

*Full Length Research Paper*

# Value of Plasma Viscosity in Acute Appendicitis: a Preliminary Study

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Plasma viscosity has been reported to be of valuable importance for infection and can be used as an acute phase reactant. We aimed to determine the diagnostic accuracy of plasma viscosity in acute appendicitis. Twenty-three consecutive patients with a surgical and pathologic diagnosis of appendicitis were included in this prospective study. The control group included 20 healthy people. Venous blood samples, both from the control patients and the patients diagnosed as appendicitis preoperatively, were obtained to measure plasma viscosity. Plasma viscosity was statistically significantly higher in patients with acute appendicitis than in control patients. Plasma viscosity can be measured quickly and inexpensively and it shows only minimal intra-individual variability. Plasma viscosity can be used as an auxiliary laboratory test to diagnose acute appendicitis. However, further clinical and laboratory research is needed to support these hypotheses.

**Keywords:** Acute appendicitis, plasma viscosity, diagnosis, acute phase reactant, rheology, laboratory tests.

## INTRODUCTION

Acute appendicitis (AA) is a common surgical condition of the abdomen, the prompt diagnosis of which is rewarded by a marked decrease in morbidity and mortality (Andersson, 2004). Classically, the diagnosis of AA is based on a brief history of abdominal pain, nausea, migration of pain to the right iliac fossa, and signs of local peritonitis; diagnostic accuracy based on these symptoms ranges from 70% to 80% (Andersson, 2004; Hallan et al., 1997; Ng and Lai, 2002). Therefore, diagnostic errors are common, resulting in a median incidence of perforation of 20% and a negative laparotomy rate ranging from 2% to 30% (Andersson, 2004).

The preoperative laboratory tests can be performed easily in primary healthcare settings and often aid primary clinicians with decision making about patients with clinically suspected AA. It has been previously reported that plasma viscosity (PV) has a valuable importance for infection and can be used as an acute

phase reactant (Yetkin et al., 2001). In this study, we aimed to measure the diagnostic accuracy of PV in AA.

## MATERIALS AND METHODS

The ethics committee of the university approved the study protocol, and written informed consent was obtained from all patients and healthy volunteers. Subjects with additional systemic disorders such as heart failure, hepatic cirrhosis, malignancy, renal insufficiency, hematological disorders, and those with an infectious disease requiring antibiotic therapy were excluded. Additionally, patients who took a proton pump inhibitor or an H2 receptor antagonist were excluded. Twenty-five consecutive patients with a preoperative diagnosis of AA were included in this prospective study. Besides demographics and pain duration, operative findings and pathology results were recorded. The patients were assessed according to two parameters; A. pain duration longer or shorter than 24 hours, B. presence of complicated (gangrenous/perforated) or non-complicated (phlegmonous) appendicitis. Two patients who were not diagnosed as appendicitis after surgery and pathology were also excluded from the study. The final AA group consisted of 23 patients (male: 14, female: 9, age range 16-58 years). The control group included randomized healthy 20 volunteers (male: 10, female: 10, age range 19-50 years).

Venous blood samples (2 mL), both from the control patients and the patients diagnosed as appendicitis preoperatively, were

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**Table 1.** Sex, age, plasma viscosity values of patients with acute appendicitis and controls

	Acute appendicitis (n=23)	Control (n=20)	P
Sex (male/female)	14/9	10/10	.39
Age (years)*	35.6 ± 12.8	37.3 ± 8	.6
Plasma viscosity (cP)*	1.59 ± 0.27	1.35 ± 0.2	.002

\*Values are means ± standard deviation.

**Table 2.** Comparison of acute appendicitis patients with pain durations shorter than 24 hours and longer than 24 hours

	Pain duration shorter than 24 h (n=10)	Pain duration longer than 24 h (n=13)	P
Plasma viscosity (cP)*	1.48 ± 0.18	1.67 ± 0.31	.114

\*Values are means ± standard deviation.

**Table 3.** Comparison of acute appendicitis patients with phlegmonous and complicated appendicitis

	Phlegmonous (n=17)	Complicated (n=6)	P
Plasma viscosity (cP)*	1.53 ± 0.24	1.75 ± 0.33	.220

\*Values are means ± standard deviation.

obtained to measure PV. In each subject, 2 mL blood was centrifuged, and PV was measured using viscosimetry (Brookfield DV-II Pro, Brookfield Engineering Laboratories, Inc, Middleboro, MA, USA) (Yetkin et al., 2006; Dikmenoglu et al., 2006; Woodward et al., 2003). For each plasma sample, 3 measurements were performed and an average was determined.

### Statistical Analyses

Continuous variables or their nonparametric counterparts were compared using *t* or Mann-Whitney *U* test where appropriate. Values for *P* less than .05 were considered statistically significant.

## RESULTS

No statistically significant difference was found between patients with AA and controls with regard to sex and age. PV levels were significantly increased in patients with AA compared with controls (Table 1). In the assessment of the pain duration parameter, PV levels were not significantly different between the 2 subgroups (Table 2). In the assessment of presence of complicated or non-complicated appendicitis, PV levels were not significantly different between the 2 subgroups (Table 3).

## DISCUSSION

Several parameters (i.e. C-reactive protein, white blood cell count, lymphocyte/leukocyte rate, interleukin-6,

interleukin-10, interleukin-4, interleukin-5, interleukin-12, tumor necrosis factor alpha, endotoxin, erythrocyte sedimentation rate, procalcitonin, fibrinogen, alpha 2-macroglobulin, alpha 1-antitrypsin, D-Lactate) for the diagnosing of AA have been investigated in the literature.

PV was comparably elevated when acute or chronic tissue damage resulted in reactant changes in the plasma protein pattern, as after injury, surgery, infection, infarction, autoimmune disease, or invasive malignancy (Lowe, 1994).

PV is a specific measure of plasma protein changes, is independent of red blood cell changes, and shows little variation with demographic factors (Lowe, 1994). The effects of age, sex, and pregnancy on PV are minimal. Cigarette smoking also has little effect on PV (Lowe, 1994; Lowe et al., 1991). The contribution of individual plasma proteins and lipoproteins to PV depends on their concentration, molecular weight, rigidity, and asymmetric shape<sup>5</sup>. The viscosity of plasma depends on its macromolecular content, the plasma proteins in particular. Among the plasma proteins, fibrinogen is the one that most affects PV. Although fibrinogen constitutes a very small portion of the plasma proteins, its thin and long shape make it an important determinant. Simple measurement of fibrinogen level thus may give an idea about PV. However, protein-protein interactions also have important effects on PV, especially during pathological conditions. Determining PV by a viscometer not only reflects the effect of fibrinogen, but it demonstrates the effect of protein-protein interactions as

well (Dikmenoglu et al., 2006). Furthermore, other acute phase proteins, like alpha 2-macroglobulin, certain

immunoglobulins, and large lipoproteins also influence PV. This makes it a biochemically composite variable (Yetkin et al., 2006).

In this study, we found that PV level was significantly higher in patients with AA. We speculate that this may be due to the effect of plasma proteins. However, there was no correlation between PV and other clinical variables such as duration of symptoms and degree of inflammation of the appendix.

The microscale characteristics of venular flow are significantly altered during inflammation or changes in local hematocrit (King et al., 2004). In the pathophysiology of acute appendicitis, proximal obstruction of the lumen with ongoing mucus secretion of the appendiceal mucosa distal to the obstruction into a closed lumen causing elevation of intraluminal pressure followed by increased venous pressure and mucosal ischemia is suggested. Once luminal pressure exceeds 85 mmHg, thrombosis of the venules that drain the appendix occurs and, in the setting of continued arteriolar in flow, vascular congestion and engorgement of the appendix become manifest (Boley et al., 1969). The rheology of blood, which is mainly regulated by PV, and relative motion of the cellular elements and chemical solutes, is important in promoting platelet-wall interactions in hemostasis and leukocyte-wall interactions in inflammation (Dikmenoglu et al., 2006; King et al., 2004). In our study, we demonstrated that PV levels were statistically significantly higher in patients diagnosed as acute appendicitis as compared to control group. Taken together with the information on the pathophysiology of acute appendicitis, the findings in the present study suggested that PV might play a possible role in the pathogenesis of acute appendicitis. However, further clinical and laboratory research is needed to support this hypothesis.

A limitation of our study is that the control group was composed of healthy volunteers and the number of the patients diagnosed with appendicitis in this study was also small.

In conclusion, PV can be measured quickly and inexpensively and it shows only minimal intraindividual variability. PV can be used as an auxiliary laboratory test to diagnose AA. However, further clinical and laboratory research is needed to support these hypotheses.

## REFERENCES

Andersson RE (2004). Meta-analysis of the clinical and laboratory diagnosis of appendicitis. *Br. J. Surg.* 91: 28-37.

- Boley SJ, Agrawal GP, Warren AR, Veith FJ, Levowitz BS, Treiber W, Dougherty J, Schwartz SS, Gliedman ML (1969). Pathophysiologic effects of bowel distention on intestinal blood flow. *Am. J. Surg.* 117: 228-234.
- Dikmenoglu N, Ciftci B, Ileri E, Guven SF, Seringec N, Aksoy Y, Ercil D (2006). Erythrocyte deformability, plasma viscosity and oxidative status in patients with severe obstructive sleep apnea syndrome. *Sleep Med.* 7: 255-261.
- Hallan S, Asberg A, Edna TH (1997). Additional value of biochemical tests in suspected acute appendicitis. *Eur. J. Surg.* 163: 5333-5338.
- King MR, Bansal D, Kim MB, Sarelius IH (2004). The Effect of Hematocrit and Leukocyte Adherence on Flow Direction in the Microcirculation. *Ann. Biomed. Eng.* 32: 803-814.
- Lowe GD (1994). Should plasma viscosity replace the ESR? *Br. J. Haematol.* 86: 6-11.
- Lowe GD, Wood DA, Douglas JT, Riemersma RA, Macintyre CC, Takase T, Tuddenham EG, Forbes CD, Elton RA, Oliver MF (1991). Relationships of plasma viscosity, coagulation and fibrinolysis to coronary risk factors and angina. *Thromb. Haemost.* 65: 339-343.
- Ng KC, Lai SW (2002). Clinical analysis of the related factors in acute appendicitis. *Yale. J. Biol. Med.* 75: 41-45.
- Woodward M, Lowe G, Rumley A, Imhof A, Koenig W (2003). Measurement of plasma viscosity in stored frozen samples: a general population study. *Blood Coagul. Fibrinolysis.* 14: 417-420.
- Yetkin O, Tek I, Kaya A, Ciledag A, Numanoglu N (2006). A simple laboratory measurement for discrimination of transudative and exudative pleural effusion: pleural viscosity. *Respir. Med.* 100: 1286-1290.
- Yetkin O, Tek I, Yetkin F, Numanoglu N (2001). Value of plasma viscosity as an acute phase reactant in patients with pneumonia. *Chest.* 120: 234S.