Abstract

The prostate gland is subject to various disorders. The etiology and pathogenesis of these diseases are not well understood. Moreover, despite technological advancements, the differential diagnostics of prostate disorders has become progressively more complex and controversial. It was suggested that the measurement of main electrolytes levels in expressed prostatic fluid (EPF) may be useful as a biomarker. This suggestion promoted more detailed studies of the Ca, Cl, K, Mg, and Na concentrations in EPF of healthy subjects. The present systematic analysis included 1885 studies, all of which were published in the years from 1942 to 2019 and selected by searching the databases Scopus, PubMed, Medline, Elsevier-Embase, Cochrane Library, and the Web of Science. The articles were analyzed and “Median of Means” and “Range of Means” were used to examine heterogeneity of Ca, Cl, K, Mg, and Na concentrations in EPF of apparently healthy men. The objective analysis was performed on data from the 6 studies, with more than 62 subjects. It was found that the median of means for Ca, Cl, K, Mg, and Na concentrations in prostatic fluid of apparently healthy men were 1201, 1350, 1880, 486, and 3517 mg/L, respectively. Because of small sample size and high data heterogeneity, we recommend other primary studies.

Keywords: prostate, prostatic fluid, biomarkers, main electrolytes, calcium, chlorine, potassium, magnesium, sodium

Introduction

The prostate gland is subject to various disorders and of them chronic prostatitis, benign prostatic hyperplasia, and prostate cancer are the extremely common diseases of ageing men. The etiology and pathogenesis of these diseases are not well understood. Moreover, despite technological advancements, the differential diagnostics of prostate disorders has become progressively more complex and controversial. This is particularly concerned with prostate cancer where the limitations and potential harms associated with the use of prostate-specific antigen (PSA) as a diagnostic marker. The situation is until now unknown.

Several studies have reported the MEs content in EPF of normal and affected gland. However, further investigation has been considered necessary to provide clearer hypothesis about the role of MEs in etiology and pathogenesis of prostate disorders, because the findings of various studies indicate some discrepancies. The present study addresses the significance of prostatic fluid Ca, Cl, K, Mg, and Na levels as biomarker. Therefore, we systematically reviewed the available literature and performed a statistical analysis of Ca, Cl, K, Mg, and Na concentration in EPF of normal gland, which may shed valuable insight into the etiology and diagnosis of prostate disorders.

Abbreviations: PSA, prostate-specific antigen; Ca, calcium; Cl, chlorine; K, potassium; Mg, magnesium; Na, sodium; ME, main electrolyte; TE, trace element; EPF, expressed prostatic fluid; Chem, traditional chemical analytical method; FES, flame emission spectrophotometry; AAS, atomic absorption spectrophotometry; EDXRFl, energy dispersive X-ray fluorescent microanalysis

One of the main functions of the prostate gland is the production of prostatic fluid. It contains a high concentration of Ca, Mg, Rb, Zn and some other TEs, in comparison with levels in blood serum and other human body fluids. The first finding of remarkably high levels of Zn in human expressed prostatic fluid (EPF) was reported in the early 1960s. After analyzing EPF expressed from the prostates of 8 apparently healthy men, aged 25-55years, it was found that Zn concentrations varied from 300 to 730 mg/L. After this finding several investigators suggested that the measurement of Zn levels in EPF may be useful as a marker of abnormal prostate secretory function. This suggestion promoted more detailed studies of the MEs and TEs concentrations in the EPF of healthy subjects and in those with different prostatic diseases, including Ca.40-48 MEs, such as Ca, chlorine (Cl), potassium (K), Mg, and sodium (Na) are vital for the normal functioning of the human body, there are a lot of data on the subject. However, the exact role of MEs in normal and pathophysiology of the prostate gland, specifically the prostatic fluid, is until now unknown.

Abstract

The prostate gland is subject to various disorders. The etiology and pathogenesis of these diseases are not well understood. Moreover, despite technological advancements, the differential diagnostics of prostate disorders has become progressively more complex and controversial. It was suggested that the measurement of main electrolytes levels in expressed prostatic fluid (EPF) may be useful as a biomarker. This suggestion promoted more detailed studies of the Ca, Cl, K, Mg, and Na concentrations in EPF of healthy subjects. The present systematic analysis included 1885 studies, all of which were published in the years from 1942 to 2019 and selected by searching the databases Scopus, PubMed, Medline, Elsevier-Embase, Cochrane Library, and the Web of Science. The articles were analyzed and “Median of Means” and “Range of Means” were used to examine heterogeneity of Ca, Cl, K, Mg, and Na concentrations in EPF of apparently healthy men. The objective analysis was performed on data from the 6 studies, with more than 62 subjects. It was found that the median of means for Ca, Cl, K, Mg, and Na concentrations in prostatic fluid of apparently healthy men were 1201, 1350, 1880, 486, and 3517 mg/L, respectively. Because of small sample size and high data heterogeneity, we recommend other primary studies.

Keywords: prostate, prostatic fluid, biomarkers, main electrolytes, calcium, chlorine, potassium, magnesium, sodium

Introduction

The prostate gland is subject to various disorders and of them chronic prostatitis, benign prostatic hyperplasia, and prostate cancer are the extremely common diseases of ageing men. The etiology and pathogenesis of these diseases are not well understood. Moreover, despite technological advancements, the differential diagnostics of prostate disorders has become progressively more complex and controversial. This is particularly concerned with prostate cancer where the limitations and potential harms associated with the use of prostate-specific antigen (PSA) as a diagnostic marker. The situation is until now unknown.

Several studies have reported the MEs content in EPF of normal and affected gland. However, further investigation has been considered necessary to provide clearer hypothesis about the role of MEs in etiology and pathogenesis of prostate disorders, because the findings of various studies indicate some discrepancies. The present study addresses the significance of prostatic fluid Ca, Cl, K, Mg, and Na levels as biomarker. Therefore, we systematically reviewed the available literature and performed a statistical analysis of Ca, Cl, K, Mg, and Na concentration in EPF of normal gland, which may shed valuable insight into the etiology and diagnosis of prostate disorders.
Material and methods

Data sources and search strategy

Aiming at finding the most relevant articles for this review, a thorough comprehensive web search was conducted from Scopus, PubMed, Medline, Elsevier-Embase, Cochrane Library, and the Web of Science databases between 1942 to November 2019, using the key words: main electrolytes, calcium concentration, chlorine concentration, potassium concentration, magnesium concentration, sodium concentration, expressed prostatic fluid, and their combination. For example, the search terms for MEs concentration were: ‘calcium concentration’, ‘Ca concentration’, ‘calcium content’, ‘Ca content’, ‘calcium level’, ‘Ca level’ ‘prostatic fluid calcium’, ‘prostatic fluid Ca’, ‘calcium of expressed prostatic fluid’, and ‘Ca of expressed prostatic fluid’. The language was not restricted. The titles from the search results were evaluated closely and determined to be acceptable for potential inclusion criteria. Also, references from the selected articles were examined as further search tools. Relevant studies noted in the reference lists of each selected article were also evaluated for inclusion.

Eligibility criteria

Studies were included if the control groups were healthy human males with no history or evidence of andrologia or urologic disease and Ca, Cl, K, Mg, or Na were detected in samples of EPF.

Studies were excluded if they were case reports or reviews. Studies involving subjects that were using Ca, K, and Mg supplementation were also excluded.

Data extraction

A standard extraction of data was applied, and the following available variables were extracted from each paper: method of MEs determination, number and age of health persons, samples preparing, mean and median of Ca, Cl, K, Mg, and Na concentrations, standard deviations of mean, and range of MEs concentrations.

Statistical analysis

Studies were combined based on means of Ca, Cl, K, Mg, and Na concentrations in EPF. The articles were analyzed and “Median of Means” and “Range of Means” were used to examine heterogeneity of MEs concentrations. The objective analysis was performed on data from the 6 studies, with more than 62 healthy subjects.

Results

A total of 1885 unduplicated studies were identified. Among them 6 studies were ultimately selected according to eligibility criteria, that investigated Ca, Cl, K, Mg, and Na concentrations in EPF of normal prostate (Tables 1–5), respectively.

Table 1 summarizes general data from the 6 studies on Ca concentrations in EPF samples. The retrieved studies involved more than 49 apparently healthy subjects. The ages of subjects were not presented. The information about analytical method was available for 3 studies. One study determined Ca concentration by the traditional chemical analytical method, and two using atomic absorption spectrophotometry (AAS).

Table 2 summarizes general data from the 5 studies on Cl concentrations in EPF samples. The retrieved studies involved more than 46 apparently healthy subjects. The ages of subjects were not presented. The information about analytical method was available for 2 studies. Both studies determined Cl concentration by the traditional chemical analytical method.

Table 3 summarizes general data from the 5 studies on K concentrations in EPF samples. The retrieved studies involved more than 40 apparently healthy subjects. The ages of subjects were not presented. The information about analytical method was available for 2 studies. One study determined K concentration by the traditional chemical analytical method, and other one using flame emission spectrophotometry (FES).

Table 4 summarizes general data from the 4 studies on Mg concentrations in EPF samples. The retrieved studies involved more than 46 apparently healthy subjects. The ages of subjects were not presented. The information about analytical method was available for 2 studies. Both studies determined Mg concentration using atomic absorption spectrophotometry (AAS).

Table 5 summarizes general data from the 5 studies on Na concentrations in EPF samples. The retrieved studies involved more than 39 apparently healthy subjects. The ages of subjects were not presented. The information about analytical method was available for 2 studies. One study determined Na concentration by the traditional chemical analytical method, and other one using FES.

Table 6 presents the differences between the mean of Ca, Cl, K, Mg, and Na concentration in the prostatic fluid obtained by our review and the mean of these elements in blood serum, urine, breast milk, and mixed saliva of Reference Man.

Table 1 Reference data of Ca in normal human prostatic fluid

| Reference | Meth. | n | Age | Treatment of samples | Ca, mg/L M±SD | Range* |
|-----------|-------|---|-----|----------------------|--------------|--------|
| Huggins et al., 71 | Chem | 3 | - | AD | 1210 | 1150-1310 |
| Burgos 72 | - | - | - | - | 600 | - |
| Homonnai et al., 73 | AAS | 12 | - | AD | 1280±73 | - |
| Zaneveld & Tauber 74 | - | - | - | - | 1202 | - |
| Kavanagh 75 | AAS | 34 | - | AD | 802±305 | 289-1550 |
| Daniels & Grayhack 76 | - | - | - | - | 1200 | - |

Number of all references: 6
Median of means, mg/L: 1201
Range of means, mg/L: 600-1280

M–Arithmetic mean, SD–standard deviation of mean, Range*–range of individual results, Chem–traditional chemical method, AAS–atomic absorption spectrophotometry

Citation: Zaichick VA. A systematic review of the main electrolytes concentrations in the prostate fluid of normal gland. J Anal Pharm Res. 2019;8(6):214-220. DOI: 10.15406/japfr.2019.08.00341
Table 2 Reference data of Cl in normal human prostatic fluid

| Reference         | Meth. | n  | Age | Treatment of samples | Cl, mg/L |
|-------------------|-------|----|-----|----------------------|----------|
|                   |       |    |     |                      | M±SD     | Range* |
| Huggins et al.,71 | Chem  | 8  | -   | AD                   | 1350     | 1230-1630 |
| Burgos72          |       |    |     |                      | 1350     | -     |
| Zaneveld & Tauber74| -     |    |     |                      | 1347     | -     |
| Kavanagh75        | Chem  | 38 | -   | AD                   | 1370±650 | 500-3270 |
| Daniels & Grayhack76| -   |    |     |                      | 1350     | -     |

Number of all references | 5
Median of means, mg/L | 1350
Range of means, mg/L | 1347-1370

M–arithmetic mean, SD–standard deviation of mean, Range*-range of individual results, Chem–traditional chemical method

Table 3 Reference data of K in normal human prostatic fluid

| Reference         | Meth. | n  | Age | Treatment of samples | K, mg/L |
|-------------------|-------|----|-----|----------------------|---------|
|                   |       |    |     |                      | M±SD    | Range* |
| Huggins et al.,71 | Chem  | 6  | -   | AD                   | 1890    | 1120-2400 |
| Burgos72          |       |    |     |                      | 1170    | -     |
| Zaneveld & Tauber74| -     |    |     |                      | 1877    | -     |
| Kavanagh75        | FES   | 34 | -   | AD                   | 2612±958| 1110-6120 |
| Daniels & Grayhack76| -   |    |     |                      | 1880    | -     |

Number of all references | 5
Median of means, mg/L | 1880
Range of means, mg/L | 1170-2612

M–arithmetic mean, SD–standard deviation of mean, Range*-range of individual results, Chem–traditional chemical method, FES–flame emission spectrophotometry

Table 4 Reference data of Mg in normal human prostatic fluid

| Reference         | Meth. | n  | Age | Treatment of samples | Mg, mg/L |
|-------------------|-------|----|-----|----------------------|----------|
|                   |       |    |     |                      | M±SD     | Range* |
| Homonnai et al.,73| AAS   | 12 | AD  |                      | 486±45   | -     |
| Zaneveld & Tauber74| -     |    |     |                      | 486      | -     |
| Kavanagh75        | AAS   | 34 | AD  |                      | 406±117  | 150-780 |
| Daniels & Grayhack76| -   |    |     |                      | 486      | -     |

Number of all references | 4
Median of means, mg/L | 486
Range of means, mg/L | 406-486

M–arithmetic mean, SD–standard deviation of mean, Range*-range of individual results, AAS-atomic absorption spectrophotometry
Table 5 Reference data of Na in normal human prostatic fluid

| Reference                  | Meth. | n  | Age | Treatment of samples | Na, mg/L | M±SD | Range* |
|----------------------------|-------|----|-----|----------------------|----------|------|--------|
| Huggins et al.,71          | Chem  | 5  | -   | AD                   | 3517     | 3517 | 3426-3632 |
| Burgos72                   | -     | -  | -   | -                    | 3586     | -    | 3517-3610 |
| Zaneveld & Tauber74        | -     | -  | -   | -                    | 3517     | -    | 3517-3610 |
| Kavanagh75                 | FES   | 34 | -   | AD                   | 3610±920 | 2530-7520 |
| Daniels & Grayhack76       | -     | -  | -   | -                    | 3517     | -    | 3517-3610 |

Number of all references: 5
Median of means, mg/L: 3517
Range of means, mg/L: 3517-3610

M—arithmetic mean, SD—standard deviation of mean, Range*—range of individual results, Chem—traditional chemical method, FES—flame emission spectrophotometry

Table 6 The differences between the mean of Ca, Cl, K, Mg, and Na concentration in the prostatic fluid and in blood serum, urine, breast milk, and mixed saliva of Reference Man (mg/L)

| Element | Prostatic fluid | Blood serum70 | Urine42 | Breast milk43 | Mixed saliva44 | Ratios |
|---------|-----------------|---------------|---------|---------------|----------------|-------|
| Ca      | 1201            | 97            | 151     | 386           | 37             | 1/2   |
| Cl      | 1350            | 3655          | 3350    | 563           | 288            | 0.37  |
| K       | 1880            | 191           | 1870    | 685           | 416            | 0.4   |
| Mg      | 486             | 21.7          | 81      | 36            | 7.9            | 22.4  |
| Na      | 3517            | 3251          | 2907    | 168           | 52             | 1.08  |

Discussion

Samples of EPF are much more available for study than prostate tissue and can be obtained without damaging the prostate gland. Information about Ca, Cl, K, Mg, and Na concentrations in prostatic fluid in different prostatic diseases is of obvious interest, not only to more profoundly understand the etiology and pathogenesis of prostatic diseases, but also for their diagnosis, particularly for prostate cancer diagnostics. Thus, it dictates a need in reliable values for the Ca, Cl, K, Mg, and Na concentrations in the EPF of apparently healthy subjects ranging from young adult males to elderly persons.

The range of means of Ca concentration reported in the literature for normal EPF varies widely from 600mg/L72 to 1280mg/L73 with median of means 1201mg/L (Table 1).

The range of means of Cl concentration reported in the literature for normal EPF varies from 1347mg/L to 1370mg/L with median of means 1350mg/L (Table 2).

The range of means of K concentration reported in the literature for normal EPF varies widely from 1170mg/L72 to 2612mg/L79 with median of means 1880mg/L (Table 3).

The range of means of Mg concentration reported in the literature for normal EPF varies from 406mg/L7 to 486mg/L79 with median of means 486mg/L (Table 4).

The range of means of Na concentration reported in the literature for normal EPF varies from 3517mg/L71 to 3610mg/L79 with median of means 3517mg/L (Table 5).

As indicated above, the range of means of Ca and K concentration reported in the literature for normal EPF varies widely. This can be explained by a dependence of some MEs content on many factors, including age, ethnicity, mass of the gland, diet, and others. Not all these factors were strictly controlled in cited studies. However, in our opinion, leading cause of inter-observer variability was insufficient quality control of results in these studies. In all reported papers the destructive analytical methods were used. The destructive analytical methods need in sample acid digestion under high temperature. There is evidence that by use of this treatment some quantities of MEs, including Ca and K, are lost.70-71 On the other hand; MEs of chemicals used for acid digestion can contaminate the EPF samples. Thus, when using destructive analytical methods it is necessary to control for the losses of chemical elements, for complete acid digestion of the sample, and for the contaminations by chemical elements during sample decomposition, which needs adding some chemicals. It is possible to avoid these not easy procedures using non-destructive methods. For example, such method as energy dispersive X-ray fluorescence analysis (EDXRF) is a fully instrumental and nondestructive analytical tool because a drop of EPF is investigated without requiring any sample pretreatment or its consumption.82 It is, therefore, reasonable to conclude that the choice of analytical method and quality control of results are very important factors for using the MEs concentration in EPF as biomarker.

Citation: Zaichick VA A systematic review of the main electrolytes concentrations in the prostate fluid of normal gland. J Anal Pharm Res. 2019;8(6):214-220. DOI: 10.15406/japlr.2019.08.00341
The obtained median of means for Ca concentrations in normal human prostatic fluid was at least one order of magnitude higher than mean values of the electrolyte content in blood serum and mixed saliva, and 8 and 3 times higher than in urine and breast milk, respectively (Table 6). The median of means for Mg concentrations in normal human prostatic fluid was at least one order of magnitude higher than mean values of the electrolyte content in blood serum, breast milk, and mixed saliva, and 6 times higher than in urine (Table 6). Thus, it was confirmed that the human prostatic secretion is a target fluid of human body for Ca and Mg.

There is some limitation in our study, which need to be taken into consideration when interpreting the results of this review. The sample size of each study was relatively small, and a total of about 49 normal controls were investigated from all 6 studies. As such, it is hard to make definitive conclusions about the clinical value of the Ca, Cl, K, Mg, and Na concentration in EPF as biomarker.

Conclusion

The present study is a comprehensive study regarding the determination of Ca, Cl, K, Mg, and Na concentration in EPF as a biomarker for the diagnostics of prostate disorders. The study has demonstrated that the human prostatic secretion is a target fluid of human body for Ca and Mg, because of small sample size and high heterogeneity of data for Ca and K, we recommend other primary studies.

Acknowledgments

None.

Conflicts of interest

The author declares that there are no conflicts of interest.

Funding

None.

References

1. Nickel JC. Prostatitis. Canadian Urological Association Journal. 2011;5(5):306–315.
2. Lim KB. Epidemiology of clinical benign prostatic hyperplasia. Asian Journal of Urology. 2017;4(3):148–151.
3. Siegel RL, Miller KD, Jemal A. Cancer statistics, 2017. CA Cancer J Clin. 2017;67(1):7–30.
4. Sharma S, Zapatero-Rodriguez J, O’Kennedy R. Prostate cancer diagnostics: Clinical challenges and the ongoing need for disruptive and effective diagnostic tools. Biotechnology Advances. 2017;35(2):135–149.
5. Zaichick S, Zaichick V. The effect of age on Br, Ca, Cr, Fe, Mg, Mn, Na, and Zn contents in intact human prostate investigated by neutron activation analysis. Applied Radiation and Isotopes. 2011;69(6):827–833.
6. Zaichick V, Zaichick S. Relations of the neutron activation analysis data to morphometric parameters in pediatric and nonhyperplastic young adult prostate glands. Andrology. 2013;1(1):139–146.
7. Zaichick V, Zaichick S. The effect of age on Br, Ca, Cl, K, Mg, Mn, and Na mass fraction in pediatric and young adult prostate glands investigated by neutron activation analysis. Applied Radiation and Isotopes. 2013;62:145–151.
8. Zaichick V, Zaichick S. Determination of trace elements in adults and geriatric prostate using neutron activation analysis. Journal of Radioanalytical and Nuclear Chemistry. 2012;288(1):197–202.
9. Zaichick V, Nosenko S, Moskvina I. The effect of age on 12 chemical element contents in intact prostate of adult men investigated by inductively coupled plasma atomic emission spectrometry. Biological Trace Element Research. 2012;149(2):171–183.
10. Zaichick S, Zaichick V, Nosenko S, et al. Mass fractions of 52 trace elements and zinc trace element content ratios in intact human prostates investigated by inductively coupled plasma mass spectrometry. Biological Trace Element Research. 2013;156:357–366.
11. Zaichick V, Zaichick S. Relations of morphometric parameters to zinc content in paediatric and nonhyperplastic young adult prostate glands. Australian Journal of Clinical and Experimental Urology. 2017;5(1):22–28.
12. Zaichick V, Zaichick S. The effect of age on Br, Ca, Cl, K, Mg, Mn, and Na mass fraction in pediatric and young adult prostate glands investigated by neutron activation analysis. Applied Radiation and Isotopes. 2013;62:145–151.
13. Zaichick V, Zaichick S. INAA application in the assessment of Ag, Co, Cr, Fe, Hg, Rh, Sb, Se, and Zn mass fraction in pediatric and young adult prostate glands. Journal of Radioanalytical and Nuclear Chemistry. 2013;298:1559–1566.
14. Zaichick V, Zaichick S. NAA-SLR and ICP-AES Application in the assessment of mass fraction of 19 chemical elements in pediatric and young adult prostate glands. Biological Trace Element Research. 2013;156:357–366.
15. Zaichick V, Zaichick S. Use of neutron activation analysis and inductively coupled plasma mass spectrometry for the determination of trace elements in pediatric and young adult prostate. American Journal of Analytical Chemistry. 2013;4:969–976.
16. Zaichick V, Zaichick S. INAA application in the assessment of chemical element mass fractions in adult and geriatric prostate glands. Biological Trace Element Research. 2014:90:62–73.
17. Zaichick V, Zaichick S. Use of INAA and ICP-MS for the assessment of trace element mass fractions in adult and geriatric prostate. Journal of Radioanalytical and Nuclear Chemistry. 2014;301(2):383–397.
18. Zaichick V, Zaichick S. Determination of trace elements in adults and geriatric prostate combining neutron activation with inductively coupled plasma atomic emission spectrometry. Open Journal of Biochemistry. 2014;1(2):16–33.
19. Zaichick V, Zaichick S. Age-related histological and zinc content changes in adult nonhyperplastic prostate glands. Age. 2014;36(1):167–181.
20. Zaichick V, Zaichick S. Relations of bromine, iron, rubidium, strontium, and zinc content to morphometric parameters in pediatric and nonhyperplastic young adult prostate glands. Biological Trace Element Research. 2014;157:195–204.
21. Zaichick V, Zaichick S. Relations of the neutron activation analysis data to morphometric parameters in pediatric and nonhyperplastic young adult prostate glands. Advances in Biomedical Science and Engineering. 2014;1(1):26–42.
22. Zaichick V, Zaichick S. Relations of the Al, B, Ba, Br, Ca, Cl, Cu, Fe, K, Li, Mg, Mn, Na, P, S, Si, Sr, and Zn mass fractions to morphometric parameters in pediatric and nonhyperplastic young adult prostate glands. Biometals. 2014;27:333–348.
23. Zaichick V, Zaichick S. The distribution of 54 trace elements including zinc in pediatric and nonhyperplastic young adult prostate gland tissues. Journal of Clinical and Laboratory Investigation Updates. 2014;2(1):1–15.

Citation: Zaichick VA. A systematic review of the main electrolytes concentrations in the prostate fluid of normal gland. J Andro Pharm Res. 2019;8(6):214–220. DOI: 10.15406/japlr.2019.08.00341
24. Zaichick V, Zaichick S. Androgen-dependent chemical elements of prostate gland. Andrology and Gynecology: Current Research. 2014;2(2).

25. Zaichick V, Zaichick S. Differences and relationships between morphometric parameters and zinc content in nonhyperplastic and hyperplastic prostate. British Journal of Medicine and Medical Research. 2015;8(8):692–706.

26. Zaichick V. The variation with age of 67 macro- and microelement contents in nonhyperplastic prostate glands of adult and elderly males investigated by nuclear analytical and related methods. Biological Trace Element Research. 2015;168(1):44–60.

27. Zaichick V, Zaichick S. Variations in concentration and distribution of several androgen-dependent and -independent trace elements in nonhyperplastic prostate gland tissue throughout adulthood. Journal of Andrology and Gynaecology. 2016;4(1):1–10.

28. Zaichick V, Zaichick S. Age-related changes in concentration and histological distribution of Br, Ca, Cl, K, Mg, Mn, and Na in nonhyperplastic prostate of adults. European Journal of Biology and Medical Science Research. 2016;4(2):31–48.

29. Zaichick V, Zaichick S. Age-related changes in concentration and histological distribution of 18 chemical elements in nonhyperplastic prostate of adults. World Journal of Pharmaceutical and Medical Research. 2016;2(4):5–18.

30. Zaichick V, Zaichick S. Age-related changes in concentration and histological distribution of 54 trace elements in nonhyperplastic prostate of adults. International Archives of Urology and Complications. 2016;2(2):019.

31. Zaichick V, Sviridova T, Zaichick S. Zinc in the human prostate gland: normal, hyperplastic and cancerous. International Urology and Nephrology. 1997;29(5):565–574.

32. Zaichick S, Zaichick V. Trace elements of normal, benign hypertrophic and cancerous tissues of the human prostate gland investigated by neutron activation analysis. Applied Radiation and Isotopes. 2012;70:81–87.

33. Zaichick V, Zaichick S. Trace element levels in prostate gland as carcinoma’s marker. Journal of Cancer Therapy. 2017;8(1):131–145.

34. Zaichick V, Zaichick S. Ratios of selected chemical element contents in prostatic tissue as markers of malignancy. Hematology and Medical Oncology. 2016;1(2):1–8.

35. Zaichick V, Zaichick S. Ratios of Zn/trace element contents in prostate gland as carcinoma’s markers. Cancer Reports and Reviews. 2017;1(1):1–7.

36. Zaichick V, Zaichick S. Ratios of selenium/trace element contents in prostatic gland as carcinoma’s markers. Journal of Tumor Medicine and Prevention. 2017;1(2):555556.

37. Zaichick V, Zaichick S. Ratios of rubidium/trace element contents in prostatic gland as carcinoma’s markers. Cancer Research and Clinical Oncology. 2017;1(1):13–21.

38. Zaichick V, Zaichick S. Ratios of cadmium/trace element contents in prostate gland as carcinoma’s markers. Cancer Therapy and Oncology International Journal. 2017;4(1):556526.

39. Zaichick V, Zaichick S. Ratios of cobalt/trace element contents in prostate gland as carcinoma’s markers. The International Journal of Cancer Epidemiology and Research. 2017;1(1):21–27.

40. Zaichick V, Zaichick S. Ratios of calcium/trace element contents as prostate cancer markers. Journal of Oncology Research and Therapy. 2017;4(1):116.

41. Zaichick V, Zaichick S. Ratios of Mg/trace element contents in prostate gland as carcinoma’s markers. SAJ Cancer Science. 2017;2(1):102.

42. Zaichick V, Zaichick S. Global contamination from uranium: insights into problem based on the uranium content in the human prostate gland. Journal of Environment and Health Science. 2015;1(4):1–5.

43. Zaichick V, Zaichick S. Dietary intake of minerals and prostate cancer: insights into problem based on the chemical element contents in the prostate gland. Journal of Aging Research and Clinical Practice. 2015;4(3):164–171.

44. Zaichick V, Zaichick S, Rossmann M. Intracellular calcium excess as one of the main factors in the etiology of prostate cancer. AIMS Molecular Science. 2016;3(4):635-647.

45. Zaichick V, Zaichick S, Wynchank S. Intracellular zinc excess as one of the main factors in the etiology of prostate cancer. Journal of Analytical Oncology. 2016;5(3):124–131.

46. Zaichick V. The prostatic urethra as a Venturi effect urine-jet pump to drain prostatic fluid. Medical Hypotheses. 2014;83:65–68.

47. Mackenzie AR, Hall T, Whitmore WF Jr. Zinc content of expressed human prostate fluid. Nature. 1962;193(4810):72–73.

48. Marmar JL, Katz S, Praiss DE, et al. Values for zinc in whole semen, fraction of split ejaculate and expressed prostatic fluid. Urology. 1980;16(5):478–480.

49. Zaichick V, Tsyb A, Dunchik VN, et al. Method for diagnostics of prostate diseases. Russia:1981.

50. Zaichick V, Sviridova T, Zaichick S. Zinc concentration in human prostatic fluid: normal, chronic prostatitis, adenoma, and cancer. International Urology and Nephrology. 1996;28(5):687–694.

51. Costello LC, Franklin RB. Prostatic fluid electrolyte composition for the screening of prostate cancer: a potential solution to a major problem. Prostate Cancer and Prostatic Diseases. 2009;12(1):17–24.

52. Zaichick V, Zaichick S, Br, Fe, Rb, Sr, and Zn levels in the prostatic secretion of patients with chronic prostatitis. International Archives of Urology and Complications. 2018;4:046.

53. Zaichick V, Zaichick S. Trace element concentrations in the expressed prostatic secretion of normal and hyperplastic prostate. Journal of Urology and Nephrology Studies. 2018;1(3):1–7.

54. Zaichick V, Zaichick S. Effect of age on the Br, Fe, Rb, Sr, and Zn concentrations in human prostatic fluid investigated by energy-dispersive X-ray fluorescence microanalysis. MicroMed. 2018;6(2):94–104.

55. Zaichick V, Zaichick S. Trace elements of expressed prostatic secretions as a source for biomarkers of prostate cancer. Journal of Clinical Research in Oncology. 2018;1(1):1–7.

56. Zaichick V, Zaichick S. Ratio of zinc to bromine, iron, rubidium, and strontium concentration in the prostatic fluid of patients with benign prostatic hyperplasia. Acta Scientific Medical Sciences. 2019;3(6):49–56.

57. Zaichick V, Zaichick S. Significance of trace element quantities in the prostatic secretion of patients with chronic prostatitis and prostate cancer. Journal of Biomedical Research and Reviews. 2019;2(1):56–61.

58. Zaichick V, Zaichick S. Ratio of zinc to bromine, iron, rubidium, and strontium concentration in the prostatic fluid of patients with benign prostatic hyperplasia. Acta Scientific Medical Sciences. 2019;3(6):49–56.

59. Zaichick V, Zaichick S. Ratio of zinc to bromine, iron, rubidium, and strontium concentration in expressed prostatic secretions as a source for biomarkers of prostate cancer. American Journal of Research. 2019;5–6:140–150.

60. Zaichick V, Zaichick S. Some trace element contents and ratios in prostatic fluids as ancillary diagnostic tools in distinguishing between the...
benign prostatic hyperplasia and chronic prostatitis. Archives of Urology. 2019;2(1):12–20.

61. Zaichick V, Zaichick S. Ratio of zinc to bromine, iron, rubidium, and strontium concentration in the prostatic fluid of patients with chronic prostatitis. Global Journal of Medical Research. 2019;19(4):9–15.

62. Zaichick V, Zaichick S. Significance of trace element quantities in the prostatic secretion of patients with benign prostatic hyperplasia and prostate cancer. Journal of Cancer Metastasis and Treatment. 2019;5(48):1–9.

63. Zaichick V, Zaichick S. Some trace element contents and ratios in prostatic fluids as ancillary diagnostic tools in distinguishing between the chronic prostatitis and prostate cancer. Medical Research and Clinical Case Reports. 2019;3(1):1–10.

64. Zaichick V, Zaichick S. Some trace element contents and ratios in prostatic fluids as ancillary diagnostic tools in distinguishing between the benign prostatic hyperplasia and prostate cancer. Cancer Therapy and Oncology International Journal. 2019;14(1):1–7.

65. Zaichick V, Zaichick S. Age-dependence of some trace element concentrations and their ratios in human prostatic fluid. Journal of Aging Research and Healthcare. 2019;2(4):11–20.

66. Zaichick V. Using prostatic fluid levels of rubidium and zinc concentration multiplication in non-invasive and highly accurate screening for prostate cancer. Journal of Cancer Prevention and Current Research. 2019;10(6):151–158.

67. Zaichick V, Zaichick S. Using prostatic fluid levels of zinc to bromine concentration ratio in non-invasive and highly accurate screening for prostate cancer. Journal of Hematology and Oncology Research. 2019;3(3):21–31.

68. Zaichick V, Zaichick S. Using prostatic fluid levels of zinc to iron concentration ratio in non-invasive and highly accurate screening for prostate cancer. SSRG International Journal of Medical Science. 2019;6(11):24–31.

69. Zaichick V, Zaichick S. Using prostatic fluid levels of zinc to strontium concentration ratio in non-invasive and highly accurate screening for prostate cancer. Acta Scientific Cancer Biology. 2020;4(1):12–21.

70. Zaichick V. Medical elementology as a new scientific discipline. Journal of Radio analytical and Nuclear Chemistry. 2006;269:303–309.

71. Huggins C, Scott WW, Heinen JH. Chemical composition of human semen and of the secretions of the prostate and seminal vesicles. American Journal of Physiology. 1942;136:467–473.

72. Burgos MH. Biochemical and functional properties related to sperm metabolism and fertility. In: Male accessory sex organs. New York: Academic press. 1974;151–160.

73. Homonnai ZT, Matzkin H, Fainman N, et al. The cation composition of the seminal plasma and prostatic fluid and its correlation to semen quality. Fertility and Sterility. 1978;29(5):539–542.

74. Zaneveld LJ, Tauber PF. Contribution of prostatic fluid components to the ejaculate. Prog Clin Biol Res. 1981;75A:265–277.

75. Kavanagh JP. Sodium, potassium, calcium, magnesium, zinc, citrate and chloride content of human prostatic and seminal fluids. J Reprod Fertil. 1985;75(1):35–41.

76. Daniels GF, Grayhack JT. Physiology of prostatic secretion. In: Scientific Foundation in Urology (Eds.: Chisholm G.D., Fair W.R.). Heinemann Medical Books: Chicago. 1990. 351–358 p.

77. Romics I, Bach D. Zn, Ca and Na levels in the prostatic secretion of patients with prostatic adenoma. Int Urol Nephrol. 1991;23(1):45–49.

78. Liang CZ, Zhang XJ, Wang DB, et al. Measurement of electrolyte concentrations in expressed prostatic secretion and urine from patients with chronic prostatitis and its implications. Arch Androl. 2006;52(1):29–34.

79. Zaichick V. Sampling, sample storage and preparation of biomaterials for INAA in clinical medicine, occupational and environmental health. In: Harmonization of Health-Related Environmental Measurements Using Nuclear and Isotopic Techniques. Vienna: International Atomic Energy Agency; 1997; 123–133 p.

80. Zaichick V, Zaichick S. A search for losses of chemical elements during freeze-drying of biological materials. Journal of Radioanalytical and Nuclear Chemistry. 1997;218(2):249–253.

81. Zaichick V. Losses of chemical elements in biological samples under the dry aching process. Trace Elements in Medicine. 2004;5(3):17–22.

82. Zaichick V, Zaichick S, Davydov G. Method and portable facility for measurement of trace element concentration in prostate fluid samples using radionuclide-induced energy-dispersive X-ray fluorescent analysis. Nuclear Science and Technology. 2016;27(6):1–8.

83. Iyengar GV, Kollmer WE, Bowen HGM. The elemental composition of human tissues and body fluids: a compilation of values for adults. Verlag Chemie: Weinheim; 1978.

84. Zaichick V, Tsib A, Bagirov S. Neutron Activation analysis of saliva: clinical chemistry, environmental and occupational toxicology. Journal of Radioanalytical and Nuclear Chemistry. 1995;95(1):123–132.

Citation: Zaichick V.A systematic review of the main electrolytes concentrations in the prostate fluid of normal gland. J Anal Pharm Res. 2019;8(6):214–220. DOI: 10.15406/japlr.2019.08.00341