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Correlation among Various Properties of Urine in Calcium Oxalate Stone Formers and Controls

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Abstract

The aim of our study is to evaluate correlation coefficients of surface tension and viscosity with specific gravity, pH and volume in calcium oxalate stone formers and controls. The study was conducted on 50 patients divided into two groups- Group I consist of 25 stone formers and Group II consists of 25 controls i.e. non stone formers. 24-hour urine is collected from each patient and control. The Correlation coefficient of surface tension with specific gravity for group-I & Group-II comes out to be -0.207 & 0.329, surface tension with pH for group-I & Group-II comes out to be 0.151 & -0.184, and surface tension with volume for group-I & Group-II comes out to be 0.158 & 0.122. The Correlation coefficient of Viscosity with specific gravity for group-I & Group-II comes out to be 0.088 & 0.385, Viscosity with pH for group-I & Group-II comes out to be 0.387 & -0.204 and Viscosity with volume for group-I & Group-II comes out to be 0.166 & -0.202. We can conclude from the values of coefficient coefficients that there exists no correlation between various physical properties of urine studied in relation to renal stone disease.

Key words: Specific gravity, pH, urinary output (volume), surface tension and viscosity.

1. Introduction

Renal stones are the most common disorder of the urinary tract affecting about 10% of the global population[1] and affect mankind for millennia. It is one of the major health problems in the present society as it affects a high percentage of people and this illness exists since historic times. Renal stones can develop anywhere in urinary tract. They are formed due to imbalance between fluid and certain wastes in urine due to which urine becomes overly

saturated with stone forming salts such as calcium oxalate, calcium phosphate, uric acid and struvite[2]. Renal stones may grow over months and even years before causing problem. Normally the stones are very small in size and will move through the urinary tract and pass out in the urine. However, large stones do not always pass through and may require a procedure or surgery to remove them[3]. These stones can result in extreme pain, burning sensation during urination, blood in urine, can stop the flow of urine and in some cases may lead to high blood pressure[4] and increase the risk for coronary artery disease and diabetes mellitus[5]. The renal stone formation is a persistent problem and around half of all people who earlier had a kidney stone will develop another one within five years. The recurrence rate without precautionary treatment is approximately 10% at 1 year, 33% at 5 years and 50% at 10 years[6]. Urine is a very complex polyionic solution and contains inhibitors and promoters of crystallization[7]. Important ions and molecules in relation to renal stone formation are Ca^{2+}, oxalate, phosphate, Na+, K+, H+, OH^-, Mg^{2+}, SO_4^{2-} citrate, amino acids, glycosaminoglycans etc[8]. The loss of balance between the urinary promoters and inhibitors and super saturation of urine with stone forming ions has been suggested to increase the risk of stone formation more than disturbance in any single substance[9].

We have measured various properties of urine viz. surface tension, viscosity[10], specific gravity, volume(urinary output), pH[11], specific electrical conductivity[12], organic acids[13] etc. in our previous studies. The correlation between specific gravity, volume (urinary output), and pH was studied[11]. Similarly, the correlation between surface tension and viscosity was also studied[10]. The correlation between specific electrical conductivity and organic acids was also studied[14]. The objective of our current research paper will be to study correlation of specific gravity, pH and urinary output *i.e.* volume, if any, with surface tension and viscosity in the urine of calcium oxalate stone formers and non stone formers. We present a study of 50 patients. Group I consist of 25 patients of various ages and both sexes having calcium oxalate renal stone disease *i.e.* stone formers (SF) and Group II consists of 25 controls *i.e.* non stone formers (NSF) with matched age and sex having no family history of kidney stone.

2. Materials and Methods

Patients and controls were put on equal calorific diet/kg body weight and equal amount of water for 2 days. On third day, they were asked to collect 24-hour urinary sample. Each patient is provided with two 2.5 l collecting bottles and for urine preservation 10 ml of 5% thymol in isopropyl alcohol is added into each bottle. On the day of urine collection, empty the bladder completely upon awakening and discard this urine. This is the start date and time. Write it on the collection container. After that, all urine should be collected in the bottle (also during the night) for the next 24 hours. Always store the collecting bottles in a cool place. The last urine collected should be that voided upon awakening the second day, at the same time as the start time.

3. Experimental

The various properties of urine viz. specific gravity, pH and urinary output *i.e.*

Table 1. Experimental Values of Various Parameters of Stone Formers

Subject (Patients)	Sp. Gravity	pH	Urine Volume (litres)	Surface tension (dynes/cm)	Viscosity (dyne sec/ cm^2)
1.	1.002	5.3	2.100	49.86	1.006
2.	1.032	6.5	1.800	50.7	1.011
3.	1.009	5.2	1.080	62.5	1.012
4.	1.030	5.85	1.180	55.64	1.008
5.	1.020	5.32	1.450	60.5	1.011
6.	1.015	6.14	1.020	50.5	1.014
7.	1.041	7.10	2.300	55.4	1.013
8.	1.035	6.93	1.400	52.7	1.015
9.	1.030	5.60	1.260	49.95	1.010
10.	1.036	6.15	1.450	53.5	1.009
11.	1.037	6.8	1.230	54.6	1.010
12.	1.045	6.24	1.680	62.5	1.012
13.	1.040	7.1	1.700	58.75	1.008
14.	1.030	7.5	1.200	64.5	1.015
15.	1.009	6.2	1.820	63.26	1.012
16.	1.010	7.05	1.630	55.7	1.013
17.	1.021	5.09	1.450	57.5	1.008
18.	1.020	5.36	1.200	58.24	1.007
19.	1.010	5.93	2.250	64.8	1.015
20.	1.019	7.20	1.480	65.7	1.011
21.	1.036	7.90	1.320	50.4	1.010
22.	1.025	8.2	2.100	66.8	1.013
23.	1.026	6.2	1.580	57.48	1.010
24.	1.028	6.45	1.220	61.7	1.008
25.	1.042	6.5	1.640	52.57	1.016

Table 2. Experimental Values of Various Parameters of Non Stone Formers

Subject (Patients)	Sp. Gravity	pH	Urine Volume (litres)	Surface tension (dynes/cm)	Viscosity (dyne sec/ cm^2)
1.	1.009	5.16	1.240	47.34	1.007
2.	1.003	6.67	1.000	61.7	1.008
3.	1.036	6.3	1.200	58.06	1.007
4.	1.020	6.01	1.650	63.9	1.009
5.	1.016	7.7	0.940	51.0	1.013
6.	1.030	7.2	0.920	52.39	1.010
7.	1.009	5.45	1.280	57.2	1.012
8.	1.021	6.02	1.200	55.4	1.016
9.	1.019	5.07	1.150	63.0	1.008
10.	1.025	6.83	0.900	58.5	1.009
11.	1.041	5.79	1.240	64.23	1.017
12.	1.040	6.25	0.900	60.54	1.015
13.	1.035	6.9	1.340	55.59	1.009
14.	1.020	6.0	1.280	52.5	1.013
15.	1.010	7.27	1.080	50.8	1.012
16.	1.015	7.8	0.960	53.55	1.008
17.	1.026	7.4	1.320	54.56	1.010
18.	1.036	5.75	0.980	50.22	1.018
19.	1.028	5.30	1.060	65.54	1.013
20.	1.042	6.41	0.920	69.38	1.015
21.	1.035	5.30	0.960	50.5	1.012
22.	1.016	7.02	0.950	47.98	1.009
23.	1.037	6.2	1.220	50.2	1.011
24.	1.025	5.56	0.880	48.38	1.012
25.	1.040	6.15	1.020	68.5	1.015

volume , surface tension, viscosity of the urine of calcium oxalate stone formers by standard laboratory techniques and compare these properties with that of non stone formers . The individual values of each observation of each subject in both the groups are shown in Table 1 and Table 2.

4. Results and Discussion

To find dependence of one property over another, we calculated correlation coefficient (r).

4.1 Correlation of Surface Tension with other properties studied :

The Correlation of surface tension with specific gravity, pH and volume was studied and correlation coefficient was calculated, the values of which are shown in Table 3.

Table 3. Correlation Table showing correlation coefficients of Surface Tension with other properties studied.

Properties	Group-I (SF)	Group-II (NSF)
Surface Tension vs. Specific gravity	-0.207	0.329
Surface Tension vs. pH	0.151	-0.184
Surface Tension vs. volume	0.158	0.122

The graphs showing correlation between Surface tension and specific gravity in Group-I and Group -II is shown in Figure 1 and Figure 2 respectively. The graphs showing correlation between Surface tension and pH in Group-I and Group -II is shown in Figure 3 and Figure 4 respectively. The graphs showing correlation between Surface Tension and volume in Group-I and Group -II is shown in Figure 5 and Figure 6 respectively.

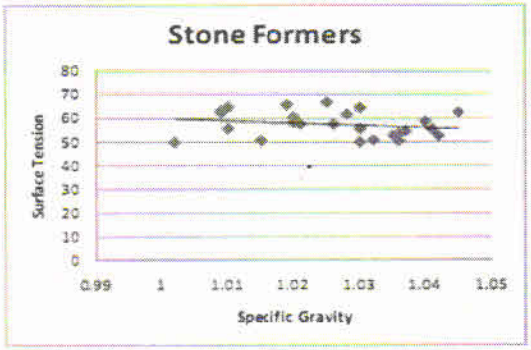

Figure 1 Correlation between Sp gravity and Surface tension for Group-I

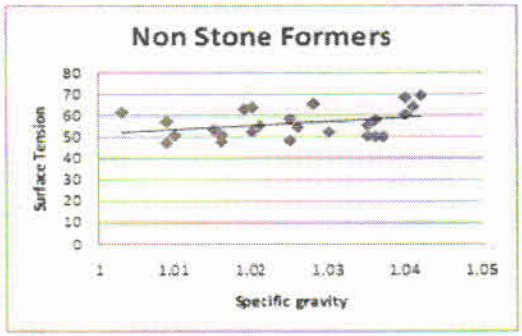

Figure 2. Correlation between Sp gravity and Surface tension for Group-II

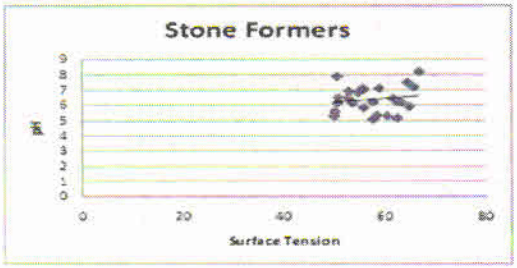

Figure 3 Correlation between pH and Surface tension for Group-I

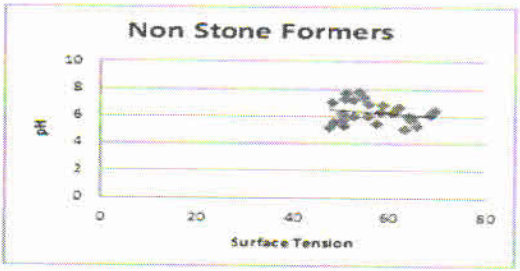

Figure 4. Correlation between pH and Surface tension for Group-II

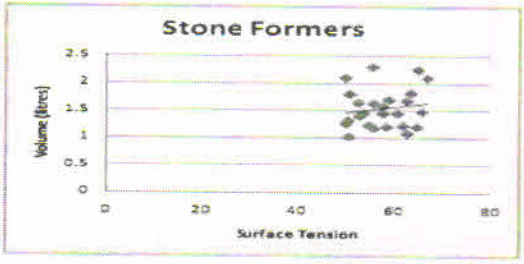

Figure 5. Correlation between volume and Surface tension for Group-I

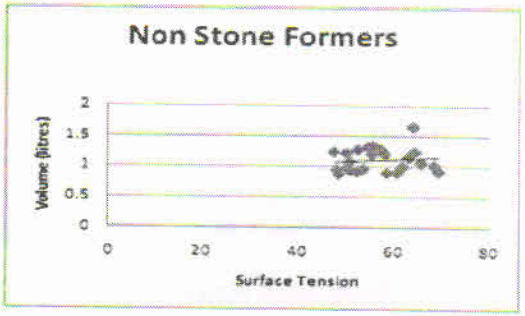

Figure 6. Correlation between volume and Surface tension for Group-II

From correlation coefficient of Surface tension with specific gravity, pH and volume as shown in Table 3, we found that no positive or negative perfect correlation is found between the properties studied.

4.2 Correlation of Viscosity with other properties studied :

The Correlation of viscosity with specific gravity, pH and volume was studied and correlation coefficient was calculated, the values of which are shown in Table 4.

Table 4. Correlation Table showing correlation coefficients of Viscosity with other properties studied.

Properties	Group-I (SF)	Group-II (NSF)
Viscosity vs. Specific gravity	0.088	0.385
Viscosity vs. pH	0.387	-0.204
Viscosity vs. volume	0.166	-0.202

The graphs showing correlation between Viscosity and specific gravity in Group-I and Group -II is shown in Figure 7 and Figure 8 respectively. The graphs showing correlation between Viscosity and pH in Group-I and Group -II is shown in Figure 9 and Figure 10 respectively. The graphs showing correlation between Viscosity and volume in Group-I and Group -II is shown in Figure 11 and Figure 12 respectively.

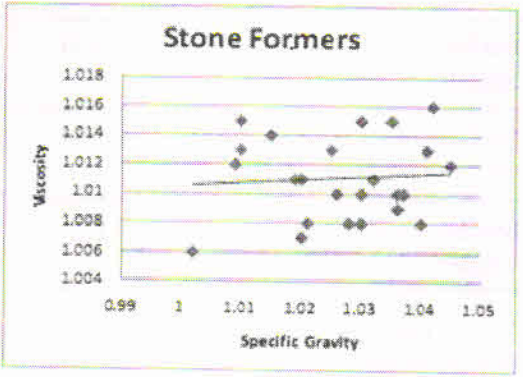

Figure 7. Correlation between Sp gravity and Viscosity for Group-I

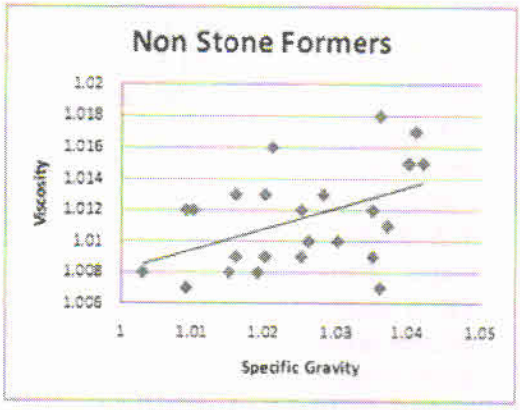

Figure 8 Correlation between Sp gravity and Viscosity for Group-II

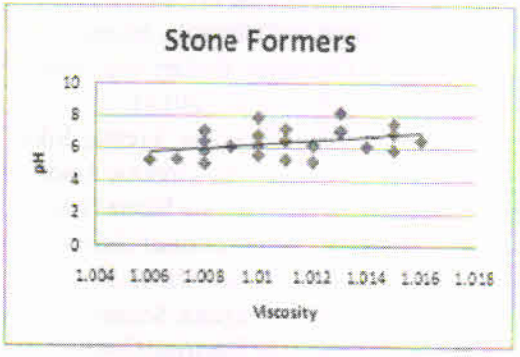

Figure 9 Correlation between pH and Viscosity for Group-I

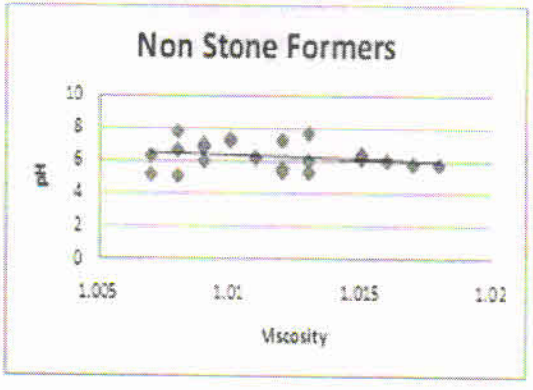

Figure 10 Correlation between pH and Viscosity for Group-II

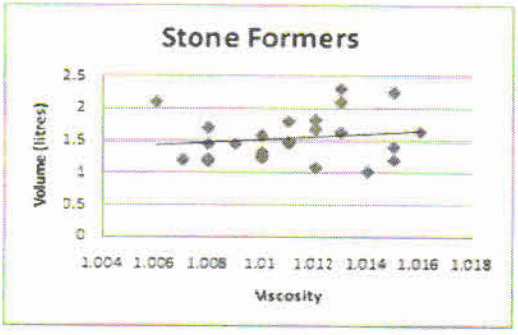

Figure 11 Correlation between volume and Viscosity for Group-I

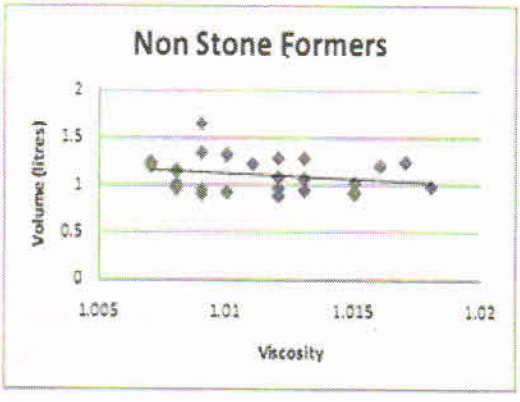

Figure 12 Correlation between volume and Viscosity for Group-II

From correlation coefficient of viscosity with specific gravity, pH and volume as shown in Table 4, we found that no positive or negative perfect correlation is found between the properties studied. Thus, we can conclude from the values of coefficient coefficients that there exists no correlation between various physical properties of urine studied in relation to renal stone disease.

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