
FBS	4.25	MMOL/L	1.2-30
BUN	8.9	MMOL/L	6.5-17
Creatinine	0.135	MMOL/L	0.01-0.15
Cholesterol	876	Mg/dl	1251-310
ALT	8.72	U/L	6-19
AST	7.5	U/L	4.8-10
ALP	20.7	U/L	12.5-27

Table2: Biochemical results in Group 2

BLOOD BIOCHEMISTRY			
TEST	RESULT	UNIT	REFRENCE RANGE (RABBIT)
FBS	9.33	MMOL/L	1.2-30
BUN	10.5	MMOL/L	6.5-17
Creatinine	0.18	MMOL/L	0.01-0.15
Cholesterol	930.1	Mg/dl	310 - 1251
ALT	17.1	U/L	6-19
AST	8.6	U/L	4.8-10
ALP	23.14	U/L	12.5 - 27

Table 3: Biochemical results in Group 3

BLOOD BIOCHEMISTRY			
TEST	RESULT	UNIT	REFRENCE RANGE (RABBIT)
FBS	4.25	MMOL/L	1.2-30
BUN	8.9	MMOL/L	6.5-17
Creatinine	0.135	MMOL/L	0.01-0.15
Cholesterol	876	Mg/dl	1251-310
ALT	8.72	U/L	6-19
AST	7.5	U/L	4.8-10
ALP	20.7	U/L	12.5-27

Based on Tables 1, 2, and 3, the FBS level in group 2 is higher than in other groups, which could be related to metabolic disorders. BUN and Creatinine are within the normal range in all groups except group 2, which has a higher BUN. Significant changes in liver enzyme levels (ALT and AST) were also observed, especially in group 2, which has a higher ALT level.

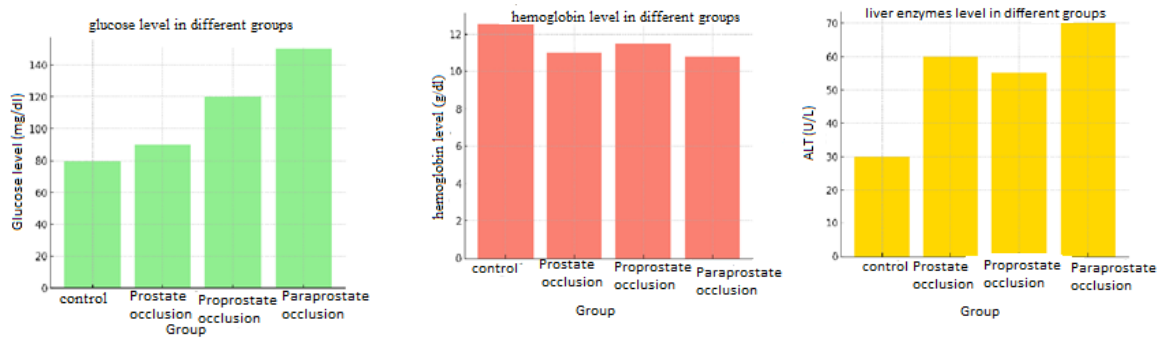

Figure 1: The graph of comparing some biochemichal parameters

Figure (1) shows that occlusion methods significantly affect the prostate. Changes in liver enzymes and glucose levels in the occlusion-treated groups indicate therapeutic effects that can be related to clinical treatment decisions in humans. These changes can indicate the side effects caused by occlusion.

2. **Complete Blood Count (CBC) Results:**

Table 4: Comparison of CBC results in groups

Group / TEST	Group 1	Group 2	Group 3	NORMAL RANGE (Rabbit)
WBC ($\times 10^3/\mu L$)	12.1	7.85	8.3	7.1 – 15.4
RBC ($\times 10^6/\mu L$)	5.95	5.3	5.83	3.22 – 7.2
Hb (g/dL)	12.33	9.7	11.9	7.57 – 16.81
Hct (%)	37	35	36	30-51
MCV (Fl)	31.9	29.65	31.2	25.5 – 36.2
MCH (Pg)	11.6	10.8	11.3	7.5 – 16.8
MCHC (g/dl or %)	30.4	29.9	30.2	28-36
Platelet ($\times 10^3/\mu L$)	450	260	420	300-700
Neutrophils (%)	32	34	32	25-36
Band Neutrophils (%)	1	2	1	0-2
Lymphocyte (%)	65	60	65	53-73
Monocyte (%)	1	2	1	0-4
Eosinophils (%)	1	1	1	0-3
Basophils (%)	0	1	0	0-1

According to Table (4), the WBC counts for all groups fell within the acceptable range of 7.1 – 15.4 $\times 10^3/\mu L$, suggesting a consistent immune response across the groups. RBC counts in all groups were also within the normal range of 3.22 – 7.2 $\times 10^6/\mu L$, although Group 2's RBC count was positioned at the lower end. There were variations in hemoglobin levels among the groups, which might imply mild anemia in Group 2. All groups showed Hct values within the normal range of 30 – 51%, indicating a suitable red blood cell mass in relation to plasma volume. Group 2's platelet count was significantly low at 260 $\times 10^3/\mu L$, contrasted with the normal range of 300 – 700 $\times 10^3/\mu L$, pointing to a possible case of thrombocytopenia. The CBC outcomes reflect generally healthy hematological profiles for the rabbit subjects across all groups, though Group 2 requires particular attention due to its reduced hemoglobin and platelet counts.

Table 5: Comparison of PSA level and prostate size before and after surgery in different groups

Group	Preoperative PSA	Postoperative PSA	Preoperative prostate size	Postoperative prostate size
Control	2.1	2.5	0.5	0.6
Prostate occlusion	8.1	4.5	0.6	1.0
Proprostate occlusion	1.2	0.3	5.6	0.7
Paraprostate occlusion	5.1	6.0	2.6	3.0

Table 6: Comparison of changes in prostate size

Group	Mean postoperative PSA	Changes in prostate size
Control	2.5	0.1
Prostate Occlusion	4.5	1.0
Proprostate Occlusion	0.3	-4.9
Paraprostate Occlusion	6.0	0.4

The results show that (Table 6), The Control Group demonstrated a slight rise in average postoperative PSA and prostate size, reflecting minimal change. In the Prostate Occlusion Group, there was a marked reduction in postoperative PSA levels along with a slight increase in prostate size. The Prostate Occlusion Group experienced a significant drop in mean postoperative PSA and a considerable decrease in prostate size, indicating a successful intervention. The Paraprostate Occlusion Group saw an increase in mean postoperative PSA and a slight uptick in prostate size, suggesting possible complications or ineffective treatment.

Discussion

The results of this study indicated a significant increase in prostate-specific antigen (PSA) levels in the occlusion-treated groups, particularly in the prostate occlusion group, which exhibited the highest PSA levels. This elevation suggests stimulation of the prostate gland and alterations in its function. These findings align with those of Lilja et al. (1988), who demonstrated that PSA levels increase with the progression of prostate cancer, suggesting that similar physiological changes occur in both animal and human models (9). This correlation allows for meaningful comparisons and supports the use of rabbit models to investigate new treatments for prostate conditions.

Preoperative and postoperative measurements of prostate size showed a significant increase in size within the occlusion groups. This enlargement may be attributed to tissue inflammation and histopathological changes resulting from reduced blood circulation. Previous studies, such as those conducted by Balk et al. (2003), have proposed that changes in prostate size serve as important markers for evaluating prostate diseases, reinforcing the relevance of our findings in both animal models and clinical settings (10).

Biochemical analyses revealed elevated levels of liver enzymes (ALT and AST) in the occlusion groups, particularly pronounced in the prostate occlusion group. These increases indicate liver damage and inflammation, corroborating research by Yousef and Diamandis (2001), which explored the relationship between increased liver enzymes and inflammatory conditions. The systemic effects observed suggest that occlusion procedures may have broader implications for the overall health of rabbits, highlighting potential risks associated with these interventions (15).

Hematological evaluations showed notable changes in white and red blood cell counts, with a significant increase in white blood cell (WBC) counts evident in the occlusion-treated groups. This elevation indicates an immune response, potentially reflecting systemic inflammation. Similar findings were reported by Fan et al. (2018), who investigated immune responses in animal models, supporting the notion that these changes can be critical indicators of immune health and responses to future treatments (13).

The present study's results can be applied to clinical settings related to human prostate health. The observed increases in PSA levels and alterations in liver enzyme activity align with findings reported in patients with prostate cancer or benign prostatic hyperplasia (BPH). Elevated PSA levels are often suggestive of underlying prostatic conditions; however, they can also be influenced by factors such as inflammation or obstruction (16). These insights can serve as a foundation for designing clinical trials aimed at evaluating new treatments for prostate diseases.

In summary, this study highlights the importance of monitoring PSA levels, prostate size, liver function tests, and immune responses when assessing treatment outcomes for prostate lesions. The findings emphasize that while certain interventions may effectively reduce PSA levels and manage prostate lesions, they may also lead to systemic effects that require careful consideration.

Conclusion

The results of the present study, compared with previous studies, indicate that occlusion methods significantly affect prostate health and other body systems. The consistency of these results with previous results confirms that the rabbit animal model can be used as an appropriate model to evaluate and study the effects of new therapeutic methods on human prostate diseases. The results revealed significant changes in the PSA level and prostate size of rabbits. These results can be a good basis for starting clinical studies in humans. Clinical studies can help to investigate the effectiveness and safety of this method in patients with prostate diseases such as benign prostatic hyperplasia (BPH) and prostate cancer. These studies should assess the safety, tolerability, and effectiveness of the occlusion method.

Evaluating therapeutic methods to investigate their long-term impacts on the patient's health is one of the key points. In this case, further studies are needed to investigate the long-term impacts of occlusion on the prostate and other organs (such as the kidney and liver) in animals and humans. These studies could include periodic assessments of changes in blood parameters, kidney, and liver function, and histopathological assessments. Determining the appropriate dose and optimal conditions for occlusion is a fundamental issue that should be examined. In this study, rabbits were treated using specific methods. However, different doses and different treatment conditions should be investigated, including assessment of the level of occlusion, treatment timing, and individual differences to determine the most accurate and effective protocol.

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