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Relationship between pre-micro-TESE serum anti-Müllerian hormone (AMH) levels and sperm retrieval success in patients diagnosed with non-obstructive azoospermia: A retrospective study

Non-obstrüktif azoospermi tanılı hastalarda mikro-TESE öncesi serum anti-Müllerian hormon (AMH) düzeyleri ile sperm elde etme başarısı arasındaki ilişki: Retrospektif bir çalışma

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Abstract

Objective: We aimed to evaluate the relationship between serum anti-Müllerian hormone (AMH) levels measured before microdissection testicular sperm extraction (mTESE) and sperm retrieval (SR) success in men diagnosed with non-obstructive azoospermia (NOA).

Materials and Methods: The present study was based on retrospective evaluation of 58 patients who presented to our clinic between January 2025 and April 2026, were diagnosed with NOA, and underwent mTESE. Patient age, duration of infertility, serum AMH, follicle-stimulating hormone (FSH), luteinizing hormone (LH) testosterone levels, and the AMH/testosterone ratio were recorded. Demographic and hormonal parameters were compared between the successful SR (+SR) and unsuccessful SR (-SR) groups after mTESE.

Results: The mean age of the study population (n=58) was 35.53±6.10 years, and the mean infertility duration was 8.25±4.53 years. The mean serum AMH level was 2.42±2.35 ng/mL (median: 2.14 ng/mL; range: 0.01-9.87 ng/mL). +SR was achieved in 29 patients (50%), whereas no sperm could be retrieved in the remaining 29 patients (50%). Comparison of two groups revealed no statistically significant difference between the sperm-positive and sperm-negative groups with respect to age, duration of infertility, AMH, FSH, LH, testosterone, or the AMH/testosterone ratio. Receiver operating characteristic analysis revealed an area under the curve value of 0.531 for AMH (95% confidence interval: 0.379-0.683, p=0.690), indicating no significant predictive value. Binomial logistic regression analysis also found no variable to be a significant predictor of +SR.

Conclusion: Serum AMH level, either alone or in combination with other hormonal parameters, was not found to be a reliable clinical biomarker for predicting SR outcomes in men with NOA undergoing mTESE. Larger, prospective, etiologically stratified studies are required to determine the definitive role of AMH in preoperative evaluation.

Keywords: Anti-Müllerian hormone, microdissection testicular sperm extraction, non-obstructive azoospermia

PRECIS: Serum anti-Müllerian hormone levels are not a reliable predictor of sperm retrieval success in men with non-obstructive azoospermia undergoing microdissection testicular sperm extraction.

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Öz

Amaç: Bu çalışmanın amacı, non-obstrüktif azoospermi (NOA) tanılı hastalarda mikrodiseksiyon testiküler sperm ekstraksiyonu (mTESE) öncesi ölçülen serum anti-Müllerian hormon (AMH) düzeyi ile sperm elde etme (SR) başarısı arasındaki ilişkinin değerlendirilmesidir.

Gereç ve Yöntemler: Ocak 2025-Nisan 2026 tarihleri arasında kliniğimizde NOA tanısı ile mTESE uygulanan 58 hastanın dosyaları retrospektif olarak analiz edildi. Hastaların yaş, infertilite süresi, serum AMH, folikül uyarıcı hormon (FSH), luteinleştirici hormon (LH) ve testosteron düzeyleri ile AMH/testosteron oranları kaydedildi. Demografik ve hormonal parametreler, mTESE sonrası sperm elde edilen (+SR) ve sperm elde edilemeyen (-SR) grupları arasında karşılaştırıldı.

Bulgular: Çalışmaya dahil edilen 58 hastanın ortalama yaşı 35,53±6,10 yıl olup, ortalama infertilite süresi 8,25±4,53 yıl idi. Ortalama serum AMH düzeyi 2,42±2,35 ng/mL (medyan: 2,14 ng/mL; aralık: 0,01-9,87 ng/mL) idi. mTESE sonrası 29 hastada (%50) +SR, diğer 29 hastada (%50) -SR. +SR ve -SR gruplar arasında yaş, infertilite süresi, AMH, FSH, LH, testosteron veya AMH/testosteron oranı açısından istatistiksel olarak anlamlı fark bulunmadı. Alıcı işletim karakteristiği analizinde AMH için eğri altındaki alan değeri 0,531 (95% güven aralığı: 0,379-0,683, p=0,690) olarak bulundu ve bu sonuç anlamlı bir öngörü değeri olmadığını göstermektedir. Binomial lojistik regresyon analizinde de hiçbir değişken +SR anlamlı bir belirleyicisi olarak bulunmadı.

Sonuç: Serum AMH düzeyi, tek başına veya diğer hormonal parametrelerle birlikte, NOA hastalarında mTESE başarısını öngören güvenilir bir biyobelirteç değildir. Daha geniş ve prospektif çalışmalar gereklidir.

Anahtar Kelimeler: Anti-Müllerian hormon, mikro-TESE, non-obstrüktif azoospermi

Introduction

Azoospermia represents the absence of detectable spermatozoa upon microscopic examination of a centrifuged ejaculate sample in at least two consecutive examinations. Its prevalence is approximately 1% of the general male population, but increases to 10-15% among men presenting with infertility[1]. Azoospermia is categorized into two types: obstructive and non-obstructive. In the obstructive type, although sperm production in the testes is normal, spermatozoa cannot adequately mix with the ejaculate due to an obstruction at some point along the genital tract. Non-obstructive azoospermia (NOA), on the other hand, is defined as inadequate sperm production resulting from testicular disorders, leading to the absence of sperm in the ejaculate[2].

For patients with NOA, testicular sperm extraction (TESE) serves as a key surgical method to obtain spermatozoa for use in assisted reproductive treatment[3-5]. The principal techniques employed for testicular sperm retrieval (SR) included conventional TESE (cTESE) and microdissection TESE (mTESE)[6]. The mTESE technique is increasingly preferred due to its higher SR success rate and reduced tissue loss compared to cTESE[7]. However, the lack of reliable clinical markers that can preoperatively predict whether successful SR can be achieved with mTESE in men with NOA remains a significant problem[8]. Although various studies have reported positive SR (+SR) rates ranging from 30% to 60% in this field, mTESE still results in unsuccessful SR (-SR) in a considerable proportion of men with NOA[9,10]. Therefore, clinicians and patients must weigh the anticipated outcome of mTESE against the possibility of retrieval failure before the procedure. This uncertainty imposes a heavy burden on both physicians and patients, leading to unnecessary physical and emotional stress. Over the past decades, various investigations have focused on detecting reliable markers capable of predicting +SR. The predictive potential of various hormones, such as follicle-stimulating hormone (FSH), inhibin B (InhB), and anti-Müllerian hormone (AMH), has been investigated. The logical basis for the predictive ability of these hormones on SR lies in their fundamental roles in spermatogenesis and their function as markers of Sertoli cell maturation[11]. However, the literature has yielded mixed results regarding their predictive value. Serum AMH level has been proposed as a potential predictor, particularly in cases of idiopathic NOA (iNOA) where the cause of azoospermia is unknown[12]. In recent studies, it has been suggested that there might be a relationship between serum AMH levels and mTESE success in patients with NOA, but the results have been heterogeneous[13].

This study aims to evaluate the relationship between preoperative serum AMH levels and the success rate of SR following mTESE in male patients diagnosed with NOA who presented to our clinic for assisted reproductive techniques.

Materials and Methods

Medical records of men diagnosed with NOA who underwent mTESE at Acıbadem Maslak Hospital IVF Center between January 2025 and April 2026 were retrospectively reviewed. Ethical approval of the study was obtained from the Acıbadem University Ethics Committee (approval number: 2026-10/421, date: 11.06.2026), and the study was conducted in accordance with the principles of the 1975 Declaration of Helsinki, as revised in 2000. Informed consent was obtained from all participants prior to inclusion.

The required sample size was calculated as 56 patients for an SR+/SR- ratio of 1, assuming a power of 80%, a type 1 error of 0.05, and an area under the curve (AUC) of 0.703. A total of 184 patient files were reviewed, and 58 patients were included in the study.

Inclusion criteria:

1. Having been diagnosed with NOA,
2. Having undergone mTESE at our clinic,
3. Having had serum AMH level measured prior to mTESE (Figure 1).

For each patient file, patient age, duration of infertility, serum AMH, FSH, luteinizing hormone (LH) and total testosterone levels, karyotype, additional etiological factors for NOA (history of mumps or undescended testis), previous TESE history and its outcome, and the presence or absence of sperm following mTESE were recorded.

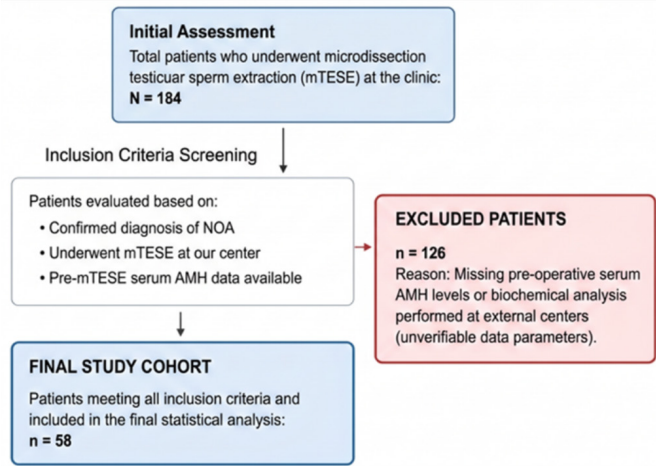


Figure 1. Flow chart of patient selection. Of 184 men who underwent mTESE at our center, 126 were excluded because preoperative serum AMH was unavailable or biochemical analyses had been performed at an external laboratory and could not be verified, leaving 58 men for analysis

AMH: Anti-Müllerian hormone, NOA: Non-obstructive azoospermia, mTESE: Microdissection testicular sperm extraction

mTESE

Semen Analysis

Semen samples were collected after a period of 2 to 5 days of sexual abstinence. Samples were obtained by masturbation and collected in a sterile container. Following a waiting period of 20-30 minutes in the laboratory, during which the semen changes from a gel-like to a liquid consistency, it is examined directly under a microscope. Prior to microscopic examination, the semen is evaluated macroscopically, and semen volume, odor, color, viscosity, and pH are noted. Microscopic examination assesses the presence or absence of sperm in the semen, as well as sperm count, motility, and morphology.

A diagnosis of azoospermia is made when no sperm are observed in the semen on two consecutive occasions one month apart. In patients with no visible sperm, the next step is to re-evaluate the semen after centrifugation. The semen is placed in a tube, centrifuged at 3000 rpm for 10-15 minutes, and the resulting pellet is re-examined for the presence of sperm. A diagnosis of azoospermia is made in patients with no sperm observed after centrifugation.

Diagnosis of NOA

Patients diagnosed with azoospermia are evaluated by a urologist at our clinic. First, a detailed medical history is obtained, and a testicular examination is performed. On testicular examination, palpation of atrophic testes is recorded as a finding suggestive of NOA. Following the physical examination, the patient's hormonal profile is assessed. At our clinic, FSH, LH, and total testosterone levels are routinely measured. Recently, AMH levels have also been included in the routine protocol for patients scheduled for mTESE. In the hormonal profile, FSH >10-12 IU/L and total testosterone <300 ng/dL (10-12 nmol/L) are considered significant for NOA. In vitro fertilization (IVF) treatment is planned for patients diagnosed with NOA. In appropriate patients diagnosed with NOA, treatment with clomiphene citrate and antioxidant therapy is initiated before the mTESE procedure.

mTESE Procedure

The patient is placed on the operating table in the supine position. The scrotal skin is stretched over the anterior surface of the testis, and a single 2-3 cm midline scrotal incision is made. The testis, along with the spermatic cord, is delivered through the incision. The testicular parenchyma is then exposed under 6-8x microscopic magnification. The testicular parenchyma is dissected at 16-25x magnification, and dilated tubular structures are excised. The excised testicular tissue samples are sent to the IVF laboratory in a Petri dish containing sperm solution. The procedure is terminated in patients in whom sperm are found; in patients with no sperm found, biopsy samples are taken for histopathological diagnosis.

Statistical Analysis

Jamovi (version 2.6.44) software was utilized for all statistical analysis. Data distribution characteristics were evaluated for normality with Shapiro-Wilk test. For variables not following a normal distribution, descriptive statistics were presented as median and mean ± standard deviation. When normality assumptions were not met, the Mann-Whitney U test was applied to compare variables between the study groups. For normally distributed variables, the Independent Samples t-test was used. The diagnostic accuracy of hormonal markers (AMH, FSH, LH, testosterone and the AMH/testosterone ratio) in predicting +SR with mTESE was evaluated using receiver operating characteristic (ROC) curve analysis. The AUC and 95% confidence interval (CI) were calculated. AUC values were calculated with +SR as the positive outcome, assuming that higher marker values predict +SR; values below 0.5 therefore indicate an inverse association. Standard errors and 95% CIs were calculated with the DeLong method. Binomial Logistic Regression analysis was performed to evaluate the independent effects of demographic and hormonal parameters in distinguishing between groups with +SR and -SR. Given the number of +SR events (n=29), the model was limited to three predictors (AMH, age and FSH) to avoid overfitting. The reference category for the dependent variable was set as "-SR." Model fit was evaluated using the Omnibus test (χ^2), McFadden's R^2, and AIC values. The presence of multicollinearity among variables was examined using the variance inflation factor (VIF); a VIF value >5 was considered indicative of multicollinearity. Across all statistical procedures, a p-value below 0.05 was regarded as indicative of statistical significance.

Results

The demographic and hormonal characteristics of the 58 patients are summarized in Table 1. The mean age of the patients was 35.53±6.10 years, and the mean infertility duration was 8.25±4.53 years. The mean serum AMH level was 2.42±2.35 ng/mL, with a median value of 2.14 ng/mL (range: 0.01-9.87 ng/mL). +SR was achieved in 29 patients (50%), whereas -SR was observed in the remaining 29 (50%). A previous TESE history was present in 42 patients (72.4%), with prior SR success in 14 (33.3%) and failure in 28 (66.7%). Most patients had a normal karyotype (89.7%), while chromosomal abnormalities were detected in 10.3%, including Klinefelter syndrome (6.9%), translocation (1.7%), and inversion (1.7%). No identifiable etiology for NOA was found in 81.0% of patients; a history of undescended testis and mumps was reported in 12.1% and 6.9%, respectively.

No statistically significant differences were observed between the +SR and -SR groups for any of the demographic or hormonal parameters (Table 2). The mean age was 35.21±6.16 years in the -SR group and 35.86±6.13 years in the +SR group, with no significant difference between the groups (p=0.554). Infertility duration was also comparable between the two groups (8.21±4.17 years vs. 8.29±4.94 years, respectively; p=0.876). Table 2 compares the demographic and hormonal parameters between micro-TESE groups. Regarding hormonal parameters, no statistically significant difference was found in AMH levels between the groups (-SR: 2.14±1.89 ng/mL; +SR: 2.69±2.74 ng/mL; p=0.692) (Figure 2). Although FSH levels were numerically higher in the -SR group (26.30±19.02 IU/L) compared to the +SR group (22.67±20.21 IU/L), this difference did not reach statistical significance (p=0.347). No significant differences were observed for LH (p=0.539) or testosterone (p=0.975). In the ROC analysis, none of the serum hormonal markers including AMH, FSH, LH, and testosterone showed statistically significant predictive value for +SR during mTESE in patients with NOA . All AUC values ranged between 0.43 and 0.53, with p-values >0.05, indicating that these biomarkers alone cannot reliably distinguish between sperm-positive and sperm-negative groups. Therefore, the clinical utility of these individual hormone levels as standalone preoperative predictors for mTESE success is not supported by this analysis (Table 3, Figure 3).

A binomial logistic regression analysis was performed to predict +SR in patients with NOA undergoing mTESE. Table 4 shows the binomial logistic regression analysis for predicting +SR with mTESE. The model included AMH, age and FSH as independent variables. None of the variables emerged as a significant predictor of +SR (AMH: odds ratio: 1.098, 95% CI: 0.853-1.414, p=0.467). The overall model was not statistically significant (Omnibus χ^2=1.30, df=3, p=0.730), and the McFadden's R^2 value was 0.016, indicating very poor explanatory power. All VIF values were below 5 (highest VIF=1.20 for AMH). These findings are consistent with the univariate analyses (ROC and

Table 1. Descriptive characteristics of the study population (n=58)

Variable	Mean ± SD	Median (min-max)
Age (years)	35.53±6.10	35.00 (26-52)
AMH (ng/mL)	2.42±2.35	2.14 (0.01-9.87)
FSH (IU/L)	24.49±19.54	20.40 (3.10-115.00)
LH (IU/L)	12.19±7.98	8.77 (2.12-38.30)
Testosterone (nmol/L)	11.10±9.48	7.80 (1.25-52.60)
Infertility duration (years)	8.25±4.53	8.00 (1.00-23.00)
AMH/testosterone ratio	0.37±0.66	0.18 (0.003-4.58)
mTESE outcome	**n**	**%**
-SR	29	50.0
+SR	29	50.0

Continuous variables are presented as mean ± SD and median (min-max); categorical variables as n (%)
AMH: Anti-Müllerian hormone, FSH: Follicle-stimulating hormone, LH: Luteinizing hormone, mTESE: Microdissection testicular sperm extraction, SD: Standard deviation, -SR: Negative sperm retrieval, +SR: Positive sperm retrieval

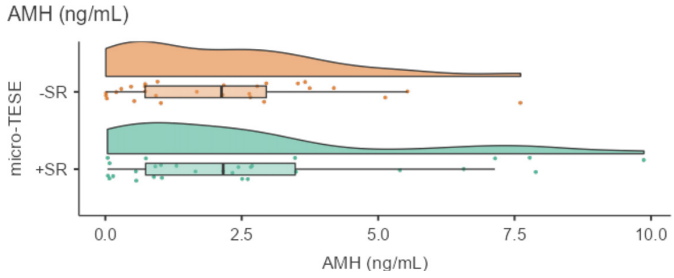


Figure 2. Distribution of preoperative serum AMH in men with negative (-SR) and positive (+SR) sperm retrieval at mTESE. For each group the density curve, the box plot (median, IQR and 1.5×IQR whiskers) and the individual values are shown. AMH levels did not differ significantly between the groups (2.14±1.89 vs. 2.69±2.74 ng/mL; p=0.692)

AMH: Anti-Müllerian hormone, NOA: Non-obstructive azoospermia, IQR: Interquartile range, mTESE: microdissection testicular sperm extraction, SR: Sperm retrieval

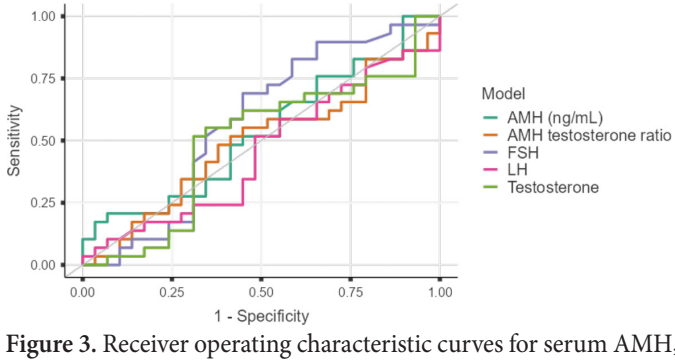


Figure 3. Receiver operating characteristic curves for serum AMH, FSH, LH, testosterone and the AMH/testosterone ratio in predicting positive sperm retrieval at mTESE. The diagonal line indicates no discrimination (AUC=0.5). Corresponding AUC values and 95% confidence intervals are given in Table 3

AMH: Anti-Müllerian hormone, AUC: Area under the curve, FSH: Follicle-stimulating hormone, LH: Luteinizing hormone; mTESE: Microdissection testicular sperm extraction

Table 2. Comparison of demographic and hormonal parameters between the -SR and +SR groups

Variables	Groups	Mean ± SD	Median (IQR)	p-value
Age (years)	-SR	35.21±6.16	33.00 (10)	0.554
	+SR	35.86±6.13	35.00 (6)	
AMH (ng/mL)	-SR	2.14±1.89	2.13 (2.22)	0.692
	+SR	2.69±2.74	2.16 (2.74)	
FSH (IU/L)	-SR	26.30±19.02	25.00 (28.7)	0.347
	+SR	22.67±20.21	16.70 (13.5)	
LH (IU/L)	-SR	12.80±7.50	8.72 (10.13)	0.539
	+SR	11.57±8.52	8.81 (6.15)	
Testosterone (nmol/L)	-SR	11.46±11.37	6.00 (15.32)	0.975
	+SR	10.74±7.30	11.90 (12.24)	
Infertility duration (years)	-SR	8.21±4.17	8.00 (5)	0.876
	+SR	8.29±4.94	8.00 (6)	
AMH testosterone ratio	-SR	0.267±0.250	0.188 (0.312)	0.902
	+SR	0.462±0.894	0.172 (0.348)	

Data are presented as mean ± SD and median (interquartile range). p-values were obtained with the Mann-Whitney U test
AMH: Anti-Müllerian hormone, FSH: Follicle-stimulating hormone, IQR: Interquartile range, LH: Luteinizing hormone, SD: Standard deviation, -SR: Negative sperm retrieval, +SR: Positive sperm retrieval

Table 3. Predictive performance of serum hormonal markers for SR in mTESE

			95% CI		
	AUC	**SE**	**Lower**	**Upper**	**p**
AMH	0.531	0.0775	0.379	0.683	0.690
FSH	0.427	0.0790	0.273	0.582	0.358
LH	0.452	0.0773	0.301	0.604	0.538
Testosterone	0.497	0.0798	0.341	0.654	0.970
AMH/testosterone ratio	0.510	0.0779	0.357	0.663	0.897

AUC values were calculated with +SR as the positive outcome, assuming that higher marker values predict +SR; values below 0.5 indicate an inverse association. SE and 95% CIs were calculated with the DeLong method; p-values test the null hypothesis AUC: 0.5
AMH: Anti-Müllerian hormone, AUC: Area under the curve, CI: Confidence interval, FSH: Follicle-stimulating hormone, LH: Luteinizing hormone, mTESE: Microdissection testicular sperm extraction, SE: Standard error, +SR: Positive sperm retrieval

Mann-Whitney U test), demonstrating that neither AMH nor the other parameters assessed can reliably predict +SR in patients with NOA undergoing mTESE.

Comparison according to previous TESE history is presented in Table 5. Of the 58 patients included in the study, 42 (72.4%) had undergone at least one previous TESE procedure, whereas 16 (27.6%) had no history of TESE. Patients with a previous TESE history exhibited significantly lower serum testosterone levels compared with those without prior TESE (9.77±9.99 vs. 14.60±7.12 nmol/L, p=0.019). In addition, the duration of infertility was significantly longer in the previous TESE group (9.39±4.35 vs. 5.25±3.61 years, p=0.001). No significant differences were observed between the groups regarding age, serum AMH, FSH, LH levels, or the AMH/testosterone ratio (all p>0.05).

Discussion

AMH has become a focus of increasing interest due to its potential role in predicting +SR with mTESE in men diagnosed with NOA or iNOA[14-17]. AMH is secreted by Sertoli cells and plays an important role in the development and physiological function of the testes[18]. Although the exact role of AMH in adult males is still being investigated, it is thought to be linked to the process of spermatogenesis. Like InhB, AMH has been proposed as a surrogate marker of Sertoli cell maturation; in this context, less mature cells produce more AMH compared to more mature cells, which likely reflects the degree of spermatogenesis[19-23]. This has led to the hypothesis that AMH levels may predict SR in mTESE. Alfano et al.[14] were the first to demonstrate that higher serum AMH levels and a high AMH/testosterone ratio in men with iNOA might reflect the depletion of the intra-testicular germ cell reservoir. In particular, serum AMH levels and the AMH/total testosterone ratio appeared to be more reliable biomarkers of +SR in mTESE, providing a basis for future scientific investigations. Studies by Zhang et al.[16] and Deng et al.[17] confirmed these findings. These investigations assessed the predictive role of AMH specifically in iNOA and, more broadly, in NOA. This underscores the potential of AMH to reflect spermatogenesis across a wider spectrum of NOA etiologies. A recent multi-center collaborative study validated the role of AMH in predicting +SR in men with iNOA undergoing mTESE[12]. Our study also examined the relationship between AMH level and sperm positivity. When data from 58 patients with NOA who underwent mTESE were analyzed, the overall SR success rate (+SR) was found to be 50%. No significant differences were observed between the +SR and -SR groups regarding age or duration of infertility. Regarding hormonal parameters, no statistically significant difference in serum AMH levels was observed between the groups. ROC analysis yielded an AUC value for AMH of 0.531 (95% CI: 0.379-0.683, p=0.690), indicating that AMH does not possess significant predictive power for successful SR. Binomial logistic regression analysis also found no variable to be a significant predictor of successful SR.

In the study by Aboukhshaba et al.[24], serum AMH levels were found to have moderate value in predicting the chance of sperm finding in patients with no prior SR attempt, but were not a strong marker for the overall cohort or for patients with previous failed attempts. In a group of 18 men who had not undergone prior SR, serum AMH levels were significantly associated with SR. For treatment-naive patients, the optimal AMH threshold was determined as 0.133 ng/mL (sensitivity: 91%, specificity: 29%).

Table 4. Binomial logistic regression analysis for predicting successful SR with mTESE

Variables	Estimate (B)	SE	p	OR	95% CI (lower)	95% CI (upper)	VIF
Intercept	-0.97204	1.7526	0.579	0.378	0.012	11.74	-
Age (years)	0.02543	0.0455	0.576	1.026	0.938	1.121	1.04
AMH (ng/mL)	0.09367	0.1289	0.467	1.098	0.853	1.414	1.20
FSH (IU/L)	-0.00635	0.0151	0.673	0.994	0.965	1.023	1.17

The dependent variable was SR outcome, with -SR as the reference category; estimates represent the log odds of +SR. AIC: 87.11. Model fit: Omnibus χ^2=1.30, df=3, p=0.730; McFadden R^2=0.016
AIC: Akaike information criterion, AMH: Anti-Müllerian hormone, B: Regression coefficient, CI: Confidence interval, FSH: Follicle-stimulating hormone, mTESE: Microdissection testicular sperm extraction, OR: Odds ratio, SE: Standard error, VIF: Variance inflation factor, -SR: Negative sperm retrieval, +SR: Positive sperm retrieval

Table 5. Comparison of study parameters between patients with and without previous TESE history

Variable	Previous TESE (+) (n=42)	Previous TESE (-) (n=16)	p
Age (years)	35.88±5.71; 35.00 (8.50)	34.63±7.15; 32.00 (8.75)	0.488[a]
AMH (ng/mL)	2.27±2.11; 2.14 (2.21)	2.80±2.94; 2.06 (3.13)	0.728
FSH (IU/L)	26.55±21.39; 22.65 (18.11)	19.07±12.53; 17.20 (19.39)	0.265
LH (IU/L)	12.92±8.42; 9.05 (9.93)	10.25±6.54; 8.21 (9.12)	0.175
Testosterone (nmol/L)	9.77±9.99; 5.30 (12.53)	14.60±7.12; 14.54 (8.30)	**0.019**
Infertility duration (years)	9.39±4.35; 9.00 (4.38)	5.25±3.61; 4.50 (5.50)	**0.001**
AMH/testosterone ratio	0.42±0.75; 0.22 (0.35)	0.21±0.23; 0.14 (0.16)	0.216

Data are presented as mean ± standard deviation; median (interquartile range). [a]: Independent samples t-test; all other comparisons were performed with the Mann-Whitney U test. Bold p-values indicate statistical significance (p<0.05). AMH: Anti-Müllerian hormone, FSH: Follicle-stimulating hormone, LH: Luteinizing hormone, TESE: Testicular sperm extraction

A negative correlation was observed between serum AMH levels and FSH levels, and a positive correlation with testicular volume. It was emphasized that serum AMH level could be used as a marker to assess the likelihood of SR, particularly in patients undergoing mTESE for the first time, but should be evaluated together with patient history, physical examination, and other laboratory tests when making clinical decisions. The study by Aboukhshaba et al.[24] suggested that the predictive value of AMH might be limited specifically to patients who have never undergone a prior SR procedure (treatment-naive). In our study, we did not exclude patients with previous failed TESE attempts, which may have negatively affected the predictive performance of AMH and other hormonal markers. Indeed, the inclusion of patients with prior SR history who may represent a subgroup with more severe testicular pathology and impaired spermatogenic reserve could have introduced heterogeneity that masked the true predictive capacity of these parameters. This is supported by our univariate findings, which demonstrated that patients with previous TESE history had significantly lower testosterone levels and longer infertility duration, suggesting more advanced testicular dysfunction. However, despite these significant differences between groups, neither AMH nor any other parameter emerged as an independent predictor in the multivariable model.

In the study by Pozzi et al.[12], AMH levels were found to be a significant marker for predicting the likelihood of successful SR (+SR) during mTESE in men with iNOA. Men with +SR were found to have significantly lower basal serum AMH levels compared to men with -SR (p=0.005). Multivariable logistic regression analysis confirmed that low AMH levels were independently associated with successful SR, even after adjusting for factors such as age, testicular volume, and other hormones (FSH, estradiol). The study determined an AMH threshold of <4 ng/mL as providing the highest accuracy for predicting successful SR (accuracy: 70.3%, sensitivity: 73.9%, specificity: 66.6%). AMH is secreted by Sertoli cells in the testes. After puberty, as Sertoli cells mature, AMH levels decline. The findings of this study suggest that higher AMH levels in men with unsuccessful SR may reflect that Sertoli cells remain in an immature (primordial) state, consequently leading to more severely impaired spermatogenesis. The researchers emphasize that AMH levels should not be used as a sole decision-making criterion before mTESE surgery but rather as a valuable tool for counseling and guiding patients regarding their chance of success. There is no universally accepted cut-off value for serum AMH. Reported cut-off values in studies range from 0.133 ng/mL to 4 ng/mL. This suggests that the optimal cut-off value is population-specific. The distribution of AMH in our cohort may not overlap with previously established thresholds. Similarly, in the meta-analysis by Puia et al.[13], high serum AMH levels were found to have a negative association with SR success (SMD=-2.58; p<0.00001). This indicates that serum AMH levels are significantly linked to TESE outcomes. In contrast, no significant relationship was found between AMH levels in seminal plasma and SR success. It is thought that this may be due to proteolytic activity in seminal fluid degrading AMH and impairing measurement accuracy. AMH is secreted by Sertoli cells and reflects the functional status of these cells.

Low serum AMH levels in men with NOA may indicate Sertoli and germ cell dysfunction. In some conditions (e.g., Sertoli cell-only syndrome), AMH levels are markedly low. Although AMH is a promising biomarker, it cannot definitively predict the presence of sperm on its own. The overlap in AMH values between successful and unsuccessful cases, as well as high inter-individual variability, limits its clinical use. It is emphasized that using AMH together with other clinical and biochemical markers (e.g., the AMH/testosterone ratio) rather than alone may provide higher predictive accuracy. For instance, the AMH/testosterone ratio has been reported to offer better prediction than AMH alone in some studies. In summary, although serum AMH levels are a useful adjunctive tool for predicting TESE success, they should be interpreted together with other hormones and clinical findings when making clinical decisions[13]. In our analysis, the AMH/testosterone ratio also did not show significant predictive value (AUC=0.510, p=0.897). This finding suggests that the utility of AMH-based markers depends on the population and clinical context.

Study Limitations

The current study has some important limitations. First, the retrospective nature of the study and the relatively small sample size may have reduced statistical power and increased the risk of selection bias. Second, patients with NOA were evaluated as a heterogeneous population without stratification according to the underlying etiology. Important clinical subgroups such as iNOA, Klinefelter syndrome, cryptorchidism related NOA, genetic causes, and post chemotherapy NOA were not analyzed seperately, since previous studies have suggested that AMH may be particularly informative in selected groups, especially iNOA, this heterogeneity may have masked a subgroup specific association between AMH and SR outcomes. Finally, hormone measurements were performed at a single center, potentially limiting generalizability. Taken together, our results and the conflicting data in the literature indicate that serum AMH level alone is not a universally reliable biomarker for predicting mTESE success in unselected NOA populations. Although AMH shows promise in specific subgroups (particularly iNOA and treatment-naive patients), its routine use in clinical practice as a standalone marker is not currently supported by sufficient evidence.

Conclusion

Our study concluded that serum AMH level, either alone or in combination with other demographic and hormonal parameters, is not a reliable clinical biomarker for predicting +SR in men with NOA undergoing mTESE. Although serum AMH level is a promising predictor in selected subgroups such as iNOA, its predictive value before mTESE was not confirmed in a heterogeneous NOA population. The present findings indicate that AMH alone is insufficient for clinical decision-making and should be interpreted alongside other clinical and hormonal parameters. Studies with larger sample sizes, in which patients with NOA are stratified according to etiology, are needed to define the definitive role of AMH in the preoperative evaluation of patients with NOA.

Ethics

Ethics Committee Approval: Ethical approval of the study was obtained from the Acıbadem University Ethics Committee (approval number: 2026-10/421, date: 11.06.2026), and the study was conducted in accordance with the principles of the 1975 Declaration of Helsinki, as revised in 2000.

Informed Consent: Informed consent was obtained from all participants prior to inclusion.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.Y., N.P., Ö.K., T.G., B.E., İ.Ö.A., B.T., Consept: A.Y., B.T., Design: A.Y., N.P., B.T., Data Collection or Processing: A.Y., N.P., Ö.K., T.G., B.E., İ.Ö.A., B.T., Analysis or Interpretation: A.Y., N.P., Ö.K., T.G., B.T., Literature Search: N.P., Ö.K., B.T., Writing: N.P., B.T.

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