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Evaluation of Nasal Mucociliary Clearance in Patients with Sperm Motility Disorder

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ABSTRACT

Nasal mucociliary clearance (NMC) is a vital defense mechanism. Given the structural similarities between respiratory cilia and sperm flagella, this study evaluated NMC duration in patients with asthenozoospermia. This prospective study included 10 patients with isolated asthenozoospermia and 10 healthy controls. Individuals with a history of smoking, allergic rhinitis, nasal polyps, or use of medications affecting NMC were excluded. NMC was measured using the saccharin test. The mean age was 34.6±4.4 years in the patient group and 29.6±3.7 years in the control group. The mean NMC duration was longer in the asthenozoospermia group than in the control group (12.7 vs. 7.2 min); however, the difference did not reach statistical significance (p=0.08). Although a longer mean NMC duration was observed in the asthenozoospermia group, the difference was not statistically significant, and clearance times remained within normal physiological limits. These preliminary findings suggest that isolated asthenozoospermia is not routinely accompanied by overt or subclinical nasal mucociliary dysfunction.

Keywords: Asthenozoospermia, infertility, male, mucosiliary, nasal

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INTRODUCTION

Nasal mucociliary clearance is a fundamental defense mechanism of the upper respiratory tract, responsible for removing inhaled particles, pathogens, and debris through the coordinated interaction of mucus production and ciliary activity.[1–3] Effective mucociliary transport depends on the structural integrity and synchronized beating of motile cilia lining the respiratory epithelium. Disruption of this system may lead to impaired clearance, predisposing individuals to recurrent infections and chronic airway disease.[3] A variety of methods have been developed to assess mucociliary function, including both in vivo and in vitro techniques. Among these, the saccharin test remains one of the most widely used because of its simplicity, noninvasiveness, and cost-effectiveness, with results shown to correlate well with more advanced measurement techniques.[2,3] Normal mucociliary clearance times typically range from 9 to 17 minutes, with prolonged durations indicating impaired ciliary function.

In the clinical assessment of infertility, semen analysis is indispensable, particularly because sperm motility serves as a critical predictor of reproductive success. Asthenozoospermia, defined

Table 1. Demographic data and nasal mucociliary clearance parameters of the asthenozoospermia and control groups

Parameters	Asthenozoospermia group (n=10)	Control froup (n=10)	p
Age (years), mean±SD	34.6±4.4	29.6±3.7	0.052
NMC duration (min), mean±SD	12.7±8.5	7.2±1.8	0.080
NMC duration (min), median (IQR)	10.2 (9.1–16.8)	6.8 (5.9–8.2)	0.095

IQR: Interquartile range; NMC: Nasal mucociliary clearance; SD: Standard deviation.

as reduced sperm motility, is one of the most common abnormalities identified in infertile men and is frequently associated with defects in the sperm flagellum.[4] The sperm flagellum and motile respiratory cilia share a highly conserved axonemal ultrastructure characterized by a "9+2" microtubule arrangement and dynein arms that generate motility.[5] Structural or functional defects in these components may impair motility across different biological systems.

This relationship is well established in primary ciliary dyskinesia (PCD), a genetically heterogeneous disorder characterized by defective ciliary motility that leads to chronic respiratory disease, impaired mucociliary clearance, and male infertility due to immotile or dysmotile sperm.[6,7] Recent advances in molecular genetics have further demonstrated that mutations affecting axonemal proteins can result in a broad spectrum of clinical phenotypes, ranging from classic PCD to milder or subclinical forms of ciliopathy.[7–9] Within this spectrum, patients with isolated asthenozoospermia may plausibly harbor subtle axonemal defects that also impair respiratory mucociliary clearance, even in the absence of overt systemic ciliopathy.

Therefore, the aim of the present study was to evaluate nasal mucociliary clearance in patients with isolated asthenozoospermia and to investigate whether a functional relationship exists between sperm motility and respiratory ciliary activity. We hypothesized that patients with sperm motility disorders would exhibit prolonged mucociliary clearance times compared with healthy controls, reflecting a shared underlying dysfunction in axonemal structure.

METHODS

This prospective case–control study was conducted at the Departments of Otorhinolaryngology and Urology at Erciyes University Faculty of Medicine. Ethical approval for this study was obtained from Erciyes University Health Sciences Research Ethics Committee (Approval Number: 2024/296, Date: 18.12.2024). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The study included 10 male patients with isolated asthenozoospermia and 10 healthy controls. Patients were recruited from individuals undergoing infertility evaluation in the urology clinic. Asthenozoospermia was defined based on semen analysis performed according to World Health Organization (WHO) criteria.[4] Only patients with isolated sperm motility disorders and normal hormonal profiles, including gonadotropins, thyroid hormones, and prolactin, were included. The control group consisted of healthy male volunteers with normal semen parameters or individuals from infertile couples with confirmed female-factor infertility and a normal male evaluation. Participants older than 18 years were included in the study.

To minimize confounding factors affecting mucociliary clearance, the exclusion criteria included a history of smoking, allergic rhinitis, nasal polyposis, previous nasal surgery, recent upper respiratory tract infection (within the last 2 weeks), use of medications known to affect mucociliary function, chronic diseases affecting mucociliary clearance, advanced varicocele, previous surgical procedures (such as orchiectomy, orchiopexy, or inguinal herniorrhaphy), and previous infections affecting testicular function or the ejaculatory ducts (such as epididymo-orchitis and urethritis).

All participants underwent a detailed otorhinolaryngological examination before inclusion. Nasal mucociliary clearance was assessed using the saccharin test according to a standardized protocol. A small saccharin particle (1–2 mm) was placed on the anterior portion of the inferior turbinate under direct visualization in a controlled setting. Participants were instructed to breathe normally without sneezing, coughing, sniffing, or manipulating the nose and to report their first perception of a sweet taste. The time interval was recorded in minutes as the mucociliary clearance time. To minimize observer bias, the evaluator recording the transit times was blinded to the participants' group assignments.

All data were analyzed using IBM SPSS Statistics (version 27; IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean±standard deviation, and normality of distribution was assessed using appropriate methods, including the Shapiro–Wilk test. The Mann–Whitney U test or independent-samples t-test was used to compare the patient and control groups, as appropriate according to the data distribution. For all analyses, $p<0.05$ was considered statistically significant.

RESULTS

The mean age was 34.6±4.4 years in the patient group and 29.6±3.7 years in the control group (p=0.052). Although the mean clearance time was numerically longer in patients (12.7±8.5 minutes; median, 10.2 min) than in controls (7.2±1.8 minutes; median, 6.8 min), this difference did not reach statistical significance (p=0.08). Importantly, the mean value in the patient group remained within the established physiological reference range of 9–17 minutes (Table 1).

DISCUSSION

The present study aimed to investigate nasal mucociliary clearance in patients with isolated asthenozoospermia based on the hypothesis that the shared "9+2" axonemal ultrastructure of sperm flagella and motile respiratory cilia may result in parallel dysfunction.[1–3,5] Although our findings did not reach statistical significance, a clear trend toward prolonged mucociliary clearance time was observed in the patient group compared with healthy controls (12.7 vs. 7.2 minutes, p=0.08). While the classical association between ciliary immotility and infertility is well established in syndromic conditions such as primary ciliary dyskinesia.[6–8] Our study explores a more subtle and clinically underrecognized scenario. These preliminary findings raise the possibility that isolated asthenozoospermia may represent a subclinical phenotype within a broader ciliopathy spectrum, a concept that warrants further investigation.[5,9]

Despite the lack of statistical significance, the observed difference in mucociliary clearance time is noteworthy. A p-value of 0.08 suggests a trend that may have reached statistical significance with a larger sample size. Indeed, insufficient statistical power due to the limited sample size (n=20) is one of the most important limitations of this study and increases the likelihood of a type II error. Future studies with larger cohorts are needed to validate these findings and better characterize the magnitude of this association.

The method used to assess mucociliary clearance should also be considered. The saccharin test is a widely accepted, noninvasive, and cost-effective technique, with results comparable to those obtained using more complex methods.[2,3] However, it is inherently subjective and depends on patient perception. Recent advances in the assessment of ciliary function allow for more precise evaluation of ciliary beat frequency and pattern.[10] The lack of such objective measurements in the present study represents another limitation.

In addition, the cross-sectional design precludes causal inference between sperm motility disorders and mucociliary dysfunction. Ultrastructural or genetic analyses were not performed; therefore, the hypothesis of underlying subclinical axonemal defects remains speculative. Although rigorous exclusion criteria were applied, the potential influence of unrecognized variables cannot be completely excluded.

Nevertheless, this study also has several important strengths. To our knowledge, it is among the first to specifically investigate nasal mucociliary clearance in patients with isolated asthenozoospermia, addressing a relatively unexplored clinical question. The prospective design and inclusion of an age-matched control group enhance the internal validity of the findings. Furthermore, the application of strict exclusion criteria reduces the impact of known confounders, allowing for a more focused evaluation of the relationship between sperm motility and mucociliary function. The use of a standardized and widely accepted method further supports the reproducibility and clinical applicability of the results.

From a clinical perspective, prolonged mucociliary clearance in patients with sperm motility disorders may reflect broader systemic ciliary dysfunction rather than an isolated reproductive abnormality. Given that semen analysis remains the cornerstone of male infertility evaluation.[4] Identifying associated extrapulmonary functional impairments may provide additional insight into the underlying pathophysiological mechanisms.[6,9] If this association is confirmed in larger cohorts, patients presenting with asthenozoospermia could potentially benefit from a comprehensive otorhinolaryngological evaluation to facilitate earlier recognition of mild or atypical forms of ciliary dysfunction.

Conversely, subtle mucociliary dysfunction in otherwise asymptomatic individuals may provide clues to underlying subclinical ciliopathies. Such an approach could contribute to earlier recognition of mild or atypical forms of ciliary dysfunction, which are currently underdiagnosed.

In conclusion, our results demonstrate no statistically significant difference in nasal mucociliary clearance time between patients with isolated asthenozoospermia and healthy controls, with mean clearance times remaining within normal physiological limits. These findings do not currently provide sufficient evidence to support the presence of subclinical ciliary dysfunction in isolated sperm motility disorders. Future prospective studies using larger patient cohorts, objective measurements of ciliary beat frequency, and ultrastructural axonemal evaluations are warranted.

Ethics Committee Approval: Ethics committee approval was obtained from Erciyes University Health Sciences Research Ethics Committee (Approval Number: 2024/296, Date: 18.12.2024).

Informed Consent: Informed consent was obtained from all patients and control group participants.

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