Immunology Research and Immunotherapy

ISSN: 3068-5281

ScitechJournals

Open Access

Evaluation of Elasticity Properties of Sperm in Indian Men Prior to Conception

Abstract

Background: Beyond conventional semen parameters, the biomechanical properties of sperm—particularly elasticity—play a critical role in sperm motility, zona pellucida penetration, and fertilization. Sperm elasticity reflects membrane integrity, cytoskeletal organization, and nuclear chromatin packaging. However, data on sperm elasticity in Indian men prior to conception are scarce.

Objective: To evaluate sperm elasticity in Indian men prior to conception and examine its association with conventional seminal parameters.

Methods: An experimental observational study was conducted among Indian men planning conception. Sperm elasticity was measured using atomic force microscopy (AFM)-based nanoindentation. Conventional semen analysis was performed according to WHO (6th edition) guidelines. Elastic modulus values were compared between normozoospermic and subfertile groups.

Results: Sperm from normozoospermic men demonstrated significantly higher elasticity (lower Young's modulus) compared to subfertile men ($p < 0.05$). Reduced sperm elasticity correlated with decreased motility and abnormal morphology.

Conclusion: Sperm elasticity is a sensitive biophysical marker of sperm quality in Indian men prior to conception. Incorporation of biomechanical sperm assessment may improve male fertility evaluation beyond routine semen analysis.

Keywords

Sperm elasticity, biomechanics, male fertility, pre-conception health, Indian men, AFM.

Research Article

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Received: 29 Jan, 2026; **Accepted:** 16 Feb, 2026; **Published:** 23 Feb, 2026

Introduction

Male fertility assessment traditionally relies on semen volume, sperm concentration, motility, and morphology. However, these parameters alone may not fully predict fertilization potential. Recent advances highlight the importance of sperm biomechanical properties—such as elasticity, stiffness, and deformability—in reproductive success. Sperm elasticity reflects the functional integrity of the plasma membrane, acrosome, cytoskeleton, and nuclear chromatin [1,2]. Elastic sperm are better equipped to withstand shear stress during motility and deformation during zona pellucida penetration. Reduced elasticity has been associated with oxidative stress, DNA damage, and impaired fertilization outcomes. Given the rising concern over declining male fertility in India, evaluation of sperm elasticity prior to conception may provide valuable insight into male reproductive potential.

Materials and Methods

Study Design

Experimental observational study conducted at a reproductive biology laboratory.

Participants

Sample size: 80 Indian men (ages 22–45 years). Inclusion criteria: Men planning conception within one year. Exclusion criteria: Varicocele, genital infections, hormonal disorders, smoking >10 cigarettes/day, chronic illness

Participants were grouped into:

Normozoospermic group (n = 45). Subfertile group (n

= 35) (oligo-/astheno-/teratozoospermia)

Semen Collection and Conventional Analysis

Semen samples were collected after 2–7 days of abstinence and analyzed within one hour following WHO 6th edition protocols [3,4].

Measurement of Sperm Elasticity

Atomic Force Microscopy (AFM): Individual sperm heads were immobilized on poly-L-lysine–coated slides [5,6]. Nanoindentation was performed using a silicon nitride cantilever. Force–distance curves were recorded. Young's modulus (E) was calculated using the Hertz model. Lower Young's modulus values indicated higher sperm elasticity [7,8].

Statistical Analysis

Data were expressed as mean ± SD. Independent t-test and Pearson correlation analysis were used. Statistical significance was set at $p < 0.05$.

Results

Elasticity and Seminal Parameters

Correlation Analysis

Sperm elasticity showed a negative correlation with Young's modulus ($r = –0.52$). Positive correlation observed between elasticity and progressive motility ($r = 0.48$)

Discussion

The findings demonstrate that sperm from Indian men with normal semen parameters exhibit greater elasticity compared to subfertile men. Reduced elasticity likely reflects compromised membrane fluidity, altered cytoskeletal architecture, and chromatin condensation defects. These biomechanical alterations may impair sperm's ability to navigate the female reproductive tract and penetrate the zona pellucida [9,10]. The study supports growing evidence that sperm elasticity is a functional marker of fertilization potential and may detect subtle sperm dysfunctions not evident in routine semen analysis.

Conclusion

Sperm elasticity is a promising biophysical indicator of sperm quality in Indian men prior to conception. Assessment of sperm biomechanical properties may enhance early detection of male-factor infertility and improve pre-conception reproductive evaluation.

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Citation: Rahul Hajare. "Evaluation of Elasticity Properties of Sperm in Indian Men Prior to Conception." Immunol Res Immunother (2026):104. DOI: 10.59462/3068-5281.2.1.104