



Does Varicocele Repair Improve Conventional Semen Parameters? A Meta-Analytic Study of Before-After Data

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Purpose: The purpose of this meta-analysis is to study the impact of varicocele repair in the largest cohort of infertile males with clinical varicocele by including all available studies, with no language restrictions, comparing intra-person conventional semen parameters before and after the repair of varicoceles.

Materials and Methods: The meta-analysis was performed according to PRISMA-P and MOOSE guidelines. A systematic search was performed in Scopus, PubMed, Cochrane, and Embase databases. Eligible studies were selected according to the PICOS model (Population: infertile male patients with clinical varicocele; Intervention: varicocele repair; Comparison: intra-person before-after varicocele repair; Outcome: conventional semen parameters; Study type: randomized controlled trials [RCTs], observational and case-control studies).

Results: Out of 1,632 screened abstracts, 351 articles (23 RCTs, 292 observational, and 36 case-control studies) were included in the quantitative analysis. The before-and-after analysis showed significant improvements in all semen parameters after varicocele repair (except sperm vitality); semen volume: standardized mean difference (SMD) 0.203, 95% CI: 0.129–0.278; $p < 0.001$; $I^2 = 83.62\%$, Egger's $p = 0.3329$; sperm concentration: SMD 1.590, 95% CI: 1.474–1.706; $p < 0.001$; $I^2 = 97.86\%$, Egger's $p < 0.0001$; total sperm count: SMD 1.824, 95% CI: 1.526–2.121; $p < 0.001$; $I^2 = 97.88\%$, Egger's $p = 0.0063$; total motile sperm count: SMD 1.643, 95% CI: 1.318–1.968; $p < 0.001$; $I^2 = 98.65\%$, Egger's $p = 0.0003$; progressive sperm motility: SMD 1.845, 95% CI: 1.537%–2.153%; $p < 0.001$; $I^2 = 98.97\%$, Egger's $p < 0.0001$; total sperm motility: SMD 1.613, 95% CI 1.467%–1.759%; $p < 0.001$; $I^2 = 97.98\%$, Egger's $p < 0.001$; sperm morphology: SMD 1.066, 95% CI 0.992%–1.211%; $p < 0.001$; $I^2 = 97.87\%$, Egger's $p = 0.1864$.

Conclusions: The current meta-analysis is the largest to date using paired analysis on varicocele patients. In the current meta-analysis, almost all conventional semen parameters improved significantly following varicocele repair in infertile patients with clinical varicocele.

Keywords: Controlled before-after studies; Infertility, male; Meta-analysis; Varicocele

INTRODUCTION

Varicocele is a condition defined as abnormal dilatation and tortuosity of the pampiniform plexus of veins in the scrotum and spermatic cord [1]. The condition is common with a variable reported prevalence, depending on the method of varicocele identification, the person's age, and the fertility status. Among the general male population, a clinical (palpable) varicocele is reported in 15% to 18% of male subjects, while a varicocele is detectable in 35% of male subjects during color duplex ultrasonography examination [2]. A higher prevalence is reported among infertile male subjects, with 35% of male with primary infertility and 81% of male with secondary infertility having clinical varicoceles [3]. Although left-side clinical varicoceles are more common, in up to 50% of the cases the varicoceles are bilateral, though the left-side varicoceles are almost always larger than the right-side varicoceles [1].

The association between male infertility and varicoceles has been widely studied over the past several decades. In a large study conducted by World Health Organization (WHO), which included 9,038 male from 34 centers over 12 months, 25% of the male with abnormal semen analysis had a varicocele [4]. However, the precise etiology and pathogenesis of varicocele are still elusive. Several mechanisms have been postulated to explain the development of varicoceles in males [5]. However, the mechanisms by which varicocele affects male fertility and, similarly, whether varicocelectomy is beneficial or not, are not fully understood. Oxidative stress, heat stress, local hormonal imbalances, testicular hypoperfusion, and stasis of blood with an accumulation of toxins have all been suggested as potential mechanisms through which varicocele may negatively impact male reproductive health. Nevertheless, none of these mechanisms can stand alone to precisely explain the deleterious effects of varicoceles on testicular function [6].

Current guidelines from the European Association of Urology (EAU) and the American Urologic Association and the American Society of Reproductive Medicine (AUA/ASRM) recommend varicocele repair for a man with a palpable varicocele, infertility, one or more semen abnormalities, and a normally fertile female partner [7,8]. EAU guidelines also state that "varicocele repair may lead to sperm appearing in the ejaculate in male with non-obstructive azoospermia."

Despite the guidelines' recommendations, the association between male infertility and varicoceles is still unclear. Although varicoceles are referred to as the most surgically correctable cause of male infertility [9] a recent Cochrane Systematic Review concluded that it is uncertain whether varicocele repair compared to no treatment in subfertile men led to an improvement in live birth rates, as the quality of evidence was considered poor [10]. Further, many men who have a varicocele have successfully fathered children naturally without any treatment. There are also discrepancies between the AUA and EAU male infertility guidelines regarding which patients may benefit from varicocele repair [7,8]. Systematic reviews and meta-analyses have previously been performed evaluating the role of varicocele repair in male infertility; however, these have been limited by English language articles leading to analysis of relatively small sample sizes [11,12]. A meta-analysis on a very large sample size of infertile male with varicoceles who underwent varicocele repair is needed to clarify the association between varicocele repair and improvement in semen parameters. The latter represent valuable outcomes to measure the effect of varicocele repair on male infertility since semen parameters reflect men's health and testicular function, while pregnancy or live birth is multifactorial, depending on a multitude of factors, including female fertility status.

Accordingly, the objective of this study is to assess the impact of varicocele repair on conventional semen parameters by comparing values before and after repair in infertile male.

MATERIALS AND METHODS

1. Search strategy

The present meta-analysis was performed according to the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) for RCTs [13,14], and the MOOSE guidelines for Meta-analyses and Systematic Reviews of Observational Studies [15]. The search strategy comprised a combination of the following Medical Subjects Headings (MeSH) and search terms: varicoc*, management, embolization/embolisation, microsurg*/micro-surg*, varicocelectomy, repair, correction, treatment, ligation, surg*, operation, radiolog*, sperm*, semen, seminal, ejaculate, asperm*/azoosperm*, oligo*/oligosperm*/oligozoosperm*,

astheno*/asthenosperm*/asthenozoosperm*, terato*/teratosperm*/teratozoosperm*, and necro*/necrosperm*/necrozoosperm*. These exhaustive systematic searches were performed in the Scopus, PubMed, Cochrane, and Embase databases, between 1970 to the present. While the search was limited to only original articles and human studies, there were no language restrictions applied. After the elimination of duplicates, the abstracts identified by the searches were screened for eligibility. For each article, an assessment of eligibility was performed by two independent reviewers in an unblinded manner. The titles and abstracts of the studies were first independently screened for inclusion. In cases of uncertainty, each researcher screened the full text to determine inclusion. Any disagreements between reviewers were resolved by discussion between the two reviewers. However, if no consensus was reached, then a third reviewer made the final decision.

Full papers of the eligible abstracts were downloaded, including non-English papers which were translated into English by native speakers of the language of the article. The full papers were assessed for eligibility using the PICOS (Population, Intervention, Comparison/Comparator, Outcome, Study type) model question (Table 1) [16], and the selected papers were subjected to data extraction. The selection of eligible studies and data extraction was performed by a group of 37 researchers. Prior to assessing the studies, these researchers underwent methodical training exercises to ensure that a standardized approach was applied throughout the study [17]. The protocol of this systematic review and meta-analysis was registered with PROSPERO (number CRD42022329848).

2. Data extraction

The following data were collected: study design, characteristics of varicocele and varicocele repair (method, laterality), time from varicocele repair to first follow-up evaluation, number of patients, various semen parameters (semen volume, sperm concentration, total sperm count, total motile sperm count, progressive sperm motility, total sperm motility, sperm vitality, and sperm morphology) before and after varicocele repair.

3. Quality assessment

The quality of evidence (QoE) of the studies was assessed at the same time as data extraction, by a team of thirty-seven researchers supervised by twelve team leaders and co-team leaders.

All studies were assessed using the Cambridge Quality Checklists [18]. Further assessment of QoE was performed for randomized controlled trials (RCTs) using three other scales specific to this study design: the Cochrane Risk of Bias [19], the Jadad score [20], and the CONSORT guidelines [21]. The last three scales were used to allow for better stratification and evaluation of the QoE of each study with a wider range of scores resulting from the sum of the different scales.

The selection of eligible studies, data extraction, and QoE assessment was performed by a group of 37 researchers, as detailed elsewhere [17,22].

4. Statistical analysis

The statistical analysis was performed using MedCalc Statistical Software (version 20.027; MedCalc Software Ltd). Standardized mean difference (SMD) between pre- and post-varicocelectomy with standard error and 95% confidence interval (95% CI) were used

Table 1. PICOS model (population, intervention, comparison/comparator, outcomes, study type)

	Inclusion criteria	Exclusion criteria
Population	Infertile male with clinical varicocele	Adolescents
Intervention	Varicocele repair	-
Comparison	i) Conventional semen parameters analyzed before varicocele repair. ii) Conventional semen parameters analyzed after varicocele repair.	-
Outcome	Conventional semen parameters: semen volume, sperm concentration, total sperm count, total motile sperm count, progressive sperm motility, total sperm motility, sperm vitality, and sperm morphology	-
Study type	Randomized controlled studies, observational studies	Animal studies, <i>In vitro</i> studies, Reviews and Meta-analyses, Case reports, Book chapters, Editorials

to evaluate the outcomes and calculated according to both the fixed and random effects models based on the level of in-between study heterogeneity [23]. Heterogeneity between the different studies was determined using the Cochrane's Q-test and I² statistic for inconsistency [24] with an I² value higher than 50% indicating inconsistency among the studies analyzed. The random-effect model was chosen if significant heterogeneity was detected, while the fixed-effect model was chosen if no significant heterogeneity was detected. Possible publication bias was evaluated using Egger's test [25]. Results are presented as Forest plots. For all tests employed a p-value<0.05 was considered significant.

RESULTS

One thousand six hundred and thirty-two abstracts were extracted using the above-mentioned search strategy. After removing 661 duplicates, 971 abstracts were evaluated. Of these, 100 articles were identified by title and abstract as reviews, case reports, book chapters, or as papers on unrelated topics and were therefore excluded. Of the remaining 871 articles, 164 full-texts

were not found, whereas 154 were excluded after reading the full-text because they had no extractable data (e.g., data reported as median and interquartile range), and 200 were excluded because of different outcomes. Finally, 351 studies assessing the impact of varicocele repair on conventional semen parameters using a before-after approach were included in the present analysis (Fig. 1).

Among the 351 included studies, 292 were observational and 36 were case-control studies. The remaining 23 studies were RCTs. The main characteristics of the included studies are shown in Table 2 [26-367]. QoE assessment is provided in Table 3 and 4 [26-366].

1. Semen volume

The result of the before-after analysis of semen volume is summarized in Table 5.

Eighty-two articles were included to analyze this outcome, for a total of 12,566 infertile patients with clinical varicocele before varicocele repair, and 10,825 patients after varicocele repair. The analysis of combined results showed a significantly higher semen volume in patients following varicocele repair compared to the

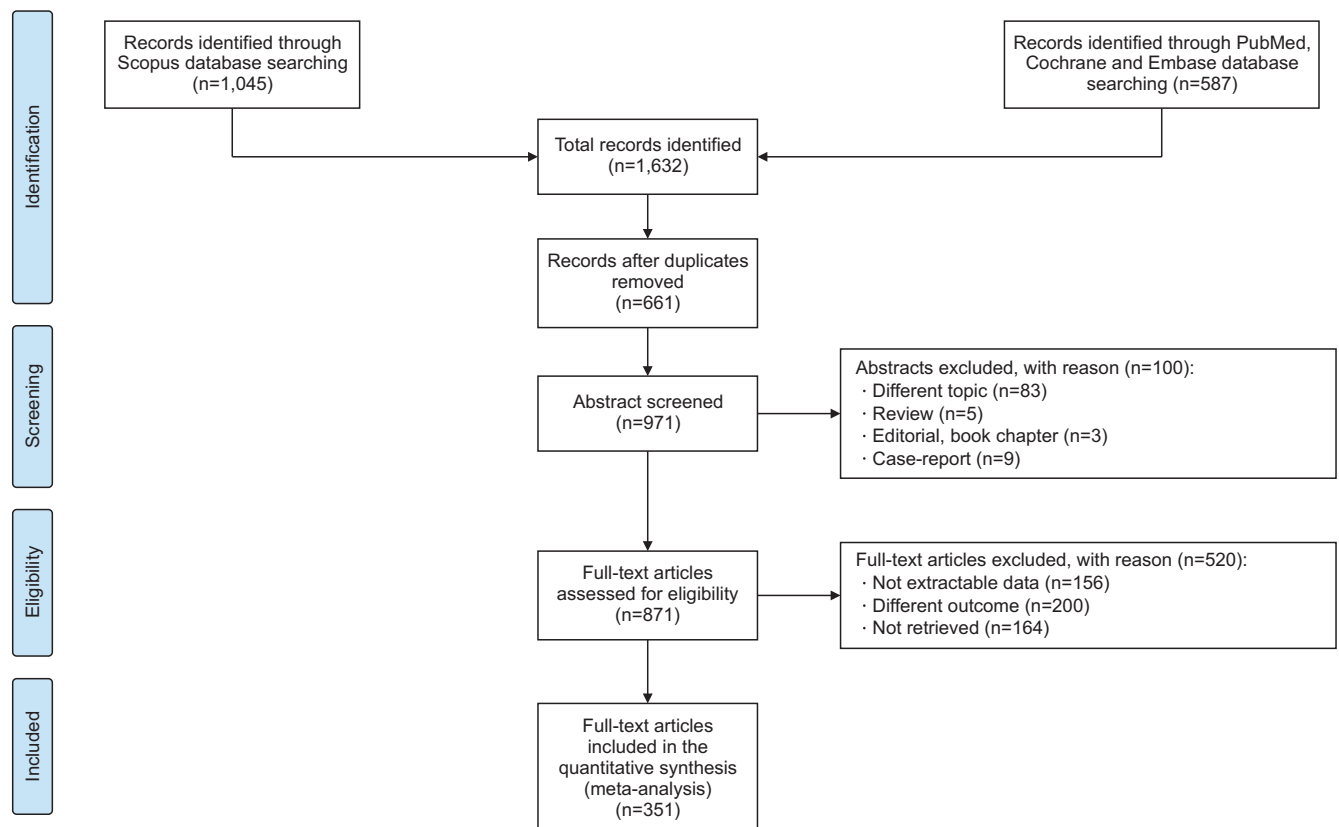


Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow-chart

Table 2. Endpoint measures of the included studies

First author	Year	Study design	Outcome								
			SV	SC	TC	V	TM	PM	TMSC	SM	
Haensch [26]	1976	Observational	X	X							X
Rodriguez-Rigau [27]	1978	Observational	X	X				X		X	
Johnsen [28]	1978	Observational			X						X
Nilsson [29]	1979	Observational	X	X	X			X			X
Greenberg [30]	1979	Observational	X	X			X				X
Homonnai [31]	1980	Observational		X			X				X
Gogol [32]	1980	Observational		X							X
Lukkarinen [33]	1984	Observational	X	X				X			X
Foresta [34]	1984	Observational		X				X			
Tinga [35]	1984	Observational			X			X			X
Shinoda [36]	1985	Observational	X	X				X			
Marmar [37]	1985	Observational		X				X			X
Segenreich [38]	1986	Observational		X							
Vereecken [39]	1986	Observational		X				X			X
Hadziselimovic [40]	1986	Observational	X	X				X			X
Burke [41]	1987	Observational						X			X
Nagai [42]	1988	Observational			X			X			
Okuyama [43]	1988	Observational		X					X		
Gerris [44]	1988	Observational		X				X			
Yarborough [45]	1989	Observational		X				X			X
Parsch [46]	1990	Observational		X	X			X	X	X	X
Kuroiwa [47]	1991	Observational	X	X				X			
Dhabuwala [48]	1992	Observational		X					X		X
Donovanjr [49]	1992	Observational		X				X		X	
Ito [50]	1993	Observational	X	X				X			
Steckel [51]	1993	Observational		X				X			
Ross [52]	1993	Observational		X				X			X
Hirokawa [53]	1993	Observational		X						X	
Lerchl [54]	1993	Observational		X	X			X			X
Kondoh [55]	1993	Observational		X				X			
Yamamoto [56]	1994	Observational		X					X		X
Dewire [57]	1994	Observational		X				X			
Knudson [58]	1994	Observational		X				X		X	
Nakada [59]	1994	Observational		X				X			
Yamamoto [60]	1995	Observational		X					X		X
Ferguson [61]	1995	Observational	X	X				X			X
Chiang [62]	1995	Observational		X				X			
Segenreich [63]	1995	Observational		X	X						
Watanabe [64]	1995	Observational		X							
Su [65]	1995	Observational		X				X			
Parikh [66]	1996	Observational			X			X	X		
Jarow [67]	1996	Observational			X						
Punekar [68]	1996	Observational			X			X			
Takahara [69]	1996	Observational		X				X			
Atikeler [70]	1996	Observational		X				X			
Vazquez-Levin [71]	1997	Observational	X	X	X			X			X
Segenreich [72]	1997	Observational		X	X						

Table 2. Continued 1

First author	Year	Study design	Outcome							
			SV	SC	TC	V	TM	PM	TMSC	SM
Seftel [73]	1997	Observational		X			X			X
Hauser [74]	1997	Observational		X			X			
Bablok [75]	1997	Observational		X			X			
Nozawa [76]	1997	Observational		X					X	X
Johnsen [77]	1997	Observational		X					X	
Flati [78]	1997	Observational		X			X			
Barbalias [79]	1998	Observational		X			X			X
Abdulmaaboud [80]	1998	Observational		X			X			X
Aşci [81]	1998	Observational		X					X	X
Matthews [82]	1998	Observational								X
Schatte [83]	1998	Observational	X	X			X	X	X	X
Madjar [84]	1998	Observational			X		X			X
Ismail [85]	1999	Observational	X	X			X	X		
Zini [86]	1999	Observational		X			X			X
Kim [87]	1999	Observational			X		X			
Scherr [88]	1999	Observational		X	X		X		X	X
Uygur [89]	1999	Observational			X		X			X
Chiang [90]	1999	Observational		X			X			X
Reichart [91]	2000	Observational	X		X		X	X		X
Grasso [92]	2000	Observational		X				X		X
Pianalto [93]	2000	Observational		X			X			X
Cayan [94]	2000	Observational		X			X			
Papanikolaou [95]	2000	Observational		X			X		X	
Pierik [96]	1998	Observational		X			X			X
Kamal [97]	2001	Observational		X			X		X	
Cayan [98]	2001	Observational							X	
Mostafa [99]	2001	Observational		X						
Jungwirth [100]	2001	Observational		X				X		
Cavallaro [101]	2001	Observational		X			X			X
Avila-Vergara [102]	2001	Observational		X			X			
Cayan [103]	2002	Observational								X
Kibar [104]	2002	Observational	X	X			X			X
Onozawa [105]	2002	Observational		X			X			X
Iwasaki [106]	2003	Observational	X	X			X			
Hsieh [107]	2003	Observational		X			X			X
Younes [108]	2003	Observational	X		X					
Fuse [109]	2003	Observational		X			X		X	
Nuhoğlu [110]	2004	Observational		X				X		X
Ishikawa [111]	2004	Observational		X			X			
O'Brien [112]	2004	Observational		X			X			
Polito [113]	2004	Observational		X				X		
Flati [114]	2004	Observational	X	X			X			
Grober [115]	2004	Observational	X	X			X		X	X
Grober [116]	2004	Observational					X		X	
Gat [117]	2004	Observational		X			X			X
Gat [118]	2004	Observational		X			X			X
Gat [119]	2004	Observational		X			X			X

Table 2. Continued 2

First author	Year	Study design	Outcome							
			SV	SC	TC	V	TM	PM	TMSC	SM
Ortapamuk [120]	2005	Observational		X			X			
Ketabchi [121]	2005	Observational		X			X			X
Watanabe [122]	2005	Observational		X			X			
Nasr-Esfahani [123]	2005	Observational		X	X		X			X
Yeşilli [124]	2005	Observational		X			X			X
Mancini [125]	2005	Observational		X			X			
Pasqualotto [126]	2005	Observational		X			X			
Ishikawa [127]	2005	Observational		X			X			
Zini [128]	2005	Observational		X			X			X
Benoff [129]	2005	Observational		X						
Pasqualotto [130]	2005	Observational		X			X			
Ku [131]	2005	Observational		X			X			X
Pasqualotto [132]	2005	Observational		X			X			
Mehrsai [133]	2005	Observational		X			X			X
Orhan [134]	2005	Observational		X			X			X
Libman [135]	2006	Observational	X	X			X			X
Ramasamy [136]	2006	Observational							X	
Hussein [137]	2006	Observational		X			X			X
Zucchi [138]	2006	Observational		X				X		
Hsieh [139]	2006	Observational		X			X			
Baccetti [140]	2006	Observational		X			X	X		
Djaladat [141]	2006	Observational		X			X			
Shin [142]	2006	Observational		X			X			
Ashrafi [143]	2007	Observational		X	X		X			X
Okeke [144]	2007	Observational	X	X			X			X
Qadan [145]	2007	Observational		X						
Zini [146]	2008	Observational	X	X			X		X	X
Ozden [147]	2008	Observational		X				X		X
Flacke [148]	2008	Observational		X			X			X
Al-Said [149]	2008	Observational		X			X			
Atalay [150]	2008	Observational	X	X				X		X
Cakan [151]	2008	Observational	X	X			X			X
Balci [152]	2008	Observational		X			X		X	X
Gandini [153]	2008	Observational		X			X			X
Chen [154]	2008	Observational					X			X
Agnifili [155]	2008	Observational		X					X	
Juárez-Albarrán [156]	2008	Observational		X						
Kadhim [157]	2009	Observational		X				X		
Elbendary [158]	2009	Observational	X	X			X	X	X	
Shamsa [159]	2009	Observational		X			X			X
Hafez [160]	2009	Observational		X			X			X
Salem [161]	2009	Observational		X			X			
Jasemi [162]	2009	Observational		X				X		
Zheng [163]	2009	Observational		X			X			X
Nasr-Esfahani [164]	2009	Observational		X	X		X			X
Zorba [165]	2009	Observational							X	
Kondo [166]	2009	Observational		X			X			

Table 2. Continued 3

First author	Year	Study design	Outcome								
			SV	SC	TC	V	TM	PM	TMSC	SM	
Acar [167]	2009	Observational	X	X					X		X
Fall [168]	2010	Observational		X				X			X
Al-Adl [169]	2010	Observational	X	X				X		X	
Abdelwahab [170]	2010	Observational		X				X			X
Li [171]	2010	Observational	X	X			X		X		
Dadfar [172]	2010	Observational			X			X			X
Al-Ghazo [173]	2011	Observational								X	
Azadi [174]	2011	Observational		X				X			X
Abd Ellatif [175]	2011	Observational		X				X			X
Giagulli [176]	2011	Observational		X				X			X
Cho [177]	2011	Observational		X	X				X	X	X
Chen [178]	2011	Observational	X	X				X			X
Zini [179]	2011	Observational		X					X		
Hsiao [180]	2011	Observational		X	X			X	X		X
Ghazi [181]	2011	Observational	X	X				X	X		X
Tarhan [182]	2011	Observational		X				X		X	X
Ozturk [183]	2012	Observational		X				X			X
Mohamid [184]	2012	Observational		X				X			X
Shiraishi [185]	2012	Observational	X	X						X	
Li [186]	2012	Observational		X					X		
Tavalaee [187]	2012	Observational			X			X			X
Pirinççi [188]	2012	Observational		X							X
Gabriel [189]	2012	Observational		X				X			
Mehraban [190]	2012	Observational		X							
El-Haggar [191]	2012	Observational		X							
La Vignera [192]	2012	Observational	X	X	X		X		X		X
Ozturk [183]	2012	Observational		X							X
Navaeian-Kalat [193]	2012	Observational		X							
Armağan [194]	2012	Observational		X				X			
Kim [195]	2012	Observational	X	X							X
Keyhan [196]	2012	Observational			X						X
Abdelrahman [197]	2012	Observational		X							
Al Bakri [198]	2012	Observational	X	X				X		X	X
Lee [199]	2011	Observational		X							X
Sun [200]	2012	Observational		X							X
Ollandini [201]	2013	Observational		X					X		
Leung [202]	2013	Observational		X							X
Bonyadi [203]	2013	Observational	X	X							
Smit [204]	2013	Observational		X	X				X		X
Camargo [205]	2013	Observational	X	X					X		X
Zhang [206]	2014	Observational		X				X		X	X
Kang [207]	2013	Observational		X				X			X
Bozhedomov [208]	2014	Observational	X	X					X		
Camargo [209]	2014	Observational	X	X				X			X
Prasivoravong [210]	2014	Observational			X		X		X		X
Komiya [211]	2014	Observational	X	X							X
Wang [212]	2014	Observational		X					X		X

Table 2. Continued 4

First author	Year	Study design	Outcome							
			SV	SC	TC	V	TM	PM	TMSC	SM
Enatsu [213]	2014	Observational		X			X			
Samplaski [214]	2014	Observational	X	X					X	X
Hosseinifar [215]	2014	Observational	X	X			X			X
Kadioglu [216]	2014	Observational	X	X				X		
Lehtihet [217]	2014	Observational	X		X		X	X		
Al-Adl [218]	2014	Observational	X	X			X		X	
Li [219]	2014	Observational		X						
Chen [220]	2014	Observational		X			X			X
Lee [221]	2014	Observational		X			X			
Choe [222]	2015	Observational	X	X			X			X
Guo [223]	2015	Observational		X			X	X		X
Kiziler [224]	2015	Observational		X			X			
Zhang [225]	2015	Observational		X						
Youssef [226]	2015	Observational		X						X
Cantoro [227]	2015	Observational		X			X			
Ener [228]	2015	Observational		X				X		X
Telli [229]	2015	Observational		X	X			X		X
Tavalaee [230]	2015	Observational		X			X			
Shabana [231]	2015	Observational		X				X		
Abdelaziz [232]	2015	Observational	X	X				X		X
Mohammed [233]	2015	Observational		X				X		X
McGarry [234]	2015	Observational		X			X			
Hou [235]	2015	Observational			X					
Fukuda [236]	2015	Observational	X	X			X		X	X
Naderi [237]	2015	Observational	X	X						X
Hu [238]	2015	Observational	X	X		X				X
Amer [239]	2015	Observational		X			X	X		
Lee [240]	2015	Observational		X			X	X		
Cantoro [241]	2015	Observational		X			X			X
Pajovic [242]	2015	Observational					X	X		
Ni [243]	2015	Observational		X				X		X
Wang [244]	2015	Observational		X						X
Binhazzaa [245]	2016	Observational		X		X		X	X	X
Arab [246]	2016	Observational		X			X			X
Kucuk [247]	2016	Observational		X				X		X
Lv [248]	2016	Observational		X				X		
Ener [249]	2016	Observational		X						
Karami [250]	2016	Observational		X						X
Park [251]	2016	Observational		X		X				X
Guo [252]	2016	Observational		X				X		
Barekat [253]	2016	Observational		X			X			X
Sofimajidpour [254]	2016	Observational		X	X		X			X
Ariagno [255]	2016	Observational		X	X			X		X
Mohamed [256]	2017	Observational	X	X				X		X
Samplaski [257]	2017	Observational							X	
Pijoan [258]	2017	Observational		X			X			X
Mostafa [259]	2017	Observational		X			X	X		

Table 2. Continued 5

First author	Year	Study design	Outcome							
			SV	SC	TC	V	TM	PM	TMSC	SM
Alkandari [260]	2017	Observational					X			
Morshed [261]	2017	Observational		X			X			
Qu [262]	2017	Observational	X	X		X		X		X
Akand [263]	2017	Observational		X			X			
Feng [264]	2017	Observational		X	X		X			
Gao [265]	2017	Observational		X	X		X			X
Gao [266]	2017	Observational		X	X		X			X
Afsin [267]	2018	Observational	X	X				X		X
Ketabchi [268]	2018	Observational			X			X		X
Vahidi [269]	2018	Observational	X	X						X
Lu [270]	2018	Observational		X						X
Çayan [271]	2018	Observational							X	
Gupta [272]	2018	Observational		X			X			
Allameh [273]	2018	Observational		X			X			X
Shafi [274]	2018	Observational		X				X		X
Hosseini [275]	2018	Observational		X				X		X
Sun [276]	2018	Observational	X	X				X		X
Dubin [277]	2018	Observational		X			X		X	
Liu [278]	2018	Observational	X	X						X
Alenzi [279]	2019	Observational		X			X			
Kızılay [280]	2019	Observational	X	X	X		X	X	X	X
Abdulmageed [281]	2019	Observational		X						
Bolat [282]	2019	Observational		X					X	X
Camargo [283]	2019	Observational	X	X	X			X	X	X
Masterson [284]	2019	Observational							X	
Ates [285]	2019	Observational	X	X	X			X	X	
Belardin [286]	2019	Observational		X	X			X		X
Palmisano [287]	2019	Observational		X				X		X
Abbasi [288]	2020	Observational	X	X			X	X		
Ilktac [289]	2020	Observational	X							X
Teng [290]	2020	Observational		X			X			X
Nasser [291]	2020	Observational		X						X
Abd El Rahman [292]	2020	Observational		X			X			X
Ghaed [293]	2020	Observational	X	X				X		X
Habib [294]	2020	Observational		X			X			
Özkaptan [295]	2020	Observational		X			X			X
Kamal [296]	2020	Observational	X	X	X			X		
Jin [297]	2020	Observational		X			X			
Senturk [298]	2020	Observational		X						X
Öztekin [299]	2020	Observational	X	X	X		X	X		
Ghanem [300]	2020	Observational		X				X		X
Omar [301]	2020	Observational	X	X			X			X
Gok [302]	2020	Observational	X	X				X		X
Mostafa [303]	2020	Observational		X			X			X
Alkhamees [304]	2020	Observational			X		X			X
Khan [305]	2020	Observational			X					
Ok [306]	2020	Observational	X	X	X		X		X	

Table 2. Continued 6

First author	Year	Study design	Outcome							
			SV	SC	TC	V	TM	PM	TMSC	SM
Phan [307]	2021	Observational			X		X			
Erdogan [308]	2021	Observational		X					X	
Fernández-Concha Schwalb [309]	2021	Observational		X					X	
Kavoussi [310]	2021	Observational	X	X				X	X	X
Fuschi [311]	2021	Observational		X				X		X
Pazir [312]	2021	Observational								X
Shomarufov [313]	2021	Observational	X							
Morini [314]	2021	Observational	X	X	X		X	X		X
Majzoub [367]	2021	Observational	X	X			X	X	X	X
Hudson [315]	1985	Case-control		X				X		
Hudson [316]	1986	Case-control		X				X		
Giordanengo [317]	1993	Case-control		X				X		X
Yamamoto [318]	1996	Case-control		X				X	X	X
Fuse [319]	1996	Case-control		X				X		
Mandressi [320]	1996	Case-control	X		X			X		
Koşar [321]	2000	Case-control		X				X		X
Zarrilli [322]	2000	Case-control		X				X	X	
Fujisawa [323]	2003	Case-control		X				X		
Salama [324]	2003	Case-control		X						
Di Bisceglie [325]	2003	Case-control		X					X	X
Gazzera [326]	2006	Case-control		X				X		X
Zini [327]	2006	Case-control								X
Di Bisceglie [328]	2007	Case-control		X					X	X
Baazeem [11]	2009	Case-control	X	X				X		X
Ichioka [329]	2009	Case-control			X			X		
Nasr Esfahani [330]	2010	Case-control		X						
Seo [331]	2010	Case-control	X	X		X	X			X
Esteves [332]	2010	Case-control	X	X	X				X	X
Sathya Srini [333]	2011	Case-control		X						
Ghanem [334]	2011	Case-control		X					X	X
Sadek [335]	2011	Case-control		X				X		X
Awadallah [336]	2011	Case-control		X				X		
Mohamed [337]	2011	Case-control	X	X				X		
Gokce [338]	2013	Case-control		X	X			X	X	X
Alhathal [339]	2016	Case-control		X					X	
Ni [340]	2016	Case-control		X				X	X	X
Chen [341]	2016	Case-control	X	X				X		X
Abdelbaki [342]	2017	Case-control	X	X				X	X	X
Bou Nasr [343]	2017	Case-control	X	X	X	X	X			X
Gomaa [344]	2018	Case-control	X	X	X			X	X	X
Turgut [345]	2020	Case-control		X				X		X
El-Ariny [346]	2020	Case-control		X					X	
Fathi [347]	2021	Case-control		X					X	X
El Taieb [348]	2020	Case-control	X	X					X	X
Yavetz [349]	1992	RCT		X	X			X		X
Sayfan [350]	1992	RCT			X					X
Breznik [351]	1993	RCT		X				X		

Table 2. Continued 7

First author	Year	Study design	Outcome							
			SV	SC	TC	V	TM	PM	TMSC	SM
Nieschlag [352]	1995	RCT		X						
Unal [353]	2001	RCT		X				X		X
Abdel-Maguid [354]	2010	RCT		X					X	
Abdel-Meguid [355]	2011	RCT		X					X	X
Mansour Ghanaie [356]	2012	RCT		X	X				X	X
Azizollahi [357]	2013	RCT			X			X	X	X
Akin [358]	2014	RCT						X		X
Asr Badr [359]	2017	RCT	X		X			X		X
Bryniarski [360]	2017	RCT	X	X	X	X	X	X	X	X
Guo [361]	2017	RCT		X				X		X
Abdelsalam [362]	2017	RCT							X	
Vyas [363]	2017	RCT		X				X		X
Ketabchi [268]	2018	RCT			X					
Babak [364]	2018	RCT		X				X		X
Zaazaa [365]	2018	RCT		X	X			X		X
Almekaty [366]	2019	RCT		X				X		

RCT: randomized controlled trial, PM: progressive sperm motility, SC: sperm concentration, SM: sperm morphology, SV: semen volume, TC: total sperm count, TM: total sperm motility, TMSC: total motile sperm count, V: sperm vitality.

Table 3. Quality of evidence assessment^a for observational and case-control studies

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Haensch [26]	1976	Observational	0	3	3	6
Rodriguez-Rigau [27]	1978	Observational	1	3	4	8
Johnsen [28]	1978	Observational	1	3	3	7
Nilsson [29]	1979	Observational	1	3	4	8
Greenberg [30]	1979	Observational	1	3	3	7
Homonnai [31]	1980	Observational	1	3	3	7
Gogol [32]	1980	Observational	1	3	3	7
Lukkarinen [33]	1984	Observational	2	3	4	9
Foresta [34]	1984	Observational	1	2	2	5
Tinga [35]	1984	Observational	1	2	1	4
Shinoda [36]	1985	Observational	1	3	3	7
Marmar [37]	1985	Observational	1	3	3	7
Segenreich [38]	1986	Observational	1	3	3	7
Vereecken [39]	1986	Observational	2	2	3	7
Hadziselimovic [40]	1986	Observational	3	3	3	9
Burke [41]	1987	Observational	1	3	3	7
Nagai [42]	1988	Observational	1	2	3	6
Okuyama [43]	1988	Observational	1	3	6	10
Gerris [44]	1988	Observational	1	3	3	7
Yarborough [45]	1989	Observational	0	2	3	5
Parsch [46]	1990	Observational	1	2	4	7
Kuroiwa [47]	1991	Observational	1	3	3	7
Dhabuwala [48]	1992	Observational	2	2	4	8

Table 3. Continued 1

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Donovanjr [49]	1992	Observational	0	3	3	6
Ito [50]	1993	Observational	1	2	4	7
Steckel [51]	1993	Observational	1	3	4	8
Ross [52]	1993	Observational	4	2	3	9
Hirokawa [53]	1993	Observational	1	2	4	7
Lerchl [54]	1993	Observational	0	3	4	7
Kondoh [55]	1993	Observational	1	3	4	8
Yamamoto [56]	1994	Observational	3	3	3	9
Dewire [57]	1994	Observational	3	2	4	9
Knudson [58]	1994	Observational	0	3	4	7
Nakada [59]	1994	Observational	1	2	3	6
Yamamoto [60]	1995	Observational	1	2	4	7
Ferguson [61]	1995	Observational	1	2	3	6
Chiang [62]	1995	Observational	1	2	4	7
Segenreich [63]	1995	Observational	2	3	3	8
Marmar [37]	1995	Observational	0	2	4	6
Watanabe [64]	1995	Observational	1	3	3	7
Su [65]	1995	Observational	3	2	1	6
Parikh [66]	1996	Observational	1	2	6	9
Jarow [67]	1996	Observational	1	3	3	7
Punekar [68]	1996	Observational	2	3	4	9
Takahara [69]	1996	Observational	1	3	4	8
Atikeler [70]	1996	Observational	1	3	4	8
Vazquez-Levin [71]	1997	Observational	4	2	3	9
Segenreich [72]	1997	Observational	1	2	3	6
Seftel [73]	1997	Observational	2	2	4	8
Hauser [74]	1997	Observational	2	3	3	8
Bablok [75]	1997	Observational	1	2	3	6
Nozawa [76]	1997	Observational	1	2	4	7
Johnsen [77]	1997	Observational	2	3	3	8
Flati [78]	1997	Observational	2	3	3	8
Barbalias [79]	1998	Observational	2	3	3	8
Abdulmaaboud [80]	1998	Observational	1	2	3	6
Aşci [81]	1998	Observational	1	2	3	6
Matthews [82]	1998	Observational	2	3	6	11
Schatte [83]	1998	Observational	2	3	3	8
Madjar [84]	1998	Observational	1	2	3	6
Ismail [85]	1999	Observational	2	2	3	7
Zini [86]	1999	Observational	1	3	3	7
Kim [87]	1999	Observational	1	3	3	7
Scherr [88]	1999	Observational	1	3	4	8
Uygur [89]	1999	Observational	1	3	3	7
Chiang [90]	1999	Observational	0	3	4	7
Reichart [91]	2000	Observational	2	3	4	9
Grasso [92]	2000	Observational	2	3	4	9
Pianalto [93]	2000	Observational	2	2	3	7

Table 3. Continued 2

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Cayan [94]	2000	Observational	3	3	4	10
Papanikolaou [95]	2000	Observational	1	2	3	6
Pierik [96]	1998	Observational	3	3	3	9
Kamal [97]	2001	Observational	2	2	3	7
Cayan [98]	2001	Observational	0	2	3	5
Mostafa [99]	2001	Observational	2	2	3	7
Jungwirth [100]	2001	Observational	2	3	3	8
Cavallaro [101]	2001	Observational	3	3	4	10
Avila-Vergara [102]	2001	Observational	1	2	3	6
Cayan [103]	2002	Observational	2	2	1	5
Kibar [104]	2002	Observational	3	2	3	8
Onozawa [105]	2002	Observational	3	2	4	9
Iwasaki [106]	2003	Observational	1	3	3	7
Hsieh [107]	2003	Observational	2	3	3	8
Younes [108]	2003	Observational	1	3	3	7
Fuse [109]	2003	Observational	3	2	4	9
Nuhoğlu [110]	2004	Observational	2	3	3	8
Ishikawa [111]	2004	Observational	1	2	3	6
O'Brien [112]	2004	Observational	1	2	3	6
Polito [113]	2004	Observational	3	3	3	9
Flati [114]	2004	Observational	2	3	3	8
Grober [115]	2004	Observational	2	3	3	8
Grober [116]	2004	Observational	2	2	3	7
Gat [117]	2004	Observational	2	3	3	8
Gat [118]	2004	Observational	2	3	3	8
Gat [119]	2004	Observational	3	3	3	9
Ortapamuk [120]	2005	Observational	1	3	4	8
Ketabchi [121]	2005	Observational	2	3	3	8
Watanabe [122]	2005	Observational	1	3	3	7
Nasr-Esfahani [123]	2005	Observational	2	3	4	9
Yeşilli [124]	2005	Observational	1	3	4	8
Mancini [125]	2005	Observational	1	3	4	8
Pasqualotto [126]	2005	Observational	1	3	3	7
Ishikawa [127]	2005	Observational	2	2	3	7
Zini [128]	2005	Observational	4	2	3	9
Benoff [129]	2005	Observational	3	3	4	10
Pasqualotto [130]	2005	Observational	1	3	3	7
Ku [131]	2005	Observational	1	2	3	6
Pasqualotto [132]	2005	Observational	1	3	3	7
Mehrsai [133]	2005	Observational	1	3	3	7
Orhan [134]	2005	Observational	1	3	3	7
Libman [135]	2006	Observational	1	2	3	6
Ramasamy [136]	2006	Observational	2	3	4	9
Hussein [137]	2006	Observational	2	3	4	9
Zucchi [138]	2006	Observational	2	2	4	8
Hsieh [139]	2006	Observational	1	3	3	7

Table 3. Continued 3

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Baccetti [140]	2006	Observational	1	3	4	8
Djaladat [141]	2006	Observational	1	3	3	7
Shin [142]	2006	Observational	0	2	3	5
Ashrafi [143]	2007	Observational	2	3	4	9
Okeke [144]	2007	Observational	1	2	3	6
Qadan [145]	2007	Observational	2	3	3	8
Zini [146]	2008	Observational	4	3	4	11
Ozden [147]	2008	Observational	3	2	4	9
Flacke [148]	2008	Observational	1	3	4	8
Al-Said [149]	2008	Observational	4	3	6	13
Atalay [150]	2008	Observational	1	3	4	8
Cakan [151]	2008	Observational	3	2	6	11
Balci [152]	2008	Observational	1	2	3	6
Gandini [153]	2008	Observational	2	2	3	7
Chen [154]	2008	Observational	2	3	3	8
Agnifili [155]	2008	Observational	2	3	3	8
Juárez-Albarrán [156]	2008	Observational	1	3	3	7
Kadhim [157]	2009	Observational	2	3	4	9
Elbendary [158]	2009	Observational	3	3	4	10
Shamsa [159]	2009	Observational	2	2	4	8
Hafez [160]	2009	Observational	2	2	4	8
Salem [161]	2009	Observational	2	2	4	8
Jasemi [162]	2009	Observational	3	2	3	8
Zheng [163]	2009	Observational	3	3	4	10
Nasr-Esfahani [164]	2009	Observational	3	3	3	9
Zorba [165]	2009	Observational	3	2	3	8
Kondo [166]	2009	Observational	2	3	3	8
Acar [167]	2009	Observational	2	3	3	8
Fall [168]	2010	Observational	2	3	3	8
Al-Adl [169]	2010	Observational	1	2	3	6
Abdelwahab [170]	2010	Observational	3	3	4	10
Li [171]	2010	Observational	1	3	3	7
Dadfar [172]	2010	Observational	3	3	3	9
Al-Ghazo [173]	2011	Observational	1	2	3	6
Azadi [174]	2011	Observational	1	3	6	10
Abd Ellatif [175]	2011	Observational	3	3	6	12
Giagulli [176]	2011	Observational	3	3	6	12
Cho [177]	2011	Observational	2	2	3	7
Chen [178]	2011	Observational	3	3	3	9
Zini [179]	2011	Observational	3	3	3	9
Hsiao [180]	2011	Observational	4	2	3	9
Ghazi [181]	2011	Observational	2	3	3	8
Tarhan [182]	2011	Observational	3	3	3	9
Ozturk [183]	2012	Observational	3	2	2	7
Mohamid [184]	2012	Observational	2	3	3	8
Shiraishi [185]	2012	Observational	2	2	3	7

Table 3. Continued 4

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Li [186]	2012	Observational	2	2	3	7
Tavalaee [187]	2012	Observational	2	2	3	7
Pirinççi [188]	2012	Observational	2	2	3	7
Gabriel [189]	2012	Observational	3	3	3	9
Mehraban [190]	2012	Observational	2	3	3	8
El-Haggar [191]	2012	Observational	2	3	3	8
La Vignera [192]	2012	Observational	3	3	3	9
Ozturk [183]	2012	Observational	3	3	3	9
Navaeian-Kalat [193]	2012	Observational	2	3	3	8
Armağan [194]	2012	Observational	2	2	3	7
Kim [195]	2012	Observational	0	3	3	6
Keyhan [196]	2012	Observational	2	3	3	8
Abdelrahman [197]	2012	Observational	1	3	3	7
Al Bakri [198]	2012	Observational	1	2	3	6
Lee [199]	2011	Observational	2	3	3	8
Sun [200]	2012	Observational	2	3	3	8
Ollandini [201]	2013	Observational	2	3	3	8
Leung [202]	2013	Observational	1	2	3	6
Bonyadi [203]	2013	Observational	1	3	3	7
Smit [204]	2013	Observational	3	3	3	9
Camargo [205]	2013	Observational	2	3	3	8
Zhang [206]	2014	Observational	2	3	3	8
Kang [207]	2013	Observational	3	3	3	9
Bozhedomov [208]	2014	Observational	3	3	3	9
Camargo [209]	2014	Observational	2	3	3	8
Prasivoravong [210]	2014	Observational	3	3	3	9
Komiya [211]	2014	Observational	3	2	3	8
Wang [212]	2014	Observational	4	3	3	10
Enatsu [213]	2014	Observational	2	2	3	7
Samplaski [214]	2014	Observational	2	2	3	7
Hosseinifar [215]	2014	Observational	2	3	3	8
Kadioglu [216]	2014	Observational	3	2	3	8
Lehtihet [217]	2014	Observational	2	3	3	8
Al-Adl [218]	2014	Observational	3	3	3	9
Li [219]	2014	Observational	1	3	3	7
Chen [220]	2014	Observational	2	2	3	7
Lee [221]	2014	Observational	1	3	3	7
Choe [222]	2015	Observational	3	2	3	8
Guo [223]	2015	Observational	3	3	3	9
Kiziler [224]	2015	Observational	3	3	3	9
Zhang [225]	2015	Observational	3	3	3	9
Youssef [226]	2015	Observational	2	3	3	8
Cantoro [227]	2015	Observational	3	3	3	9
Ener [228]	2015	Observational	2	3	3	8
Telli [229]	2015	Observational	3	3	3	9
Tavalaee [230]	2015	Observational	2	3	3	8

Table 3. Continued 5

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Shabana [231]	2015	Observational	3	3	3	9
Abdelaziz [232]	2015	Observational	2	3	3	8
Mohammed [233]	2015	Observational	3	3	3	9
McGarry [234]	2015	Observational	3	2	4	9
Hou [235]	2015	Observational	2	3	3	8
Fukuda [236]	2015	Observational	2	3	3	8
Naderi [237]	2015	Observational	2	2	3	7
Hu [238]	2015	Observational	2	3	3	8
Amer [239]	2015	Observational	2	3	3	8
Lee [240]	2015	Observational	2	2	3	7
Cantoro [241]	2015	Observational	3	3	6	12
Pajovic [242]	2015	Observational	2	3	3	8
Ni [243]	2015	Observational	3	3	4	10
Wang [244]	2015	Observational	2	3	3	8
Binhazaa [245]	2016	Observational	3	3	3	9
Arab [246]	2016	Observational	2	2	3	7
Kucuk [247]	2016	Observational	3	3	3	9
Lv [248]	2016	Observational	2	3	3	8
Ener [249]	2016	Observational	2	3	3	8
Karami [250]	2016	Observational	2	3	3	8
Park [251]	2016	Observational	2	3	3	8
Guo [252]	2016	Observational	3	3	3	9
Barekat [253]	2016	Observational	3	3	3	9
Sofimajidpour [254]	2016	Observational	2	3	3	8
Ariagno [255]	2016	Observational	3	3	3	9
Mohamed [256]	2017	Observational	1	3	3	7
Samplaski [257]	2017	Observational	2	2	3	7
Pijoan [258]	2017	Observational	1	3	4	8
Mostafa [259]	2017	Observational	1	3	3	7
Alkandari [260]	2017	Observational	1	3	3	7
Morshed [261]	2017	Observational	2	2	3	7
Qu [262]	2017	Observational	3	3	3	9
Akand [263]	2017	Observational	3	3	3	9
Feng [264]	2017	Observational	4	2	6	12
Gao [265]	2017	Observational	4	2	6	12
Gao [266]	2017	Observational	1	2	4	7
Afsin [267]	2018	Observational	3	3	3	9
Ketabchi [268]	2018	Observational	3	3	3	9
Vahidi [269]	2018	Observational	2	3	3	8
Lu [270]	2018	Observational	2	3	3	8
Çayan [271]	2018	Observational	2	3	3	8
Gupta [272]	2018	Observational	2	2	3	7
Allameh [273]	2018	Observational	3	3	3	9
Shafi [274]	2018	Observational	1	2	3	6
Hosseini [275]	2018	Observational	1	2	3	6
Sun [276]	2018	Observational	2	3	3	8

Table 3. Continued 6

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Dubin [277]	2018	Observational	1	2	3	6
Liu [278]	2018	Observational	1	2	3	6
Alenzi [279]	2019	Observational	3	2	3	8
Kızılay [280]	2019	Observational	2	3	3	8
Abdulmageed [281]	2019	Observational	2	3	3	8
Bolat [282]	2019	Observational	2	2	3	7
Camargo [283]	2019	Observational	1	3	3	7
Masterson [284]	2019	Observational	1	3	3	7
Ates [285]	2019	Observational	1	2	3	6
Belardin [286]	2019	Observational	1	3	3	7
Palmisano [287]	2019	Observational	1	3	3	7
Abbasi [288]	2020	Observational	1	2	3	6
Ilktac [289]	2020	Observational	1	2	3	6
Teng [290]	2020	Observational	2	2	3	7
Nasser [291]	2020	Observational	1	3	3	7
Abd El Rahman [292]	2020	Observational	1	3	3	7
Ghaed [293]	2020	Observational	1	3	3	7
Habib [294]	2020	Observational	1	3	3	7
Özkaptan [295]	2020	Observational	1	2	3	6
Kamal [296]	2020	Observational	2	3	6	11
Jin [297]	2020	Observational	1	3	3	7
Senturk [298]	2020	Observational	1	2	3	6
Öztekin [299]	2020	Observational	1	2	3	6
Ghanem [300]	2020	Observational	1	3	3	7
Omar [301]	2020	Observational	1	3	3	7
Gok [302]	2020	Observational	2	3	3	8
Mostafa [303]	2020	Observational	2	3	3	8
Alkhamees [304]	2020	Observational	3	2	3	8
Khan [305]	2020	Observational	1	3	3	7
Ok [306]	2020	Observational	3	2	3	8
Phan [307]	2021	Observational	0	3	3	6
Erdogan [308]	2021	Observational	2	2	3	7
Fernández-Concha Schwalb [309]	2021	Observational	1	2	4	7
Kavoussi [310]	2021	Observational	1	2	4	7
Fuschi [311]	2021	Observational	3	3	3	9
Pazir [312]	2021	Observational	1	2	3	6
Shomarufov [313]	2021	Observational	1	2	3	6
Morini [314]	2021	Observational	2	2	3	7
Majzoub [367]	2021	Observational	2	2	3	7
Hudson [315]	1985	Case-control	0	3	4	7
Hudson [316]	1986	Case-control	0	3	4	7
Giordanengo [317]	1993	Case-control	2	2	6	10
Yamamoto [318]	1996	Case-control	2	3	6	11
Fuse [319]	1996	Case-control	1	3	4	8
Mandressi [320]	1996	Case-control	2	3	6	11
Koşar [321]	2000	Case-control	2	3	4	9

Table 3. Continued 6

First Author	Year	Type of study	Cambridge Quality Checklist			Total quality score (2–15)
			Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	
Zarrilli [322]	2000	Case-control	2	3	4	9
Fujisawa [323]	2003	Case-control	3	3	4	10
Salama [324]	2003	Case-control	1	3	4	8
Di Bisceglie [325]	2003	Case-control	3	2	4	9
Gazzera [326]	2006	Case-control	3	3	4	10
Zini [327]	2006	Case-control	3	2	4	9
Di Bisceglie [328]	2007	Case-control	1	3	6	10
Baazeem [11]	2009	Case-control	2	3	4	9
Ichioka [329]	2009	Case-control	2	1	4	7
Nasr Esfahani [330]	2010	Case-control	2	3	6	11
Seo [331]	2010	Case-control	0	2	6	8
Esteves [332]	2010	Case-control	2	2	6	10
Sathya Srinani [333]	2011	Case-control	1	3	6	10
Ghanem [334]	2011	Case-control	2	3	6	11
Sadek [335]	2011	Case-control	3	3	4	10
Awadallah [336]	2011	Case-control	3	3	4	10
Mohamed [337]	2011	Case-control	1	3	6	10
Gokce [338]	2013	Case-control	1	2	6	9
Alhathal [339]	2016	Case-control	2	3	3	8
Ni [340]	2016	Case-control	3	3	4	10
Chen [341]	2016	Case-control	3	3	3	9
Abdelbaki [342]	2017	Case-control	2	3	4	9
Bou Nasr [343]	2017	Case-control	1	3	3	7
Gomaa [344]	2018	Case-control	2	3	6	11
Turgut [345]	2020	Case-control	1	2	4	7
El-Ariny [346]	2020	Case-control	2	3	4	9
Fathi [347]	2021	Case-control	2	3	4	9
El Taieb [348]	2020	Case-control	1	3	4	8

^aResults of the Cambridge Quality Checklist (Murray et al [18], 2009).

before parameters (SMD 0.203, 95% CI: 0.129–0.278; $p < 0.001$), in the presence of significant inter-study heterogeneity ($I^2 = 83.62\%$). Furthermore, Egger's test demonstrated no significant publication bias ($p = 0.3329$) (Table 5).

2. Sperm concentration

The before-after analysis of sperm concentration included 303 articles, for a total of 32,577 infertile patients before and 31,771 after varicocele repair. It showed a significant improvement of the sperm concentration following varicocele repair (SMD 1.590, 95% CI: 1.474–1.706; $p < 0.001$), in the presence of significant inter-study heterogeneity ($I^2 = 97.86$). Furthermore, evidence of publication bias was found with the Egger's

test ($p < 0.0001$) (Table 5).

3. Total sperm count

The analysis of the total sperm count was performed on 63 articles, for a total of 5,593 patients with clinical varicocele before and 5,337 after varicocele repair. We found a significant increase in the total sperm count following varicocele repair (SMD 1.824, 95% CI: 1.526–2.121; $p < 0.001$). The test for heterogeneity revealed the presence of significant inter-study heterogeneity ($I^2 = 97.88\%$). A significant publication bias was found in the results of Egger's test ($p = 0.0063$) (Table 5).

4. Total motile sperm count

Overall, the analysis of this outcome was performed

Table 4. Quality of evidence assessment^a for randomized controlled trials

First author	Year	Cambridge Quality Checklist				CONSORT guidelines (1–25)	Jadad score (1–5)	Total quality score (2–53)
		Checklist for correlates	Checklist for risk factors	Checklist for causal risk factor	Cochrane risk of bias for RCTs (7–21)			
Yavetz [349]	1992	3	3	7	2	17	2	34
Sayfan [350]	1992	2	3	7	2	18	2	34
Breznik [351]	1993	1	3	7	1	14	2	28
Yamamoto [60]	1995	2	3	7	1	16	1	30
Nieschlag [352]	1995	2	3	7	1	14	3	30
Grasso [92]	1997	2	3	7	1	16	2	31
Unal [353]	2001	3	3	4	1	8	1	20
Alkandari [260]	2017	3	3	7	3	14	1	31
Al-Said [149]	2008	3	3	7	3	14	2	32
Abdel-Maguid [354]	2010	2	3	7	1	6	1	20
Abdel-Meguid [355]	2011	3	3	7	1	23	5	42
Mansour Ghanaie [356]	2012	4	3	7	1	14	1	30
Azizollahi [357]	2013	1	3	7	1	14	2	28
Akin [358]	2014	2	3	7	1	12	1	26
Asr Badr [359]	2017	2	3	7	1	16	3	32
Bryniarski [360]	2017	2	3	7	1	18	1	32
Guo [361]	2017	2	3	7	2	19	3	36
Abdelsalam [362]	2017	3	3	7	1	11	1	26
Vyas [363]	2017	2	3	7	1	16	3	32
Ketabchi [268]	2018	3	3	7	1	15	1	30
Babak [364]	2018	2	3	7	1	16	3	32
Zaazaa [365]	2018	2	3	7	1	15	1	29
Almekaty [366]	2019	2	3	7	1	17	3	33

RCT: randomized controlled trial.

^aResults of the Cambridge Quality Checklist (Murray et al [18], 2009), Cochrane risk of bias for randomized controlled trials (Sterne et al [19], 2016), CONSORT guidelines (Schulz et al [21], 2010), and Jadad score (Jadad et al [20], 1996).

on 50 articles, a total of 6,396 infertile patients with clinical varicocele before and 6,274 after varicocele repair were included in the analysis of total sperm count. We found a significant improvement in the total sperm count following varicocele repair (SMD 1.643, 95% CI: 1.318–1.968; $p < 0.001$), and the presence of significant inter-study heterogeneity ($I^2 = 98.65\%$). The presence of publication bias was shown by Egger's test ($p = 0.0003$) (Table 5).

5. Progressive sperm motility

The effect of varicocele repair on progressive sperm motility in infertile patients with clinical varicocele was evaluated in 99 articles, using a before-after approach. The analysis was performed on 10,454 participants before and 10,252 participants after varicocele repair. The results of the meta-analysis showed that varicocele repair was associated with increased sperm

progressive motility (SMD 1.845, 95% CI: 1.537–2.153, $p < 0.001$). Heterogeneity across studies was present ($I^2 = 98.97\%$). When one study was excluded, the SMD (95% CI) for sperm progressive motility was 8.125 (4.712–11.538). A significant publication bias was found in the results of Egger's test ($p < 0.0001$) (Table 5).

6. Total sperm motility

A total of 209 articles were included for the analysis of this outcome, including 22,326 infertile patients before and 21,898 patients after varicocele repair in the before-after analysis of total motility. Overall, a significant improvement of total sperm motility was detected after varicocele repair (SMD 1.613, 95% CI: 1.467–1.759; $p < 0.001$), in the presence of significant inter-study heterogeneity ($I^2 = 97.98\%$, $p < 0.001$). Evidence of publication bias was found by Egger's test ($p < 0.001$) (Table 5).

Table 5. Results of the before-after varicocele repair analysis of conventional semen parameters

Parameter	Random	Before (n)	After (n)	SMD	95% CI	p	Heterogeneity		Publication bias
							I ²	p	Egger's test
Semen volume	Random	12,566	10,825	0.203	0.129 to 0.278	<0.001	83.62%	<0.001	0.3329
Sperm concentration	Random	32,577	31,771	1.590	1.474 to 1.706	<0.001	97.86%	<0.0001	<0.0001
Total sperm count	Random	5,593	5,337	1.824	1.526 to 2.121	<0.0001	97.88%	<0.0001	0.0063
TMSC	Random	6,396	6,274	1.643	1.318 to 1.968	<0.001	98.65%	<0.0001	0.0003
Progressive sperm motility	Random	10,454	10,252	1.845	1.537 to 2.153	<0.001	98.97%	<0.0001	<0.0001
Total sperm motility	Random	22,326	21,898	1.613	1.467 to 1.759	<0.001	97.98%	<0.0001	<0.0001
Sperm morphology	Random	21,979	21,335	1.066	0.922 to 1.211	<0.001	97.87%	<0.001	0.1864
Sperm vitality	Random	597	555	-1.310	-2.112 to -0.509	0.001	98.50%	<0.0001	0.0807

SMD: standard mean difference, TMSC: total motile sperm count.

7. Sperm morphology

A total of 195 articles were included in the analysis of sperm morphology, including 21,979 patients before and 21,335 after varicocele repair was included in the before-after analysis. The effects of varicocele repair on sperm morphology are summarized in Table 5. Overall, a significant improvement of sperm morphology was noted after varicocele repair (SMD 1.066, 95% CI: 0.992–1.211; $p < 0.001$), in the presence of significant inter-study heterogeneity ($I^2 = 97.87\%$). No evidence of publication bias was found.

8. Sperm vitality

Fourteen studies reported sperm vitality and were included in our analysis. A total of 1,152 infertile patients with clinical varicocele were included: 597 patients before varicocele repair and 555 patients after varicocele repair. The analysis showed a significant negative effect of varicocele repair on sperm vitality (SMD -1.310, 95% CI: -2.112 to -0.509; $p = 0.001$). There was considerable heterogeneity between studies ($I^2 = 98.50\%$, $p < 0.0001$), and no publication bias was evident as the Egger's test was non-significant ($p = 0.0807$) (Table 5).

DISCUSSION

Varicocele is a very common condition, affecting one in six males of the general population [1]. In infertile patients, its prevalence is even higher, being diagnosed in 19% to 41% of primary infertility and 80% of secondary infertility cases [1]. Therefore, varicocele is considered as a cause of male infertility [7]. Knowing the impact of varicocele repair on human sperm conventional parameters is important for decision-making in the management of varicocele patients.

In the last 30 years, nearly 2,000 original articles have been published on varicocele and about half have evaluated the impact of varicocele and varicocele repair on semen parameters [368]. Accordingly, varicocele remains one of the most controversial topics in male infertility. Although most international urology and reproductive societies agree on the indication for varicocele repair in cases of male infertility as with clinically palpable varicocele and abnormal semen parameters [8], there are still some clinicians who doubt the beneficial effect of varicocele repair on semen parameters and fertility status [369-371]. According to the results of the current meta-analysis, almost all semen parameters, including semen volume, sperm concentration, total sperm count, total motile sperm count, progressive sperm motility, total sperm motility, and sperm morphology, increase significantly in infertile patients with clinical varicocele following varicocele repair compared to the before-intervention values. Only sperm vitality showed a significant decrease following varicocele repair; the reason for this finding is not clear.

An earlier meta-analysis evaluated the efficacy of varicocele repair in improving the semen parameters of patients with unilateral or bilateral varicocele and at least one abnormal sperm parameter. A significant increase in sperm concentration by $9.71 \times 10^6/\text{mL}$ (95% CI: 7.34–12.08, $p < 0.00001$), and sperm progressive motility by 9.92 (95% CI: 4.90–14.95, $p = 0.0001$), was demonstrated following inguinal microsurgical varicocele repair [372]. In the same study, high ligation varicolectomy was also associated with statistically significant improvements in sperm concentration by $2.03 \times 10^6/\text{mL}$ (95% CI: 5.71–18.35, $p = 0.0002$), and motility by 11.72% (95% CI: 4.33–19.12, $p = 0.002$). A statistically

significant improvement in sperm morphology was also associated with both surgical methods (3.16%, 95% CI: 0.72–5.60, $p < 0.01$). Another meta-analysis showed that varicocele repair significantly improves sperm motility and concentration in infertile male with preoperative abnormal sperm parameters and palpable varicocele [373]. In another meta-analysis published in 2011, varicolectomy was associated with a significant increase in sperm concentration (random-effect model combined improvement 12.32×10^6 sperm/mL; 95% CI 9.45–15.19, $p < 0.0001$), progressive (improvement 9.69%; 95% CI 4.86–14.52, $p = 0.003$) and total sperm motility (improvement 10.86%; 95% CI 7.07–14.65, $p < 0.0001$) [11]. However, in that meta-analysis, the included studies displayed significant heterogeneity in terms of patients' characteristics, treatment modality (including radiologic embolization), and diagnostic criteria. In a subsequent meta-analysis, Schauer et al [374] compared the impact of three different surgical techniques for varicocele repair on semen parameters. Regardless of the surgical technique, a statistically significant improvement was observed in sperm concentration (by 7.17 to 10.85×10^6 /mL) and motility (by 6.80% to 12.25%). The positive impact of varicolectomy on sperm concentration and sperm motility is also supported by the findings from Birowo et al [375] and Majzoub et al [367].

In the present meta-analysis, the results of comparing preoperative and postoperative basic semen parameters in thousands of infertile male with clinical varicocele are in favor of varicocele repair as a treatment option to improve conventional semen parameters. These results are in line with the current guidelines of international professional societies. The recent guidelines of AUA/ASRM recommend “varicocele repair of clinical varicoceles in non-azoospermic infertile male with abnormal sperm parameters (moderate recommendation; moderate evidence level)” [8]. Similarly, the guidelines of the EAU recommend varicocele repair in “infertile men with a clinical varicocele, abnormal semen parameters, and otherwise unexplained infertility in a couple where the female partner has a good ovarian reserve to improve fertility rates without other male causes of infertility (strong recommendation; high evidence level)” [7]. The European Academy of Andrology (EAA) advises discussing varicocele treatment in infertile couples whose male partner has a palpable varicocele associated with oligoasthenoteratozoospermia [376].

However, the significant positive impact of varicocele repair on basic sperm parameters observed in the current meta-analysis is limited by the remarkable heterogeneity of the included studies and the notable high risk of publication bias towards studies with a positive outcome. It has been suggested that manuscripts with statistically significant results have a much higher chance of being published than those with null results [377]. Investigators may refrain from submitting negative results leading to non-response bias.

The current meta-analysis is the largest to date and includes 351 studies. In addition, the effect size used in the current meta-analysis is the SMD which is generally preferred over the raw mean difference because it accounts for the heterogeneity in methods of mean calculation by measuring the difference in standardized deviation unit [378]. In addition, it supports the previously published meta-analyses (Table 6) [11,367,372,379,380] which showed significant improvement in all studied semen parameters. Furthermore, the improvement in the semen volume after varicocele repair found in the present meta-analysis of 10,825 cases has not been reported by any study. In line with the above-mentioned evidence, the present study found a significant increase in sperm concentration, total sperm count, total sperm motility and specifically progressive sperm motility, and sperm morphology. Finally, surprisingly, in this meta-analysis sperm vitality was found to be decreased after varicolectomy, which is contrary to the improved motility that was observed. There is no information about this sperm quality marker in other studies. However, inter-study heterogeneity was found.

The strengths of the current meta-analysis (Fig. 2) include that it is the largest meta-analysis of its kind to date. It is also the first to report on volume and total sperm count. Control data exist in the form of semen parameters of the male in these studies prior to varicocele repair, which helps minimize the number of studies excluded to improve the power of this meta-analysis.

The current meta-analysis assessed changes in conventional semen parameters as the outcome measure; however, the extent of improvement in conventional semen parameters that would be considered significant is not agreed upon. There is marked heterogeneity in the included studies. In addition, this meta-analysis compared intra-person before-after sperm parameters using the patient's parameters before intervention as

Table 6. Evidence coming from previous meta-analyses on varicocele repair

Reference	Design	No. of studies/sample size	Result	Comment
Majzoub et al (2021) [367]	Before-After mean difference (MD)	8/600	Sperm count: 5.642 mil/mL (95% CI: 4.195–7.090, p<0.001) Total sperm motility: 7.772% (95% CI: 3.248–12.297, p=0.001) Total motile sperm count: 8.432 mil (95% CI: 4.648–12.228, p<0.001)	Severe oligospermia All observational
Birowo et al (2020) [379]	Before-After mean difference (MD)	7/289	Sperm concentration: 9.59 mil/mL; 95% CI: 7.80, 11.38; p < 0.00001) Progressive sperm motility: 8.66%; 95% CI: 6.96, 10.36; p < 0.00001) Sperm morphology: 2.73%; 95% CI: 0.65, 4.80; p = 0.01)	
Wang et al (2019) [380]	Before-After (MD)	Profound (5/151 patients), severe (2/115 patients), moderate (2/79 patients), and mild (2/248 patients)	<2 million - profound: 10.20 (95% CI: 9.11–11.30, p<0.0001) 2–5 million - severe: 15.77 (95% CI: 10.65–20.89, p<0.0001) 5–10 million - moderate: 19.18 (95% CI: 10.40–27.96, p<0.0001) >10 million - mild: 49.68 (95% CI: 38.74–60.62, p<0.0001)	Examined total motile sperm count The most significant improvement is in the mild group
Baazeem et al (2011) [11]	Before-After (MD)	Sperm concentration: 22 Total sperm motility: 17 Progressive sperm motility: 5	Sperm concentration: 12.32 mil/mL (95% CI: 9.45–15.19; p<0.0001) Total sperm motility: 10.86% (95% CI: 7.07–14.65; p<0.0001) Progressive sperm motility: 9.69% (95% CI: 4.86–14.52; p=0.003)	
Agarwal et al (2007) [372]	Before-After (MD)	17	Microsurgical varicocelectomy: Sperm concentration: 9.71 mil/mL (95% CI: 7.34–12.08, p < 0.00001) Sperm progressive motility: 9.92% (95% CI: 4.90–14.95, p=0.0001) High ligation varicocelectomy: Sperm concentration: 12.03 mil/mL (95% CI: 5.71–18.35, p=0.0002) Sperm motility: 11.72% (95% CI: 4.33–19.12, p=0.002) Both:	
Current study	Before-After SMD	351	Sperm morphology: 3.16% (95% CI: 0.72–5.60, p=0.01) Semen volume: SMD=0.23; p<0.001 Sperm concentration: SMD=1.5; p<0.001 Total sperm count: SMD=1.8; p<0.001 Total motile sperm count: SMD=1.6; p<0.001 Total motility: SMD=1.6; p<0.001 Progressive motility: SMD=1.8, p<0.001 Sperm morphology: SMD=1; p<0.001 Sperm vitality: SMD= -1.3; p=0.001	

SMD: standardized mean difference.



Fig. 2. Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis.

the control group. This approach has some drawbacks in terms of statistical methodology [381], potential of the placebo effect, non-blindness of the type of intervention *e.g.*, varicocelectomy, and it also lacks a control arm of patients that did not undergo varicocele repair. A proper control group is a key in establishing a cause-and-effect relationship of a certain variable [382] and testing the impact of an intervention on the outcome. However, this before-after analysis has the advantage of including all intervention groups, thus minimizing the number of studies excluded because of deficient data and increasing the number of patients available for analysis. The quality of the majority of the studies included in this meta-analysis is considered low due to factors such as poor study design, inadequate sample size, selective reporting, or high attrition bias (Table 3, 4). An ideal clinical trial to evaluate the impact of varicocele repair on male fertility outcomes would be to randomize a group of male with subfertility to varicocele repair or sham surgery and follow their outcomes over time. However, many ethical concerns surround such an approach and prevent its implementation. This explains the paucity of high-quality studies on the effects of varicocele repair and male fertility potential. In this regard, a meta-analysis of low-risk-of-bias RCTs would give the best QoE on the impact of varicocele re-

pair on sperm parameters. However, since high-quality RCTs are lacking, the very large number of subjects available in the present analysis helps mitigate the limitation of a before-after analysis (Fig. 2).

CONCLUSIONS

The current meta-analysis is the largest one to date. The significant improvement seen in almost all semen parameters, including semen volume, sperm concentration, total sperm count, total motile sperm count, progressive sperm motility, total sperm motility, and sperm morphology, provides strong support for the role of varicocele repair in infertile male with clinical varicoceles.

Conflict of Interest

The authors have nothing to disclose.

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Author Contribution

Conceptualization: AA. Data curation: RC, FB. Formal analysis: RH, AMH. Methodology: AA, Shah R, RC, AMH. Project administration: AA, Shah R, RC. Supervision: AA, Shah R. Writing – original draft: RC, FB, Saleh R, MG, AR, PK, TT, EK, GC, DD, NA, SK, AC, RH, AMH, GS, BH, MD, MB, SD, MF, NG, RK, RSK, KK, TAAAMH. Writing – review & editing: All authors.

REFERENCES

1. Alsaikhan B, Alrabeeh K, Delouya G, Zini A. Epidemiology of varicocele. *Asian J Androl* 2016;18:179-81.
2. Meacham RB, Townsend RR, Rademacher D, Drose JA. The incidence of varicoceles in the general population when evaluated by physical examination, gray scale sonography and color Doppler sonography. *J Urol* 1994;151:1535-8.
3. Gorelick JI, Goldstein M. Loss of fertility in men with varicocele. *Fertil Steril* 1993;59:613-6.
4. World Health Organization. The influence of varicocele on parameters of fertility in a large group of men presenting to infertility clinics. *Fertil Steril* 1992;57:1289-93.
5. Macleod J. Further observations on the role of varicocele in human male infertility. *Fertil Steril* 1969;20:545-63.
6. Clavijo RI, Carrasquillo R, Ramasamy R. Varicoceles: prevalence and pathogenesis in adult men. *Fertil Steril* 2017;108:364-9.
7. Minhas S, Bettocchi C, Boeri L, Capogrosso P, Carvalho J, Cilesiz NC, et al.; EAU Working Group on Male Sexual and Reproductive Health. European Association of Urology guidelines on male sexual and reproductive health: 2021 update on male infertility. *Eur Urol* 2021;80:603-20.
8. Schlegel PN, Sigman M, Collura B, De Jonge CJ, Eisenberg ML, Lamb DJ, et al. Diagnosis and treatment of infertility in men: AUA/ASRM guideline part II. *J Urol* 2021;205:44-51.
9. Jensen CFS, Østergren P, Dupree JM, Ohl DA, Sønksen J, Fode M. Varicocele and male infertility. *Nat Rev Urol* 2017;14:523-33.
10. Persad E, O'Loughlin CA, Kaur S, Wagner G, Matyas N, Hassler-Di Fratta MR, et al. Surgical or radiological treatment for varicoceles in subfertile men. *Cochrane Database Syst Rev* 2021;4:CD000479.
11. Baazeem A, Belzile E, Ciampi A, Dohle G, Jarvi K, Salonia A, et al. Varicocele and male factor infertility treatment: a new meta-analysis and review of the role of varicocele repair. *Eur Urol* 2011;60:796-808.
12. Asafu-Adjei D, Judge C, Deibert CM, Li G, Stember D, Stahl PJ. Systematic review of the impact of varicocele grade on response to surgical management. *J Urol* 2020;203:48-56.
13. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71.
14. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, et al.; PRISMA-P Group. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ* 2015;350:g7647.
15. Stroup DF, Berlin JA, Morton SC, Olkin I, Williamson GD, Rennie D, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis of observational studies in epidemiology (MOOSE) group. *JAMA* 2000;283:2008-12.
16. da Costa Santos CM, de Mattos Pimenta CA, Nobre MR. The PICO strategy for the research question construction and evidence search. *Rev Lat Am Enfermagem* 2007;15:508-11.
17. Cannarella R, Shah R, Boitrelle F, Saleh R, Durairajanayagam D, Harraz AM, et al. Need for training in research methodology prior to conducting systematic reviews and meta-analyses, and the effectiveness of an online training program: the global andrology forum model. *World J Mens Health* 2023. doi: 10.5534/wjmh.220128 [Epub].
18. Murray J, Farrington DP, Eisner MP. Drawing conclusions about causes from systematic reviews of risk factors: the Cambridge quality checklists. *J Exp Criminol* 2009;5:1-23.
19. Sterne JA, Hernán MA, Reeves BC, Savović J, Berkman ND, Viswanathan M, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ* 2016;355:i4919.
20. Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 1996;17:1-12.
21. Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *BMJ* 2010;340:c332.
22. Agarwal A, Saleh R, Boitrelle F, Cannarella R, Hamoda TAA, Durairajanayagam D, et al. The global andrology forum (GAF): a world-wide, innovative, online initiative to bridge the gaps in research and clinical practice of male infertility and sexual health. *World J Mens Health* 2022;40:537-42.
23. Niedhammer I, Milner A, Witt K, Klingelschmidt J, Khired-

- dine-Medouni I, Alexopoulos EC, et al. Response to letter to the editor from Dr Rahman Shiri: the challenging topic of suicide across occupational groups. *Scand J Work Environ Health* 2018;44:108-10.
24. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ* 2003;327:557-60.
 25. Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;315:629-34.
 26. Haensch R. [Influence of Palomo's varicocele operation on the spermogram]. *Hautarzt* 1976;27:449-52. German.
 27. Rodriguez-Rigau LJ, Smith KD, Steinberger E. Relationship of varicocele to sperm output and fertility of male partners in infertile couples. *J Urol* 1978;120:691-4.
 28. Johnsen SG, Agger P. Quantitative evaluation of testicular biopsies before and after operation for varicocele. *Fertil Steril* 1978;29:58-63.
 29. Nilsson S, Edvinsson A, Nilsson B. Improvement of semen and pregnancy rate after ligation and division of the internal spermatic vein: fact or fiction? *Br J Urol* 1979;51:591-6.
 30. Greenberg SH, Lipshultz LI, Wein AJ. A preliminary report of "subclinical varicocele": diagnosis by Doppler ultrasonic stethoscope. Examination and initial results of surgical therapy. *J Reprod Med* 1979;22:77-81.
 31. Homonnai ZT, Fainman N, Engelhard Y, Rudberg Z, David MP, Paz G. Varicolectomy and male fertility: comparison of semen quality and recurrence of varicocele following varicolectomy by two techniques. *Int J Androl* 1980;3:447-58.
 32. Gogol G, Anderman S, Ellenbogen A, Peer R, Schlum H, Grünstein S. Surgical treatment of varicocele in oligospermic patients: a re-evaluation. *Eur J Obstet Gynecol Reprod Biol* 1980;10:329-33.
 33. Lukkarinen O, Hellström P, Rönnerberg L. Ligation of the left spermatic vein in the treatment of male infertility. *Ann Chir Gynaecol* 1984;73:342-4.
 34. Foresta C, Ruzza G, Rizzotti A, Lembo A, Valente ML, Mastrogiacomo I. Varicocele and infertility. *J Androl* 1984;5:135-7.
 35. Tinga DJ, Jager S, Bruijnen CL, Kremer J, Mensink HJ. Factors related to semen improvement and fertility after varicocele operation. *Fertil Steril* 1984;41:404-10.
 36. Shinoda M. A pharmacological manipulation of testicular function for rational therapeutic approach to male infertility: experimental and clinical data. *Keio J Med* 1985;34:31-45.
 37. Marmar JL, DeBenedictis TJ, Praiss D. The management of varicoceles by microdissection of the spermatic cord at the external inguinal ring. *Fertil Steril* 1985;43:583-8.
 38. Segenreich E, Shmueli H, Singer R, Servadio C. Andrological parameters in patients with varicocele and fertility disorders treated by high ligation of the left spermatic vein. *Int J Fertil* 1986;31:200-3.
 39. Vereecken RL, Boeckx G. Does fertility improvement after varicocele treatment justify preventive treatment at puberty? *Urology* 1986;28:122-6.
 40. Hadziselimovic F, Leibundgut B, Da Rugna D, Buser MW. The value of testicular biopsy in patients with varicocele. *J Urol* 1986;135:707-10.
 41. Burke RK. Sperm velocity, pre- and post-washing, as a measure of the effects of varicolectomy and subsequent male fertility. *Int J Fertil* 1987;32:213-6.
 42. Nagai N, Katayama Y, Iguchi M, Esa A, Tsuzihashi H. [Treatment in male infertile clinic of Kaizuka Municipal Hospital]. *Hinyokika Kyo* 1988;34:839-46. Japanese.
 43. Okuyama A, Fujisue H, Matsui T, Doi Y, Takeyama M, Nakamura N, et al. Surgical repair of varicocele: effective treatment for subfertile men in a controlled study. *Eur Urol* 1988;14:298-300.
 44. Gerris J, Van Nueten J, Van Camp C, Gentens P, Van Dam P, Van Camp K. Clinical aspects in the surgical treatment of varicocele in subfertile men. I. Comparison of observed and expected pregnancy rates. *Eur J Obstet Gynecol Reprod Biol* 1988;27:33-41.
 45. Yarborough MA, Burns JR, Keller FS. Incidence and clinical significance of subclinical scrotal varicoceles. *J Urol* 1989;141:1372-4.
 46. Parsch EM, Schill WB, Erlinger C, Tauber R, Pfeifer KJ. Semen parameters and conception rates after surgical treatment and sclerotherapy of varicocele. *Andrologia* 1990;22:275-8.
 47. Kuroiwa T, Hasuo K, Yasumori K, Mizushima A, Yoshida K, Hirakata R, et al. Transcatheter embolization of testicular vein for varicocele testis. *Acta Radiol* 1991;32:311-4.
 48. Dhabuwala CB, Hamid S, Moghissi KS. Clinical versus subclinical varicocele: improvement in fertility after varicolectomy. *Fertil Steril* 1992;57:854-7.
 49. Donovanjr JF, Winfield HN. Laparoscopic varix ligation with Nd:YAG laser. *J Endourol* 1992;6:165-71.
 50. Ito H, Kotake T, Hamano M, Yanagi S. Results obtained from microsurgical therapy of varicocele. *Urol Int* 1993;51:225-7.
 51. Steckel J, Dicker AP, Goldstein M. Relationship between varicocele size and response to varicolectomy. *J Urol* 1993;149:769-71.
 52. Ross LS, Ruppman N. Varicocele vein ligation in 565 patients under local anesthesia: a long-term review of technique, results and complications in light of proposed management by laparoscopy. *J Urol* 1993;149(5 Pt 2):1361-3.
 53. Hirokawa M, Matsushita K, Iwamoto T, Iwasaki A, Asakura

- S, Masuda M. Assessment of Palomo's operative method for infertile varicocele. *Andrologia* 1993;25:47-51.
54. Lerchl A, Keck C, Spiteri-Grech J, Nieschlag E. Diurnal variations in scrotal temperature of normal men and patients with varicocele before and after treatment. *Int J Androl* 1993;16:195-200.
 55. Kondoh N, Meguro N, Matsumiya K, Namiki M, Kiyohara H, Okuyama A. Significance of subclinical varicocele detected by scrotal sonography in male infertility: a preliminary report. *J Urol* 1993;150:1158-60.
 56. Yamamoto M, Hibi H, Tsuji Y, Miyake K. The effect of varicocele ligation on oocyte fertilization and pregnancy after failure of fertilization in in vitro fertilization-embryo transfer. *Hinyokika Kyo* 1994;40:683-7.
 57. Dewire DM, Thomas AJ Jr, Falk RM, Geisinger MA, Lamert GK. Clinical outcome and cost comparison of percutaneous embolization and surgical ligation of varicocele. *J Androl* 1994;15 Suppl:38S-42S.
 58. Knudson G, Ross L, Stuhldreher D, Houlihan D, Bruns E, Prins G. Prevalence of sperm bound antibodies in infertile men with varicocele: the effect of varicocele ligation on antibody levels and semen response. *J Urol* 1994;151:1260-2.
 59. Nakada T, Sasagawa I, Kubota Y, Suzuki H, Kakizaki H, Adachi Y. High level of noncollagenous protein of spermatic vein in patients with varicocele. *J Urol* 1994;151:1539-42.
 60. Yamamoto M, T Y, Hibi H, Miyake K. [Should subclinical varicocele be repaired?] *Jpn J Fertil Steril* 1995;40:141-4. Japanese.
 61. Ferguson JM, Gillespie IN, Chalmers N, Elton RA, Hargreave TB. Percutaneous varicocele embolization in the treatment of infertility. *Br J Radiol* 1995;68:700-3.
 62. Chiang GJ, Lin MC, Liu SP. Significance of color Doppler sonographic unilateral and bilateral varicoceles. *Med Ultrasound* 1995;3:70.
 63. Segenreich E, Israilov SR, Shmueli J, Servadio C. [Changes in semen after low inguinal spermatic vein ligation]. *Harefuah* 1995;129:379-81, 448. Hebrew.
 64. Watanabe K, F K, Kobashigawa K, Kataoka T, Watanabe M, Yoshida H. [Studies on testicular blood flow in varicocele patients using ultrasound color Doppler method]. *Jpn J Fertil Steril* 1995;40:230-7. Japanese.
 65. Su LM, Goldstein M, Schlegel PN. The effect of varicocelectomy on serum testosterone levels in infertile men with varicoceles. *J Urol* 1995;154:1752-5.
 66. Parikh FR, Kamat SA, Kodwaney GG, Balaiah D. Computer-assisted semen analysis parameters in men with varicocele: is surgery helpful? *Fertil Steril* 1996;66:440-5.
 67. Jarow JP, Ogle SR, Eskew LA. Seminal improvement following repair of ultrasound detected subclinical varicoceles. *J Urol* 1996;155:1287-90.
 68. Punekar SV, Prem AR, Ridhorkar VR, Deshmukh HL, Kelkar AR. Post-surgical recurrent varicocele: efficacy of internal spermatic venography and steel-coil embolization. *Br J Urol* 1996;77:124-8.
 69. Takahara M, Ichikawa T, Shiseki Y, Nakamura T, Shimazaki J. Relationship between grade of varicocele and the response to varicocelectomy. *Int J Urol* 1996;3:282-5.
 70. Atikeler K, Yeni E, Semercioz A, Yalcin O, Baydinc C. The value of the gonadotrophin-releasing hormone test as a prognostic factor in infertile patients with varicocele. *Br J Urol* 1996;78:632-4.
 71. Vazquez-Levin MH, Friedmann P, Goldberg SI, Medley NE, Nagler HM. Response of routine semen analysis and critical assessment of sperm morphology by Kruger classification to therapeutic varicocelectomy. *J Urol* 1997;158:1804-7.
 72. Segenreich E, Israilov SR, Shmueli J, Niv E, Servadio C. Correlation between semen parameters and retrograde flow into the pampiniform plexus before and after varicocelectomy. *Eur Urol* 1997;32:310-4.
 73. Seftel AD, Rutchik SD, Chen H, Stovsky M, Goldfarb J, Desai N. Effects of subinguinal varicocele ligation on sperm concentration, motility and Kruger morphology. *J Urol* 1997;158:1800-3.
 74. Hauser R, Yogev L, Greif M, Hirshenbein A, Botchan A, Gamzu R, et al. Sperm binding and ultrasound changes after operative repair of varicocele: correlation with fecundity. *Andrologia* 1997;29:145-7.
 75. Bablok L, Czaplicki M, Fracki S, Marianowski L, Borkowski A. Relationship between semen quality improvement after varicocelectomy and preoperative levels of hypophyseal and gonadal hormones. *Int Urol Nephrol* 1997;29:345-9.
 76. Nozawa E. [Study on varicocele by antegrade phlebography of the internal spermatic vein]. *Jpn J Fertil Steril* 1995;42:141-50. Japanese.
 77. Johnsen N, Johnsen I, Tauber R. Semen analysis after treatment of varicocele by antegrade scrotal sclerotherapy. *Adv Exp Med Biol* 1997;424:187-8.
 78. Flati G, Talarico C, Flati D, La Pinta M, Porowska B, Proposito D, et al. Long-term results of microsurgical drainage for idiopathic varicocele. *Int Urol Nephrol* 1997;29:63-9.
 79. Barbaliás GA, Liatsikos EN, Nikiforidis G, Siablis D. Treatment of varicocele for male infertility: a comparative study evaluating currently used approaches. *Eur Urol* 1998;34:393-8.
 80. Abdulmaaboud MR, Shokeir AA, Farage Y, Abd El-Rahman A, El-Rakhawy MM, Mutabagani H. Treatment of varicocele:

- a comparative study of conventional open surgery, percutaneous retrograde sclerotherapy, and laparoscopy. *Urology* 1998;52:294-300.
81. Aşci R, Sarıkaya S, Büyükalpelli R, Yılmaz AF, Yıldız S. The outcome of varicocelelectomy in subfertile men with an absent or atrophic right testis. *Br J Urol* 1998;81:750-2.
 82. Matthews GJ, Matthews ED, Goldstein M. Induction of spermatogenesis and achievement of pregnancy after microsurgical varicocelelectomy in men with azoospermia and severe oligoasthenospermia. *Fertil Steril* 1998;70:71-5.
 83. Schatte EC, Hirshberg SJ, Fallick ML, Lipschultz LI, Kim ED. Varicocelelectomy improves sperm strict morphology and motility. *J Urol* 1998;160:1338-40.
 84. Madjar S, Moskovitz B, Issaq E, Weinberger M, Nativ O. Low inguinal approach for correction of recurrent varicocele. *Int Urol Nephrol* 1998;30:69-73.
 85. Ismail MT, Sedor J, Hirsch IH. Are sperm motion parameters influenced by varicocele ligation? *Fertil Steril* 1999;71:886-90.
 86. Zini A, Buckspan M, Jamal M, Jarvi K. Effect of varicocelelectomy on the abnormal retention of residual cytoplasm by human spermatozoa. *Hum Reprod* 1999;14:1791-3.
 87. Kim ED, Leibman BB, Grinblat DM, Lipshultz LI. Varicocele repair improves semen parameters in azoospermic men with spermatogenic failure. *J Urol* 1999;162(3 Pt 1):737-40.
 88. Scherr D, Goldstein M. Comparison of bilateral versus unilateral varicocelelectomy in men with palpable bilateral varicoceles. *J Urol* 1999;162:85-8.
 89. Uygur MC, Arik AI, Erol D, Ozer E, Ustün H. Quantitative evaluation of biopsy gun testis needle biopsy. Correlation between biopsy score of varicocele-bearing testis and sperm count. *J Reprod Med* 1999;44:445-9.
 90. Chiang P, Tsai EM, Chiang CP. Color duplex sonography in the evaluation of varicoceles. *J Med Ultrasound* 1999;7:152.
 91. Reichart M, Eltes F, Soffer Y, Zigenreich E, Yogev L, Bartoov B. Sperm ultramorphology as a pathophysiological indicator of spermatogenesis in males suffering from varicocele. *Andrologia* 2000;32:139-45.
 92. Grasso M, Lania C, Castelli M, Galli L, Franzoso F, Rigatti P. Low-grade left varicocele in patients over 30 years old: the effect of spermatic vein ligation on fertility. *BJU Int* 2000;85:305-7.
 93. Pianalto B, Bonanni G, Martella S, Renier M, Ancona E. [Results of laparoscopic bilateral varicocelelectomy]. *Ann Ital Chir* 2000;71:587-91; discussion 591-2. Italian.
 94. Cayan S, Kadioglu TC, Tefekli A, Kadioglu A, Tellaloglu S. Comparison of results and complications of high ligation surgery and microsurgical high inguinal varicocelelectomy in the treatment of varicocele. *Urology* 2000;55:750-4.
 95. Papanikolaou F, Chow V, Jarvi K, Fong B, Ho M, Zini A. Effect of adult microsurgical varicocelelectomy on testicular volume. *Urology* 2000;56:136-9.
 96. Pierik FH, Vreeburg JT, Stijnen T, van Rooijen JH, Dohle GR, Laméris JS, et al. Improvement of sperm count and motility after ligation of varicoceles detected with colour Doppler ultrasonography. *Int J Androl* 1998;21:256-60.
 97. Kamal KM, Jarvi K, Zini A. Microsurgical varicocelelectomy in the era of assisted reproductive technology: influence of initial semen quality on pregnancy rates. *Fertil Steril* 2001;75:1013-6.
 98. Cayan S, Lee D, Black LD, Reijo Pera RA, Turek PJ. Response to varicocelelectomy in oligospermic men with and without defined genetic infertility. *Urology* 2001;57:530-5.
 99. Mostafa T, Anis TH, El-Nashar A, Imam H, Othman IA. Varicocelelectomy reduces reactive oxygen species levels and increases antioxidant activity of seminal plasma from infertile men with varicocele. *Int J Androl* 2001;24:261-5.
 100. Jungwirth A, Gögüs C, Hauser G, Gomahr A, Schmeller N, Aulitzky W, et al. Clinical outcome of microsurgical subinguinal varicocelelectomy in infertile men. *Andrologia* 2001;33:71-4.
 101. Cavallaro G, Albanese V, Pollicino A. [Effects of surgical repair of first degree varicocele on gonadal function and testicular atrophy]. *Chir Ital* 2001;53:207-12. Italian.
 102. Avila-Vergara MA, Balderas-Ariza JA, Córdova-González K, Hernández-Guerrero C. [Effect of Palomo procedure on the quality of the semen in infertile patients with varicocele and oligoasthenospermia]. *Ginecol Obstet Mex* 2001;69:262-7. Spanish.
 103. Cayan S, Erdemir F, Ozbey I, Turek PJ, Kadioğlu A, Tellaloglu S. Can varicocelelectomy significantly change the way couples use assisted reproductive technologies? *J Urol* 2002;167:1749-52.
 104. Kibar Y, Seckin B, Erduran D. The effects of subinguinal varicocelelectomy on Kruger morphology and semen parameters. *J Urol* 2002;168:1071-4.
 105. Onozawa M, Endo F, Suetomi T, Takeshima H, Akaza H. Clinical study of varicocele: statistical analysis and the results of long-term follow-up. *Int J Urol* 2002;9:455-61.
 106. Iwasaki M, Murakami K, Nozaki T, et al. [Treatment of male infertility in severe oligozoospermia with varicocele]. *Jpn J Fertil Steril* 2003;48:87-92. Japanese.
 107. Hsieh ML, Chang PL, Huang ST, Wang TM, Tsui KH. Loupe-assisted high inguinal varicocelelectomy for sub-fertile men with varicoceles. *Chang Gung Med J* 2003;26:479-84.
 108. Younes AK. Improvement of sexual activity, pregnancy rate, and low plasma testosterone after bilateral varicocelelectomy

- in impotence and male infertility patients. *Arch Androl* 2003;49:219-28.
109. Fuse H, Iwasaki M, Mizuno I, Ikehara-Kawauchi Y. Evaluation of acrosome reactivity using the Acrobeads test in varicocele patients: findings before and after treatment. *Arch Androl* 2003;49:1-6.
 110. Nuhoglu B, Göçen A, Ersoy E, Ayyildiz A, Fidan V, Germiyanoğlu C. [Comparison of subinguinal microsurgery and inguinal varicocelektomy effects on sperm and hormone parameters: a 1-year follow-up]. *Turk J Urol* 2004;30:302-7. Turkish.
 111. Ishikawa T, Fujisawa M. Varicocele ligation on free testosterone levels in infertile men with varicocele. *Arch Androl* 2004;50:443-8.
 112. O'Brien J, Bowles B, Kamal KM, Jarvi K, Zini A. Does the gonadotropin-releasing hormone stimulation test predict clinical outcomes after microsurgical varicocelectomy? *Urology* 2004;63:1143-7.
 113. Polito M Jr, Muzzonigro G, Centini R, Candelari R, Antico E, Boscaro M, et al. Percutaneous therapy of varicocele: effects on semen parameters in young adults. *Urol Int* 2004;72:150-3.
 114. Flati G, Porowska B, Flati D, Veltri S, Sportelli G, Carboni M. Improvement in the fertility rate after placement of microsurgical shunts in men with recurrent varicocele. *Fertil Steril* 2004;82:1527-31.
 115. Grober ED, Chan PT, Zini A, Goldstein M. Microsurgical treatment of persistent or recurrent varicocele. *Fertil Steril* 2004;82:718-22.
 116. Grober ED, O'Brien J, Jarvi KA, Zini A. Preservation of testicular arteries during subinguinal microsurgical varicocelectomy: clinical considerations. *J Androl* 2004;25:740-3.
 117. Gat Y, Bachar GN, Zukerman Z, Belenky A, Gornish M. Varicocele: a bilateral disease. *Fertil Steril* 2004;81:424-9.
 118. Gat Y, Gornish M, Belenky A, Bachar GN. Elevation of serum testosterone and free testosterone after embolization of the internal spermatic vein for the treatment of varicocele in infertile men. *Hum Reprod* 2004;19:2303-6.
 119. Gat Y, Bachar GN, Zukerman Z, Belenky A, Gorenish M. Physical examination may miss the diagnosis of bilateral varicocele: a comparative study of 4 diagnostic modalities. *J Urol* 2004;172(4 Pt 1):1414-7.
 120. Ortapamuk H, Tekdogan UY, Naldoken S, Bulut S, Atan A. Hemodynamic evaluation of varicocele: the role of scrotal scintigraphy and Doppler ultrasonography in the prediction of postoperative seminal improvement. *Ann Nucl Med* 2005;19:529-34.
 121. Ketabchi AA, Ahmadinejad M, Ehsan M. Comparison of the effects of varicocelectomy on the spermiogram of patients with subclinical versus clinical varicocele. *Acta Med Iran* 2005;43:249-52.
 122. Watanabe M, Nagai A, Kusumi N, Tsuboi H, Nasu Y, Kumon H. Minimal invasiveness and effectivity of subinguinal microscopic varicocelectomy: a comparative study with retroperitoneal high and laparoscopic approaches. *Int J Urol* 2005;12:892-8.
 123. Nasr-Esfahani M, Razavi S, Abbasi H, Haji Mirza Alian F, Haftbaradaran B, Sadeghi M. Effect of varicocelectomy on semen parameters and sperm chromatin status. *Cell J (Yakhteh)* 2005;7:158-63.
 124. Yeşilli C, Mungan G, Seçkiner I, Akduman B, Açıkgöz S, Altan K, et al. Effect of varicocelectomy on sperm creatine kinase, HspA2 chaperone protein (creatine kinase-M type), LDH, LDH-X, and lipid peroxidation product levels in infertile men with varicocele. *Urology* 2005;66:610-5.
 125. Mancini A, Milardi D, Conte G, Festa R, De Marinis L, Littarru GP. Seminal antioxidants in humans: preoperative and postoperative evaluation of coenzyme Q10 in varicocele patients. *Horm Metab Res* 2005;37:428-32.
 126. Pasqualotto FF, Lucon AM, de Góes PM, Hallak J, Sobreiro B, Pasqualotto EB, et al. Testicular growth, sperm concentration, percent motility, and pregnancy outcome after varicocelectomy based on testicular histology. *Fertil Steril* 2005;83:362-6.
 127. Ishikawa T, Fujisawa M. Effect of age and grade on surgery for patients with varicocele. *Urology* 2005;65:768-72.
 128. Zini A, Blumenfeld A, Libman J, Willis J. Beneficial effect of microsurgical varicocelectomy on human sperm DNA integrity. *Hum Reprod* 2005;20:1018-21.
 129. Benoff S, Goodwin LO, Millan C, Hurley IR, Pergolizzi RG, Marmar JL. Deletions in L-type calcium channel alpha1 subunit testicular transcripts correlate with testicular cadmium and apoptosis in infertile men with varicoceles. *Fertil Steril* 2005;83:622-34.
 130. Pasqualotto FF, Lucon AM, de Góes PM, Sobreiro BP, Hallak J, Pasqualotto EB, et al. Relationship between the number of veins ligated in a varicocelectomy with testicular volume, hormonal levels and semen parameters outcome. *J Assist Reprod Genet* 2005;22:245-9.
 131. Ku JH, Kim SW, Park K, Paick JS. Benefits of microsurgical repair of adolescent varicocele: comparison of semen parameters in fertile and infertile adults with varicocele. *Urology* 2005;65:554-8.
 132. Pasqualotto FF, Lucon AM, de Góes PM, Sobreiro BP, Hallak J, Pasqualotto EB, et al. Is it worthwhile to operate on subclinical right varicocele in patients with grade II-III varicocele in the left testicle? *J Assist Reprod Genet* 2005;22:227-31.

133. Mehrsai A, Valojerdi MR, Djaladat H, Poormand G. Evaluation of antisperm antibodies in infertile men associated with varicocele. Pre and post varicocelectomy. *Saudi Med J* 2005;26:1479-81.
134. Orhan I, Onur R, Semerciöz A, Firdolas F, Ardicoglu A, Köksal IT. Comparison of two different microsurgical methods in the treatment of varicocele. *Arch Androl* 2005;51:213-20.
135. Libman J, Jarvi K, Lo K, Zini A. Beneficial effect of microsurgical varicocelectomy is superior for men with bilateral versus unilateral repair. *J Urol* 2006;176(6 Pt 1):2602-5; discussion 2605.
136. Ramasamy R, Schlegel PN. Microsurgical inguinal varicocelectomy with and without testicular delivery. *Urology* 2006;68:1323-6.
137. Hussein AF. The role of color Doppler ultrasound in prediction of the outcome of microsurgical subinguinal varicocelectomy. *J Urol* 2006;176:2141-5.
138. Zucchi A, Mearini L, Mearini E, Fioretti F, Bini V, Porena M. Varicocele and fertility: relationship between testicular volume and seminal parameters before and after treatment. *J Androl* 2006;27:548-51.
139. Hsieh ML, Huang ST, Chen Y, Huang HC, Wang TH, Chu SH, et al. High inguinal loupe-assisted varicocelectomy for subfertile men with varicoceles: technical feasibility, clinical outcomes and complications. *Arch Androl* 2006;52:179-83.
140. Baccetti BM, Bruni E, Capitani S, Collodel G, Mancini S, Piomboni P, et al. Studies on varicocele III: ultrastructural sperm evaluation and 18, X and Y aneuploidies. *J Androl* 2006;27:94-101.
141. Djaladat H, Mehrsai A, Rezazade M, Djaladat Y, Pourmand G. Varicocele and antisperm antibody: fact or fiction? *South Med J* 2006;99:44-7.
142. Shin JH, Lim JS. Surgical repair of varicocele: a comparative study of the retroperitoneal approach of Palomo, the modified Palomo technique and the microsurgical inguinal approach of Ivanissevich's technique. *Korean J Urol* 2006;47:1086-92.
143. Ashrafi S, Nasr-Esfahani MH, Razavi S, Abasi H, Molavi F, Tavalaee M. Effect of varicocelectomy on semen parameters and protamine deficiency 3 and 6 months post surgery. *J Isfahan Med Sch* 2007;25:77-87.
144. Okeke L, Ikuerowo O, Chiekwe I, Etukakpan B, Shittu O, Olapade-Olaopa O. Is varicocelectomy indicated in subfertile men with clinical varicoceles who have asthenospermia or teratospermia and normal sperm density? *Int J Urol* 2007;14:729-32.
145. Qadan LR, Ahmed AA, Kapila KA, Hassan NA, Kodaj JA, Pathan SK. Male infertility in Kuwait. Etiologic and therapeutic aspects. *Saudi Med J* 2007;28:96-9.
146. Zini A, Boman J, Baazeem A, Jarvi K, Libman J. Natural history of varicocele management in the era of intracytoplasmic sperm injection. *Fertil Steril* 2008;90:2251-6.
147. Ozden C, Ozdal OL, Bulut S, Guzel O, Koyuncu HH, Memis A. Effect of varicocelectomy on serum inhibin B levels in infertile patients with varicocele. *Scand J Urol Nephrol* 2008;42:441-3.
148. Flacke S, Schuster M, Kovacs A, von Falkenhausen M, Strunk HM, Haidl G, et al. Embolization of varicoceles: pretreatment sperm motility predicts later pregnancy in partners of infertile men. *Radiology* 2008;248:540-9.
149. Al-Said S, Al-Naimi A, Al-Ansari A, Younis N, Shamsodini A, A-sadiq K, et al. Varicocelectomy for male infertility: a comparative study of open, laparoscopic and microsurgical approaches. *J Urol* 2008;180:266-70.
150. Atalay A, Türk L, Özyalvaçlı E, Toktaş G, Ünlüer E, Demiray M. [Is it worthwhile to operate on subclinical right varicocele in patients with clinical varicocele in the left testicle?] *Turk J Urol* 2008;34:180-5. Turkish.
151. Cakan M, Bakirtas H, Aldemir M, Demirel F, Altug U. Results of varicocelectomy in patients with isolated teratozoospermia. *Urol Int* 2008;80:172-6.
152. Balci A, Karazincir S, Gorur S, Sumbas H, Egilmez E, Inandi T. Long-term effect of varicocele repair on intratesticular arterial resistance index. *J Clin Ultrasound* 2008;36:148-52.
153. Gandini R, Konda D, Reale CA, Pampana E, Maresca L, Spinelli A, et al. Male varicocele: transcatheter foam sclerotherapy with sodium tetradecyl sulfate--outcome in 244 patients. *Radiology* 2008;246:612-8.
154. Chen SS, Huang WJ, Chang LS, Wei YH. Attenuation of oxidative stress after varicocelectomy in subfertile patients with varicocele. *J Urol* 2008;179:639-42.
155. Agnifili A, Schietroma M, Carlei F, De Berardis B, Pescosolido A, Giuliani A, et al. [Recurrences, testicular growth and semen parameters after laparoscopic Palomo varicocelectomy]. *Chir Ital* 2008;60:549-54. Italian.
156. Juárez-Albarrán AC, Tene-Pérez CE, Maldonado-Villaseñor I, Casillas-Mesina R. [Fertility prognosis associated to percutaneous testicular biopsy in infertile varicocele patients]. *Rev Med Inst Mex Seguro Soc* 2008;46:543-50. Spanish.
157. Kadhim MA. Testicular size and resistive index measured by gray scale and color Doppler ultrasound before and after varicocelectomy in adult patients with unilateral idiopathic varicocele. *New Iraqi J Med* 2009;5:17-24.
158. Elbendary MA, Elbadry AM. Right subclinical varicocele: how to manage in infertile patients with clinical left varicocele? *Fertil Steril* 2009;92:2050-3.

159. Shamsa A, Mohammadi L, Abolbashari M, Shakeri MT, Shamsa S. Comparison of open and laparoscopic varicocelectomies in terms of operative time, sperm parameters, and complications. *Urol J* 2009;6:170-5.
160. Hafez H. Seminal improvement following microsurgical subinguinal varicocelectomy: preoperative sonographic parameters of success. *UroToday Int J* 2009;2.
161. Salem HK, Mostafa T. Preserved testicular artery at varicocele repair. *Andrologia* 2009;41:241-5.
162. Jasemi M, Saki G, Rahim F. Progressive sperm motility, sperm condensation and spontaneous pregnancy rate in infertile varicocele patients at 3-12 months after varicocelectomy. *J Appl Sci* 2009;9:2640-4.
163. Zheng YQ, Gao X, Li ZJ, Yu YL, Zhang ZG, Li W. Efficacy of bilateral and left varicocelectomy in infertile men with left clinical and right subclinical varicoceles: a comparative study. *Urology* 2009;73:1236-40.
164. Nasr-Esfahani MH, Abasi H, Razavi S, Ashrafi S, Tavalae M. Varicocelectomy: semen parameters and protamine deficiency. *Int J Androl* 2009;32:115-22.
165. Zorba UO, Sanli OM, Tezer M, Erdemir F, Shavakhabov S, Kadioglu A. Effect of infertility duration on postvaricocelectomy sperm counts and pregnancy rates. *Urology* 2009;73:767-71.
166. Kondo Y, Ishikawa T, Yamaguchi K, Fujisawa M. Predictors of improved seminal characteristics by varicocele repair. *Andrologia* 2009;41:20-3.
167. Acar H, Kilinc M, Guven S, Yurdakul T, Celik R. Comparison of semen profile and frequency of chromosome aneuploidies in sperm nuclei of patients with varicocele before and after varicocelectomy. *Andrologia* 2009;41:157-62.
168. Fall B, Diao B, Sow Y, Sarr A, Fall PA, Ndoye AK, et al. [Impact of varicocelectomy in patients with nonobstructive azoospermia or severe oligozoospermia]. *Basic Clin Androl* 2010;20:257-61. French.
169. Al-Adl AM. Intra-testicular hemodynamics and seminal parameters in men with oligospermia: preoperative predictors of improvement after varicocelectomy. *Curr Urol* 2010;4:182-7.
170. Abdelwahab O, Sherif H, Eshazly A, Zaazaa M. Antegrade scrotal sclerotherapy with and without tamoxifen for treatment of infertile men due to varicocele. *UroToday Int J* 2010;3.
171. Li L, Zeng XQ, Li YH. Safety and effectiveness of transcatheter foam sclerotherapy for testicular varicocele with a fluoroscopic tracing technique. *J Vasc Interv Radiol* 2010;21:824-8.
172. Dadfar M, Ahangarpour A, Habiby A, Khazaely D. Pre-operative serum level of inhibin B as a predictor of spermatogenesis improvement after varicocelectomy. *Urol J* 2010;7:110-4.
173. Al-Ghazo MA, Ghalayini IF, al-Azab RS, Bani-Hani I, Daradkeh MS. Does the duration of infertility affect semen parameters and pregnancy rate after varicocelectomy? A retrospective study. *Int Braz J Urol* 2011;37:745-50.
174. Azadi L, Abbasi H, Deemeh MR, Tavalae M, Arbabian M, Pilevarian AA, et al. Zaditen (ketotifen), as mast cell blocker, improves sperm quality, chromatin integrity and pregnancy rate after varicocelectomy. *Int J Androl* 2011;34(5 Pt 1):446-52.
175. Abd Ellatif ME, El Nakeeb A, Shoma AM, Abbas AE, Askar W, Noman N. Dye assisted lymphatic sparing subinguinal varicocelectomy. A prospective randomized study. *Int J Surg* 2011;9:626-31.
176. Giagulli VA, Carbone MD. Varicocele correction for infertility: which patients to treat? *Int J Androl* 2011;34:236-41.
177. Cho SY, Kim TB, Ku JH, Paick JS, Kim SW. Beneficial effects of microsurgical varicocelectomy on semen parameters in patients who underwent surgery for causes other than infertility. *Urology* 2011;77:1107-10.
178. Chen SS, Chen LK. Predictive factors of successful varicocelectomy in infertile patients. *Urol Int* 2011;86:320-4.
179. Zini A, Azhar R, Baazeem A, Gabriel MS. Effect of microsurgical varicocelectomy on human sperm chromatin and DNA integrity: a prospective trial. *Int J Androl* 2011;34:14-9.
180. Hsiao W, Rosoff JS, Pale JR, Greenwood EA, Goldstein M. Older age is associated with similar improvements in semen parameters and testosterone after subinguinal microsurgical varicocelectomy. *J Urol* 2011;185:620-5.
181. Ghazi S, Abdelfattah H. Effect of microsurgical varicocelectomy on sperm DNA fragmentation in infertile men. *Middle East Fertil Soc J* 2011;16:149-53.
182. Tarhan S, Ucer O, Sahin MO, Gumus B. Long-term effect of microsurgical inguinal varicocelectomy on testicular blood flow. *J Androl* 2011;32:33-9.
183. Ozturk U, Sener NC, Nalbant I, Karabacak OR, Ulusoy MG, Imamoglu MA. The effect of metabolic syndrome upon the success of varicocelectomy. *ScientificWorldJournal* 2012;2012:985201.
184. Mohamid MA. The effect of magnified bilateral varicocele ligation on semen quality and the natural paternity rate in subfertile men, based on the sum of varicocele grading. *Arab J Urol* 2012;10:434-9.
185. Shiraishi K, Oka S, Ito H, Matsuyama H. Comparison of the results and complications of retroperitoneal, microsurgical subinguinal, and high inguinal approaches in the treatment of varicoceles. *J Androl* 2012;33:1387-93.
186. Li F, Yamaguchi K, Okada K, Matsushita K, Ando M, Chiba

- K, et al. Significant improvement of sperm DNA quality after microsurgical repair of varicocele. *Syst Biol Reprod Med* 2012;58:274-7.
187. Tavalae M, Abbasi H, Deemeh MR, Fotohi F, Sadoughi Gilani MA, Nasr Esfahani MH. Semen parameters and chromatin packaging in microsurgical varicocelectomy patients. *Int J Fertil Steril* 2012;6:165-74.
188. Pirinççi N, Geçit İ, Güneş M, Taken K, Canbey Ö, Ceylan K. [Comparison of the techniques of the microscopic varicocelectomy and inguinal varicocelectomy]. *J Clin Anal Med* 2012;3:409-11. Turkish.
189. Gabriel MS, Chan SW, Alhathal N, Chen JZ, Zini A. Influence of microsurgical varicocelectomy on human sperm mitochondrial DNA copy number: a pilot study. *J Assist Reprod Genet* 2012;29:759-64.
190. Mehraban D, Taghdiri M, Nategh S, Ahmadzadeh A, Ranjbarov N, Hashemi Taheri AP. Ultrasonic predictors of improved seminal parameters after bilateral laparoscopic varicocelectomy. *Int Urol Nephrol* 2012;44:1121-5.
191. El-Haggag S, Nassef S, Gadalla A, Latif A, Mostafa T. Ultrasonographic parameters of the spermatic veins at the inguinal and scrotal levels in varicocele diagnosis and post-operative repair. *Andrologia* 2012;44:210-3.
192. La Vignera S, Condorelli R, Vicari E, D'Agata R, Calogero AE. Effects of varicocelectomy on sperm DNA fragmentation, mitochondrial function, chromatin condensation, and apoptosis. *J Androl* 2012;33:389-96.
193. Navaeian-Kalat E, Deemeh MR, Tavalae M, Abasi H, Modaresi M, Nasr-Esfahani MH. High total acrosin activity in varicocele individuals. *Andrologia* 2012;44 Suppl 1:634-41.
194. Armağan A, Ergün O, Baş E, Oksay T, Koşar A. Long-term effects of microsurgical varicocelectomy on pain and sperm parameters in clinical varicocele patients with scrotal pain complaints. *Andrologia* 2012;44 Suppl 1:611-4.
195. Kim TB, Chang JH, Yoon SJ, Kim SW. Hydrodynamic relationship between color Doppler ultrasonography findings and the number of internal spermatic veins in varicoceles. *Yonsei Med J* 2012;53:386-92.
196. Keyhan H, Dadvar A, Ansari M, Rafiee K. Comparison of before and after varicocelectomy levels of nitric oxide in seminal fluid of infertile men. *Nephrourol Mon* 2012;4:629-32.
197. Abdelrahman SS, Eassa BI. Outcome of loupe-assisted subinguinal varicocelectomy in infertile men. *Nephrourol Mon* 2012;4:535-40.
198. Al Bakri A, Lo K, Grober E, Cassidy D, Cardoso JP, Jarvi K. Time for improvement in semen parameters after varicocelectomy. *J Urol* 2012;187:227-31.
199. Lee HJ, Cheon SH, Ji YH, Moon KH, Kim KS, Park S, et al. Clinical characteristics and surgical outcomes in adolescents and adults with varicocele. *Korean J Urol* 2011;52:489-93.
200. Sun HB, Liu Y, Yan MB, Li ZD, Gui XG. Comparing three different surgical techniques used in adult bilateral varicocele. *Asian J Endosc Surg* 2012;5:12-6.
201. Ollandini G, Liguori G, Ziaran S, Málek T, Mazzon G, de Concilio B, et al. Varicocele treatment: a 2-centers comparison between non microsurgical open correction, laparoscopic approach and retrograde percutaneous sclerotization on 463 cases. *Arch Ital Urol Androl* 2013;85:143-8.
202. Leung L, Ho KL, Tam PC, Yiu MK. Subinguinal microsurgical varicocelectomy for male factor subfertility: ten-year experience. *Hong Kong Med J* 2013;19:334-40.
203. Bonyadi MR, Madaen SK, Saghafi M. Effects of varicocelectomy on anti-sperm antibody in patients with varicocele. *J Reprod Infertil* 2013;14:73-8.
204. Smit M, Romijn JC, Wildhagen MF, Veldhoven JL, Weber RF, Dohle GR. Decreased sperm DNA fragmentation after surgical varicocelectomy is associated with increased pregnancy rate. *J Urol* 2013;189(1 Suppl):S146-50.
205. Camargo M, Intasqui Lopes P, Del Giudice PT, Carvalho VM, Cardozo KH, Andreoni C, et al. Unbiased label-free quantitative proteomic profiling and enriched proteomic pathways in seminal plasma of adult men before and after varicocelectomy. *Hum Reprod* 2013;28:33-46.
206. Zhang M, Du L, Liu Z, Qi H, Chu Q. The effects of varicocelectomy on testicular arterial blood flow: laparoscopic surgery versus microsurgery. *Urol J* 2014;11:1900-6.
207. Kang DH, Lee JY, Chung JH, Jo JK, Lee SH, Ham WS, et al. Laparoendoscopic single site varicocele ligation: comparison of testicular artery and lymphatic preservation versus complete testicular vessel ligation. *J Urol* 2013;189:243-9.
208. Bozhedomov VA, Lipatova NA, Alexeev RA, Alexandrova LM, Nikolaeva MA, Sukhikh GT. The role of the antisperm antibodies in male infertility assessment after microsurgical varicocelectomy. *Andrology* 2014;2:847-55.
209. Camargo M, Intasqui P, de Lima CB, Montani DA, Nichi M, Pilau EJ, et al. Maldi-tof fingerprinting of seminal plasma lipids in the study of human male infertility. *Lipids* 2014;49:943-56.
210. Prasivoravong J, Marcelli F, Lemaître L, Pigny P, Ramdane N, Peers MC, et al. Beneficial effects of varicocele embolization on semen parameters. *Basic Clin Androl* 2014;24:9.
211. Komiya A, Watanabe A, Kawauchi Y, Fuse H. Analysis of inter-examination differences in sperm nuclear vacuoles among male patients with infertility. *Syst Biol Reprod Med* 2014;60:35-42.
212. Wang J, Xue B, Shan YX, Cui Y, Tao W, Zhu J, et al. Laparo-

- endoscopic single-site surgery with a single channel versus conventional laparoscopic varicocele ligation: a prospective randomized study. *J Endourol* 2014;28:159-64.
213. Enatsu N, Yamaguchi K, Chiba K, Miyake H, Fujisawa M. Clinical outcome of microsurgical varicocelectomy in infertile men with severe oligozoospermia. *Urology* 2014;83:1071-4.
 214. Samplaski MK, Yu C, Kattan MW, Lo KC, Grober ED, Zini A, et al. Nomograms for predicting changes in semen parameters in infertile men after varicocele repair. *Fertil Steril* 2014;102:68-74.
 215. Hosseinifar H, Sabbaghian M, Nasrabadi D, Modarresi T, Dizaj AV, Gourabi H, et al. Study of the effect of varicocelectomy on sperm proteins expression in patients with varicocele and poor sperm quality by using two-dimensional gel electrophoresis. *J Assist Reprod Genet* 2014;31:725-9.
 216. Kadioglu TC, Aliyev E, Celtik M. Microscopic varicocelectomy significantly decreases the sperm DNA fragmentation index in patients with infertility. *Biomed Res Int* 2014;2014:695713.
 217. Lehtihet M, Arver S, Kalin B, Kvist U, Pousette A. Left-sided grade 3 varicocele may affect the biological function of the epididymis. *Scand J Urol* 2014;48:284-9.
 218. Al-Adl AM, El-Karamany T, Issa H, Zaazaa M. The influence of antisperm antibodies, intratesticular haemodynamics and the surgical approach to varicocelectomy on seminal variables. *Arab J Urol* 2014;12:309-17.
 219. Li H, Zhang M, Jiang Y, Zhang Z, Na W. Microsurgical spermatic-inferior epigastric vein anastomosis for treating nutcracker syndrome-associated varicocele in infertile men: a preliminary experience. *Urology* 2014;83:94-9.
 220. Chen SS. Predictive factors of successful redo varicocelectomy in infertile patients with recurrent varicocele. *Andrologia* 2014;46:738-43.
 221. Lee JY, Yu HS, Ham WS, Kang DH, Kim KH, Chung DY, et al. Microsurgical intermediate subinguinal varicocelectomy. *Int Surg* 2014;99:398-403.
 222. Choe JH, Seo JT. Is varicocelectomy useful for subfertile men with isolated teratozoospermia? *Urology* 2015;86:1123-8.
 223. Guo L, Sun W, Shao G, Song H, Ge N, Zhao S, et al. Outcomes of microscopic subinguinal varicocelectomy with and without the assistance of Doppler ultrasound: a randomized clinical trial. *Urology* 2015;86:922-8.
 224. Kiziler AR, Aydemir B, Guzel S, Yazici CM, Gulyasar T, Malkoc E, et al. Comparison of before and after varicocelectomy levels of trace elements, nitric oxide, asymmetric dimethylarginine and malondialdehyde in the seminal plasma and peripheral and spermatic veins. *Biol Trace Elem Res* 2015;167:172-8.
 225. Zhang H, Li H, Hou Y, Jin J, Gu X, Zhang M, et al. Microscopic retroperitoneal varicocelectomy with artery and lymphatic sparing: an alternative treatment for varicocele in infertile men. *Urology* 2015;86:511-5.
 226. Youssef T, Abdalla E. Single incision transumbilical laparoscopic varicocelectomy versus the conventional laparoscopic technique: a randomized clinical study. *Int J Surg* 2015;18:178-83. Erratum in: *Int J Surg* 2015;20:170.
 227. Cantoro U, Catanzariti F, Lacetera V, Quaresima L, Giovanni M, Polito M. Percentage change of FSH value: new variable to predict the seminal outcome after varicocelectomy. *Andrologia* 2015;47:412-6.
 228. Ener K, Üçgül YE, Okulu E, Aldemir M, Işık E, Kayigil Ö, et al. Comparison of arterial blood supply to the testicles in the preoperative and early postoperative period in patients undergoing subinguinal varicocelectomy. *Scand J Urol* 2015;49:169-73.
 229. Telli O, Sarici H, Kabar M, Ozgur BC, Resorlu B, Bozkurt S. Does varicocelectomy affect DNA fragmentation in infertile patients? *Indian J Urol* 2015;31:116-9.
 230. Tavalae M, Bahreinian M, Barekat F, Abbasi H, Nasr-Esfahani MH. Effect of varicocelectomy on sperm functional characteristics and DNA methylation. *Andrologia* 2015;47:904-9.
 231. Shabana W, Teleb M, Dawod T, Elsayed E, Desoky E, Shahin A, et al. Predictors of improvement in semen parameters after varicocelectomy for male subfertility: a prospective study. *Can Urol Assoc J* 2015;9:E579-82.
 232. Abdelaziz AS, Burham WA, Aboelsaad AY, Badran YA, Ahmed AF. Impact of extensive laparoscopic venous disconnection on the recurrence rate and sperm DNA quality in infertile varicocele patients. *Urol Ann* 2015;7:482-7.
 233. Mohammed EE, Mosad E, Zahran AM, Hameed DA, Taha EA, Mohamed MA. Acridine orange and flow cytometry: which is better to measure the effect of varicocele on sperm DNA integrity? *Adv Urol* 2015;2015:814150.
 234. McGarry P, Alrabeeh K, Jarvi K, Zini A. Is varicocelectomy beneficial in men previously deemed subfertile but with normal semen parameters based on the new guidelines? A retrospective study. *Urology* 2015;85:357-62.
 235. Hou Y, Zhang Y, Zhang Y, Huo W, Li H. Comparison between microsurgical subinguinal varicocelectomy with and without testicular delivery for infertile men: is testicular delivery an unnecessary procedure. *Urol J* 2015;12:2261-6.
 236. Fukuda T, Miyake H, Enatsu N, Matsushita K, Fujisawa M. Assessment of time-dependent changes in semen parameters in infertile men after microsurgical varicocelectomy. *Urology* 2015;86:48-51.

237. Naderi G, Mohseni Rad H, Tabassomi F, Latif A. Seminal insulin-like growth factor-I may be involved in the pathophysiology of infertility among patients with clinical varicocele. *Hum Fertil (Camb)* 2015;18:92-5.
238. Hu W, Zhou PH, Zhang XB, Xu CG, Wang W. Roles of adrenomedullin and hypoxia-inducible factor 1 alpha in patients with varicocele. *Andrologia* 2015;47:951-7.
239. Amer MK, Mostafa RM, Fathy A, Saad HM, Mostafa T. Ropporin gene expression in infertile asthenozoospermic men with varicocele before and after repair. *Urology* 2015;85:805-8.
240. Lee YJ, Cho SY, Paick JS, Kim SW. Usefulness of 2010 World Health Organization reference values for determining indications for varicocelectomy. *Urology* 2015;85:831-5.
241. Cantoro U, Polito M, Muzzonigro G. Reassessing the role of subclinical varicocele in infertile men with impaired semen quality: a prospective study. *Urology* 2015;85:826-30.
242. Pajovic B, Radojevic N, Dimitrovski A, Radovic M, Rolovic R, Vukovic M. Advantages of microsurgical varicocelectomy over conventional techniques. *Eur Rev Med Pharmacol Sci* 2015;19:532-8.
243. Ni K, Steger K, Yang H, Wang H, Hu K, Chen B. Expression and role of leptin under hypoxic conditions in human testis: organotypic in vitro culture experiment and clinical study on patients with varicocele. *J Urol* 2015;193:360-7.
244. Wang H, Wang X, Fu D, Zhu H, Lai MK. Does varicocele grade predict the postoperative changes of semen parameters following left inguinal micro-varicocelectomy? *Asian J Urol* 2015;2:163-6.
245. Binhazzaa M, Bounasr E, Perez G, Almont T, Soulie M, Faruch M, et al. [Comparison of subinguinal microsurgical varicocelectomy vs percutaneous embolization in infertile men]. *Prog Urol* 2016;26:1178-84. French.
246. Arab D, Zadeh AA, Mirmohammadkhani M, Alinejad M. Success in varicocelectomy and its relation to some important clinical and laboratory factors. *Koomesh* 2016;17:419-25.
247. Kucuk EV, Bindaıy A, Boylu U, Onol FF, Gumus E. Randomised clinical trial of comparing effects of acupuncture and varicocelectomy on sperm parameters in infertile varicocele patients. *Andrologia* 2016;48:1080-5.
248. Lv JX, Wang LL, Wei XD, Zhang Z, Zheng TL, Huang YH, et al. Comparison of treatment outcomes of different spermatic vein ligation procedures in varicocele treatment. *Am J Ther* 2016;23:e1329-34.
249. Ener K, Aldemir M, Işik E, Okulu E, Özcan MF, Uğurlu M, et al. The impact of vitamin E supplementation on semen parameters and pregnancy rates after varicocelectomy: a randomised controlled study. *Andrologia* 2016;48:829-34.
250. Karami H, Hassanzade Hadad A, Fallahkarkan M. Six years' experience of laparoscopic varicocelectomy using bipolar electrosurgery and its effect on semen parameters. *Urol J* 2016;13:2788-93.
251. Park HJ, Choe S, Park NC. Effects of Korean red ginseng on semen parameters in male infertility patients: a randomized, placebo-controlled, double-blind clinical study. *Chin J Integr Med* 2016;22:490-5.
252. Guo TH, Tong XH, Luo LH, Luan HB, Zhou GX, Wan YY. Value of microsurgical varicocelectomy for severe oligoasthenospermia patients failed in fertilization assisted by in vitro fertilization. *Eur Rev Med Pharmacol Sci* 2016;20:1669-74.
253. Barekat F, Tavalae M, Deemeh MR, Bahreinian M, Azadi L, Abbasi H, et al. A preliminary study: N-acetyl-L-cysteine improves semen quality following varicocelectomy. *Int J Fertil Steril* 2016;10:120-6.
254. Sofimajidpour H, Ghaderi E, Ganji O. Comparison of the effects of varicocelectomy and oral L-carnitine on sperm parameters in infertile men with varicocele. *J Clin Diagn Res* 2016;10:PC07-10.
255. Ariagno JI, Mendeluk GR, Furlan MJ, Sardi M, Chenlo P, Curi SM, et al. Computer-aided sperm analysis: a useful tool to evaluate patient's response to varicocelectomy. *Asian J Androl* 2017;19:449-52.
256. Mohamed EE, Gawish M, Mohamed A. Semen parameters and pregnancy rates after microsurgical varicocelectomy in primary versus secondary infertile men. *Hum Fertil (Camb)* 2017;20:293-6.
257. Samplaski MK, Lo KC, Grober ED, Zini A, Jarvi KA. Varicocelectomy to "upgrade" semen quality to allow couples to use less invasive forms of assisted reproductive technology. *Fertil Steril* 2017;108:609-12.
258. Pijoan MM. [Analysis of seminal parameters in subfertile males without and with varicocele (pre-surgical)]. *Rev Med Rosario* 2017;83:104-10. Spanish.
259. Mostafa RM, Abol-Magd R, Younis SE, Dessouki OF, Azab M, Mostafa T. Assessment of seminal mast cells in infertile men with varicocele after surgical repair. *Andrologia* 2017;49:e12625.
260. Alkandari MH, Al-Hunayan A. Varicocelectomy: modified loupe-assisted versus microscopic technique - a prospective comparative study. *Arab J Urol* 2017;15:74-7.
261. Morshed MS, Alam AKMK, Islam AKMA, Zaman SB, Alam MS, Islam N. Effects of varicocelectomy on abnormal semen parameters in patients with clinically palpable varicocele. *Bangladesh Med Res Counc Bull* 2017;43:94-100.
262. Qu X, Shan Z, Zhang N, Guo L. Curative effect of surgery

- in combination with compound xuanju capsule in treating subclinical varicocele induced infertility. *Biomed Res* 2017;28:1247-50.
263. Akand M, Koplay M, Islamoglu N, Altintas E, Kilic O, Gul M, et al. Color Doppler ultrasound characteristics after subinguinal microscopic varicocelectomy. *Med Ultrason* 2017;19:59-65.
264. Feng Q, Qiu MX. [Microscopic spermatic vein ligation for the treatment of varicocele]. *Zhonghua Nan Ke Xue* 2017;23:1080-4. Chinese.
265. Gao QQ, Xu ZP, Yu W, Chen H, Song T, Chen Y, et al. [Laparoscopic extraperitoneal high ligation of the spermatic vein for the treatment of varicocele]. *Zhonghua Nan Ke Xue* 2017;23:987-90. Chinese.
266. Gao QQ, Xu ZP, Chen H, Song T, Dai YT, Chen Y. [Microscopic spermatic vein ligation for nutcracker phenomenon complicated with left varicocele]. *Zhonghua Nan Ke Xue* 2017;23:692-6. Chinese.
267. Afsin M, Otludil B, Dede O, Akkus M. An examination on composition of spermatozoa obtained from pre-operative and post-operative varicocele patients. *Reprod Biol* 2018;18:361-7.
268. Ketabchi AA, Salajegheh S. The effects of acupuncture treatment in infertile patients with clinical varicocele. *Nephro Urol Mon* 2018;10:e65451.
269. Vahidi S, Moein M, Nabi A, Narimani N. Effects of microsurgical varicocelectomy on semen analysis and sperm function tests in patients with different grades of varicocele: role of sperm functional tests in evaluation of treatments outcome. *Andrologia* 2018;50:e13069.
270. Lu XL, Liu JJ, Li JT, Yang QA, Zhang JM. Melatonin therapy adds extra benefit to varicocelectomy in terms of sperm parameters, hormonal profile and total antioxidant capacity: a placebo-controlled, double-blind trial. *Andrologia* 2018;50:e13033.
271. Çayan S, Akbay E. Fate of recurrent or persistent varicocele in the era of assisted reproduction technology: microsurgical subinguinal redo varicocelectomy versus observation. *Urology* 2018;117:64-9.
272. Gupta C, Chinchole A, Shah R, Pathak H, Talreja D, Kayal A. Microscopic varicocelectomy as a treatment option for patients with severe oligospermia. *Investig Clin Urol* 2018;59:182-6.
273. Allameh F, Hasanzadeh Haddad A, Abedi A, Ranjbar A, Qashqai H, Fadavi B, et al. Varicocelectomy with primary gubernaculum veins closure: a randomised clinical trial. *Andrologia* 2018. doi: 10.1111/and.12991 [Epub].
274. Shafi H, Delavar MA. The impact of loupe-assisted inguinal varicocelectomy on semen quality and pregnancy rate. *Acta Endocrinol (Buchar)* 2018;14:252-4.
275. Hosseini K, Nejatifar M, Kabir A. Comparison of the efficacy and safety of Palomo, Ivanissevich and laparoscopic varicocelectomy in Iranian infertile men with palpable varicocele. *Int J Fertil Steril* 2018;12:81-7.
276. Sun XL, Wang JL, Peng YP, Gao QQ, Song T, Yu W, et al. Bilateral is superior to unilateral varicocelectomy in infertile males with left clinical and right subclinical varicocele: a prospective randomized controlled study. *Int Urol Nephrol* 2018;50:205-10.
277. Dubin JM, Greer AB, Kohn TP, Masterson TA, Ji L, Ramasamy R. Men with severe oligospermia appear to benefit from varicocele repair: a cost-effectiveness analysis of assisted reproductive technology. *Urology* 2018;111:99-103.
278. Liu S, Hu C, Jiang N, Wang G. Laparoscopic versus open inguinal spermatic vessel ligation in infertile men with varicocele. *Biomed Res* 2018;29:1389-93.
279. Alenzi M. Efficacy of surgical varicocelectomy in treating male infertility: a hospital-based retrospective study presenting a Saudi experience. *J Kuwait Med Assoc* 2019;51:362.
280. Kızılay F, Altay B. Evaluation of the effects of antioxidant treatment on sperm parameters and pregnancy rates in infertile patients after varicocelectomy: a randomized controlled trial. *Int J Impot Res* 2019;31:424-31.
281. Abdulmageed MU, Al-Azzawi IS. A comparative study between laparoscopic varicocelectomy and open varicocelectomy in a group of Iraqi patients. *J Pak Med Assoc* 2019;69(Suppl 3):S73-7.
282. Bolat MS, Kocamanoglu F, Gulsen M, Sengul M, Asci R. The impact of age on fertility rate in patients who underwent microsurgical varicocelectomy. *Andrologia* 2019;51:e13234.
283. Camargo M, Intasqui P, Belardin LB, Antoniassi MP, Cardozo KHM, Carvalho VM, et al. Molecular pathways of varicocele and its repair - a paired labelled shotgun proteomics approach. *J Proteomics* 2019;196:22-32.
284. Masterson TA, Greer AB, Ramasamy R. Time to improvement in semen parameters after microsurgical varicocelectomy in men with severe oligospermia. *Can Urol Assoc J* 2019;13:E66-9.
285. Ates E, Ucar M, Keskin MZ, Gokce A. Preoperative neutrophil-to-lymphocyte ratio as a new prognostic predictor after microsurgical subinguinal varicocelectomy. *Andrologia* 2019;51:e13188.
286. Belardin L, Camargo M, Intasqui P, Antoniassi M, Fraietta R, Bertolla R. Cysteine-rich secretory protein 3: inflammation role in adult varicocele. *Andrology* 2019;7:53-61.
287. Palmisano F, Moreno-Mendoza D, Ievoli R, Veber-Moisés-Da Silva G, Gasanz-Serrano C, Villegas-Orsorio JF, et al. Clinical

- factors affecting semen improvement after microsurgical sub-inguinal varicocelectomy: which subfertile patients benefit from surgery? *Ther Adv Urol* 2019;11:1756287219887656.
288. Abbasi B, Molavi N, Tavalae M, Abbasi H, Nasr-Esfahani MH. Alpha-lipoic acid improves sperm motility in infertile men after varicocelectomy: a triple-blind randomized controlled trial. *Reprod Biomed Online* 2020;41:1084-91.
289. Ilktac A, Hamidli S, Ersoz C, Dogan B, Akcay M. Efficacy of varicocelectomy in primary infertile patients with isolated teratozoospermia. A retrospective analysis. *Andrologia* 2020;52:e13875.
290. Teng J, Jia Z, Ai X, Luo X, Guan Y, Hao X, et al. Robotic-assisted laparoscopic artery-sparing varicocelectomy using indocyanine green fluorescence angiography: initial experience. *Andrologia* 2020;52:e13774.
291. Nasser HM, Hussein A, Behairy GM, Abdo M. Impact of percutaneous embolization versus subinguinal microsurgical ligation on semen parameters in primary varicocele patients: comparative study. *Egypt J Radiol Nucl Med* 2020;51:249.
292. Abd El Rahman SH, Rashed LA, Akl EM, Mostafa T. Assessment of seminal YKL-40 in infertile men with varicocele. *Andrologia* 2020;52:e13756.
293. Ghaed MA, Makian SA, Moradi A, Maghsoudi R, Gandomi-Mohammadabadi A. Best time to wait for the improvement of the sperm parameter after varicocelectomy: 3 or 6 months? *Arch Ital Urol Androl* 2020;92:259-62.
294. Habib AA, Ghazy MS, Hetta WM, Shokry WS, Sallam MAN. Effect of varicocele catheter guided glue embolization on male fertility. *Sys Rev Pharm* 2020;11:554-61.
295. Özkaptan O, Balaban M, Sevinc C, Çubuk A, Sahan A, Akca O. Impact of intra-operative doppler ultrasound assistance during microsurgical varicocelectomy on operative outcome and sperm parameters. *Andrologia* 2020;52:e13641.
296. Kamal HM, El-Fallah AA, Abdelbaki SA, Khalil MM, Kamal MM, Behiry EG. Association between seminal granulysin and malondialdehyde in infertile men with varicocele and the potential effect of varicocelectomy. *Andrologia* 2020;52:e13579.
297. Jin L, Yao Q, Wu S, Dai G, Xiang H, Liu X, et al. Evaluation of clinical effects of microsurgical subinguinal varicocelectomy with and without testicular delivery. *Andrologia* 2020;52:e13605.
298. Senturk AB, Cakiroglu B, Yaytokgil M, Aydin C, Sungur M, Akkoc A. Effect of venous reflux time on testosterone and semen parameters of infertile males after microscopic varicocelectomy. *Andrologia* 2020;52:e13583.
299. Öztekin Ü, Caniklioglu M, Sarı S, Selmi V, Gürel A, Taspınar MS, et al. Evaluation of the influence of subinguinal varicocelectomy procedure on seminal parameters, reproductive hormones and testosterone/estradiol ratio. *Arch Ital Urol Androl* 2020;92:158-61.
300. Ghanem MA, Adawi EA, Hakami NA, Ghanem AM, Ghanem HA. The predictive value of the platelet volume parameters in evaluation of varicocelectomy outcome in infertile patients. *Andrologia* 2020;52:e13574.
301. Omar SS, Mahfouz W, Dawood W, Abo El-Wafa RAH, Ghazala RA, Zahran AM. Relation of nitric oxide synthase gene (NOS3) polymorphisms to varicocele risk and post-varicocelectomy seminal oxidative stress reduction. *Andrologia* 2020;52:e13525.
302. Gok B, Gok G, Koc E, Hamidi N, Alijla A, Asil E, et al. The change in thiol-disulphide homeostasis levels as an oxidative stress marker after varicocelectomy: is there a relationship with sperm parameters? *Andrologia* 2020;52:e13515.
303. Mostafa T, Nabil N, Rashed L, Abo-Sief AF, Eissa HH. Seminal SIRT1-oxidative stress relationship in infertile oligoasthenoteratozoospermic men with varicocele after its surgical repair. *Andrologia* 2020;52:e13456.
304. Alkhamees M, Bin Hamri S, Alhumaid T, Alissa L, Al-Lishli H, Abudalo R, et al. Factors associated with varicocele recurrence after microscopic sub-inguinal varicocelectomy. *Res Rep Urol* 2020;12:651-7.
305. Khan I, Qayyum A, Khan N, Akhtar MS, ullah T, Imran S. Mean changes in sperm count in adult males after varicocelectomy. *J Postgrad Med Inst* 2020;34:64-7.
306. Ok F, Erdogan O, Durmus E. Can preoperative gonadotropin and testosterone levels predict the success of varicocelectomy? *Andrologia* 2020;52:e13887.
307. Phan HT, Nguyen TX, Nguyen DV, Vu HA, Le DA, Pham NH. Efficacy of scroto-inguinal microsurgical varicocelectomy in treating male infertility. *Afr J Urol* 2021;27:38.
308. Erdogan O, Ok F, Carkci S. What is the role of pre-operative blood parameters in forecasting varicocelectomy success? *Andrology* 2021;9:916-21.
309. Fernández-Concha Schwalb JJ, Torremadé Barreda J, Suárez Novo JF, Picola Brau N, Vigués Julia F. [Initial experience in microsurgical treatment of varicocele: comparative analysis with conventional macrosurgical varicocelectomy]. *Rev Int Androl* 2021;19:88-92. Spanish.
310. Kavoussi PK, Abdullah N, Gilkey MS, Hunn C, Machen GL, Chen SH, et al. The impact of ipsilateral testicular atrophy on semen quality and sperm DNA fragmentation response to varicocele repair. *Asian J Androl* 2021;23:146-9.
311. Fuschi A, Capone L, Abuorouq S, Al Salhi Y, Velotti G, Aversa S, et al. Shear wave elastography in varicocele patients: prospective study to investigate correlation with semen parameters and histological findings. *Int J Clin Pract* 2021;75:e13699.

312. Pazir Y, Erdem S, Cilesiz NC, Kadioglu A. Determination of the time for improvement in semen parameters after varicocelectomy. *Andrologia* 2021;53:e13895.
313. Shomarufov AB, Bozhedomov VA, Akilov FA, Mukhtarov ST, Giyasov SI, Abbosov SA, et al. Prediction of reproductive function recovery after microsurgical varicocelectomy in men from infertile couples: clinical and laboratory predictors. *Andrologia* 2021;53:e14101.
314. Morini D, Spaggiari G, Daolio J, Melli B, Nicoli A, De Feo G, et al. Improvement of sperm morphology after surgical varicocele repair. *Andrology* 2021;9:1176-84.
315. Hudson RW, Perez-Marrero RA, Crawford VA, McKay DE. Hormonal parameters of men with varicoceles before and after varicocelectomy. *Fertil Steril* 1985;43:905-10.
316. Hudson RW, Perez-Marrero RA, Crawford VA, McKay DE. Hormonal parameters in incidental varicoceles and those causing infertility. *Fertil Steril* 1986;45:692-700.
317. Giordanengo F, Vandone PL, De Monti M, Lazaridis J, Giuffrida GF. Idiopathic varicocele: a comparison between types of surgery based on the results of spermiogenesis. *Minerva Chir* 1993;48:767-71.
318. Yamamoto M, Hibi H, Hirata Y, Miyake K, Ishigaki T. Effect of varicocelectomy on sperm parameters and pregnancy rate in patients with subclinical varicocele: a randomized prospective controlled study. *J Urol* 1996;155:1636-8.
319. Fuse H, Okumura A, Sakamoto M, Ohta S, Katayama T. Laparoscopic varicocele ligation. *Int Urol Nephrol* 1996;28:91-7.
320. Mandressi A, Buizza C, Antonelli D, Chisena S. Is laparoscopy a worthy method to treat varicocele? Comparison between 160 cases of two-port laparoscopic and 120 cases of open inguinal spermatic vein ligation. *J Endourol* 1996;10:435-41.
321. Koşar A, Sarica K, Ozdiler E. Effect of varicocelectomy on seminal plasma transferrin values: a comparative clinical trial. *Andrologia* 2000;32:19-22.
322. Zarrilli S, Paesano L, Colao A, Mirone V, Lombardi G, De Rosa M. FSH treatment improves sperm function in patients after varicocelectomy. *J Endocrinol Invest* 2000;23:68-73.
323. Fujisawa M, Ishikawa T, Takenaka A. The efficacy of bilateral varicocelectomy in patients with palpable bilateral varicoceles: comparative study with unilateral varicocele. *Urol Res* 2003;31:407-9.
324. Salama N, Tsuji M, Tamura M, Kagawa S. Proliferating cell nuclear antigen in testes of infertile men with varicocele--preliminary results of interrelationship with sperm count before and after varicocelectomy. *Scand J Urol Nephrol* 2003;37:48-52.
325. Di Bisceglie C, Fornengo R, Grosso M, Gazzera C, Mancini A, Andriani B, et al. Follow-up of varicocele treated with percutaneous retrograde sclerotherapy: technical, clinical and seminal aspects. *J Endocrinol Invest* 2003;26:1059-64.
326. Gazzera C, Rampado O, Savio L, Di Bisceglie C, Manieri C, Gandini G. Radiological treatment of male varicocele: technical, clinical, seminal and dosimetric aspects. *Radiol Med* 2006;111:449-58.
327. Zini A, Fischer A, Bellack D, Noss M, Kamal K, Chow V, et al. Technical modification of microsurgical varicocelectomy can reduce operating time. *Urology* 2006;67:803-6.
328. Di Bisceglie C, Bertagna A, Baldi M, Lanfranco F, Tagliabue M, Gazzera C, et al. Varicocele sclerotherapy improves serum inhibin B levels and seminal parameters. *Int J Androl* 2007;30:531-6.
329. Ichioka K, Nagahama K, Okubo K, Soda T, Ogawa O, Nishiyama H. Genetic polymorphisms in glutathione S-transferase T1 affect the surgical outcome of varicocelectomies in infertile patients. *Asian J Androl* 2009;11:333-41.
330. Nasr Esfahani MH, Abbasi H, Mirhosseini Z, Ghasemi N, Razavi S, Tavalae M, et al. Can altered expression of HSPA2 in varicocele patients lead to abnormal spermatogenesis? *Int J Fertil Steril* 2010;4:104-13.
331. Seo JT, Kim KT, Moon MH, Kim WT. The significance of microsurgical varicocelectomy in the treatment of subclinical varicocele. *Fertil Steril* 2010;93:1907-10.
332. Esteves SC, Oliveira FV, Bertolla RP. Clinical outcome of intracytoplasmic sperm injection in infertile men with treated and untreated clinical varicocele. *J Urol* 2010;184:1442-6.
333. Sathya Srin V, Belur Veerachari S. Does varicocelectomy improve gonadal function in men with hypogonadism and infertility? Analysis of a prospective study. *Int J Endocrinol* 2011;2011:916380.
334. Ghanem MA, Safan MA, Ghanem AA, Dohle GR. The role of varicocele sclerotherapy in men with severe oligo-asthenoteratozoospermia. *Asian J Androl* 2011;13:867-71.
335. Sadek A, Almohamdy AS, Zaki A, Aref M, Ibrahim SM, Mostafa T. Sperm chromatin condensation in infertile men with varicocele before and after surgical repair. *Fertil Steril* 2011;95:1705-8.
336. Awadallah AM, Sabry JH, Shalaby A, El Sharkawy MM. Pre-operative seminal plasma disturbed oxidant/ antioxidant milieu could predict failure of varicocelectomy as a therapeutic modality for male infertility. *Minerva Biotechnol* 2011;23:1-9.
337. Mohamed MA, ElShiekh MG, ElFayoumy HM, Fayad AS, Hussein IF, Hegazy AE. Impact of inguinal varicocele ligation on testicular volume, sperm parameters, and pregnancy rates. *UroToday Int J* 2011;4:part2.
338. Gokce MI, Gülpınar O, Süer E, Mermerkaya M, Aydos K, Yaman O. Effect of performing varicocelectomy before in-

- tracytoplasmic sperm injection on clinical outcomes in non-azoospermic males. *Int Urol Nephrol* 2013;45:367-72.
339. Alhathal N, San Gabriel M, Zini A. Beneficial effects of microsurgical varicocelectomy on sperm maturation, DNA fragmentation, and nuclear sulfhydryl groups: a prospective trial. *Andrology* 2016;4:1204-8.
340. Ni K, Steger K, Yang H, Wang H, Hu K, Zhang T, et al. A comprehensive investigation of sperm DNA damage and oxidative stress injury in infertile patients with subclinical, normozoospermic, and astheno/oligozoospermic clinical varicocele. *Andrology* 2016;4:816-24.
341. Chen C. Laparoscopic varicocelectomy: my personal experience of 4000 cases. *Int Surg* 2016;101:2-6.
342. Abdelbaki SA, Sabry JH, Al-Adl AM, Sabry HH. The impact of coexisting sperm DNA fragmentation and seminal oxidative stress on the outcome of varicocelectomy in infertile patients: a prospective controlled study. *Arab J Urol* 2017;15:131-9.
343. Bou Nasr E, Binhazzaa M, Almont T, Rischmann P, Soulie M, Huyghe E. Subinguinal microsurgical varicocelectomy vs. percutaneous embolization in infertile men: prospective comparison of reproductive and functional outcomes. *Basic Clin Androl* 2017;27:11.
344. Gomaa MD, Motawaa MA, Al-Nashar AM, El-Sakka AI. Impact of subinguinal varicocelectomy on serum testosterone to estradiol ratio in male patients with infertility. *Urology* 2018;117:70-7.
345. Turgut H. The effect of varicocelectomy on the pregnancy rate in patients with severe oligospermia. *Niger J Clin Pract* 2020;23:1744-7.
346. El-Ariny AF, El-Garem YF, Eid AA, Donia HM, Aly RG, Abdelmeniem IM. Seminal levels of angiotensin II and angiotensin II type 2 receptor expression on spermatozoa in varicocele patients: relation to fertility status. *Andrologia* 2020;52:e13513.
347. Fathi A, Mohamed O, Mahmoud O, Alsagheer GA, Reyad AM, Abolyosr A, et al. The impact of varicocelectomy on sperm DNA fragmentation and pregnancy rate in subfertile men with normal semen parameters: a pilot study. *Arab J Urol* 2021;19:186-90.
348. El Taieb MA, Hegazy EM, Ibrahim HM, Ibrahim AK. Seminal and serum leptin levels in male patients with varicocele and isolated asthenozoospermia before and after repair. *Ag-ing Male* 2020;23:579-84.
349. Yavetz H, Levy R, Papo J, Yogev L, Paz G, Jaffa AJ, et al. Efficacy of varicocele embolization versus ligation of the left internal spermatic vein for improvement of sperm quality. *Int J Androl* 1992;15:338-44.
350. Sayfan J, Soffer Y, Orda R. Varicocele treatment: prospective randomized trial of 3 methods. *J Urol* 1992;148:1447-9.
351. Breznik R, Vlaisavljević V, Borko E. Treatment of varicocele and male fertility. *Arch Androl* 1993;30:157-60.
352. Nieschlag E, Hertle L, Fishedick A, Behre HM. Treatment of varicocele: counselling as effective as occlusion of the vena spermatica. *Hum Reprod* 1995;10:347-53.
353. Unal D, Yeni E, Verit A, Karatas OF. Clomiphene citrate versus varicocelectomy in treatment of subclinical varicocele: a prospective randomized study. *Int J Urol* 2001;8:227-30.
354. Abdel-Maguid AF, Othman I. Microsurgical and nonmagnified subinguinal varicocelectomy for infertile men: a comparative study. *Fertil Steril* 2010;94:2600-3.
355. Abdel-Meguid TA, Al-Sayyad A, Tayib A, Farsi HM. Does varicocele repair improve male infertility? An evidence-based perspective from a randomized, controlled trial. *Eur Urol* 2011;59:455-61.
356. Mansour Ghanaie M, Asgari SA, Dadrass N, Allahkhah A, Iran-Pour E, Safarinejad MR. Effects of varicocele repair on spontaneous first trimester miscarriage: a randomized clinical trial. *Urol J* 2012;9:505-13.
357. Azizollahi G, Azizollahi S, Babaei H, Kianinejad M, Baneshi MR, Nematollahi-mahani SN. Effects of supplement therapy on sperm parameters, protamine content and acrosomal integrity of varicocelectomized subjects. *J Assist Reprod Genet* 2013;30:593-9.
358. Akin Y, Ateş M, Yücel S, Başara I, Çelik O, Bozkurt A, et al. Comparison of different ligation techniques in laparoscopic varicocelectomy. *Turk J Med Sci* 2014;44:273-8.
359. Asr Badr YA, Sepهران E, Del Azar A, Sadeghi H, Nouri M. The effect of saffron on semen analysis in infertile men with clinical varicocele after varicocelectomy. *Nephro Urol Mon* 2017;9:e59939.
360. Bryniarski P, Taborowski P, Rajwa P, Kaletka Z, Życzkowski M, Paradysz A. The comparison of laparoscopic and microsurgical varicocelectomy in infertile men with varicocele on paternity rate 12 months after surgery: a prospective randomized controlled trial. *Andrology* 2017;5:445-50.
361. Guo LQ, Zhang XL, Liu YQ, Sun WD, Zhao ST, Yuan MZ. The application of laparoscopic Doppler ultrasound during laparoscopic varicocelectomy in infertile men. *Asian J Androl* 2017;19:214-8.
362. Abdelsalam YM, Saeed WM, Moeen AM, Elganainy EO, Ahmed AI. Retroperitoneal varix ligation with sclerotherapy: a prospective randomized comparative study. *Cent European J Urol* 2017;70:296-300.
363. Vyas HG, Bhandari V, Kumar A, Nanda B, Singh H, Bhowmick S. A prospective randomized comparative trial between

- open subinguinal and loupe assisted subinguinal varicocelectomy: a single center experience. *Urol Ann* 2017;9:13-7.
364. Babak J, Behruz F, Mohammadreza Y, Morteza FK. The effect of human chorionic gonadotropin therapy on semen parameters and pregnancy rate after varicocelectomy. *Curr Urol* 2018;11:92-6.
365. Zaazaa A, Adel A, Fahmy I, Elkhayat Y, Awaad AA, Mostafa T. Effect of varicocelectomy and/or mast cells stabilizer on sperm DNA fragmentation in infertile patients with varicocele. *Andrology* 2018;6:146-50.
366. Almekaty K, Zahran MH, Zoair A, Minhas S, Salem K. The role of artery-preserving varicocelectomy in subfertile men with severe oligozoospermia: a randomized controlled study. *Andrology* 2019;7:193-8.
367. Majzoub A, ElBardisi H, Covarrubias S, Mak N, Agarwal A, Henkel R, et al. Effect of microsurgical varicocelectomy on fertility outcome and treatment plans of patients with severe oligozoospermia: an original report and meta-analysis. *Andrology* 2021;53:e14059.
368. Agarwal A, Finelli R, Durairajanayagam D, Leisegang K, Henkel R, Salvio G, et al. Comprehensive analysis of global research on human varicocele: a scientometric approach. *World J Mens Health* 2022;40:636-52.
369. Silber SJ. The varicocele dilemma. *Hum Reprod Update* 2001;7:70-7.
370. Silber S. The varicocele argument resurfaces. *J Assist Reprod Genet* 2018;35:1079-82.
371. Kantartzi PD, Goulis ChD, Goulis GD, Papadimas I. Male infertility and varicocele: myths and reality. *Hippokratia* 2007;11:99-104.
372. Agarwal A, Deepinder F, Cocuzza M, Agarwal R, Short RA, Sabanegh E, et al. Efficacy of varicocelectomy in improving semen parameters: new meta-analytical approach. *Urology* 2007;70:532-8.
373. Ficarra V, Cerruto MA, Liguori G, Mazzoni G, Minucci S, Tracia A, et al. Treatment of varicocele in subfertile men: the Cochrane review--a contrary opinion. *Eur Urol* 2006;49:258-63.
374. Schauer I, Madersbacher S, Jost R, Hübner WA, Imhof M. The impact of varicocelectomy on sperm parameters: a meta-analysis. *J Urol* 2012;187:1540-7.
375. Birowo P, Tendi W, Widayahening IS, Atmoko W, Rasyid N. The benefits of varicocele repair for achieving pregnancy in male infertility: a systematic review and meta-analysis. *Heliyon* 2020;6:e05439.
376. Colpi GM, Francavilla S, Haidl G, Link K, Behre HM, Goulis DG, et al. European Academy of Andrology guideline management of oligo-astheno-teratozoospermia. *Andrology* 2018;6:513-24.
377. Easterbrook PJ, Berlin JA, Gopalan R, Matthews DR. Publication bias in clinical research. *Lancet* 1991;337:867-72.
378. Takeshima N, Sozu T, Tajika A, Ogawa Y, Hayasaka Y, Furukawa TA. Which is more generalizable, powerful and interpretable in meta-analyses, mean difference or standardized mean difference? *BMC Med Res Methodol* 2014;14:30.
379. Birowo P, Rahendra Wijaya J, Atmoko W, Rasyid N. The effects of varicocelectomy on the DNA fragmentation index and other sperm parameters: a meta-analysis. *Basic Clin Androl* 2020;30:15.
380. Wang Q, Yu Y, Liu Y, Wang L. Outcome of varicocelectomy on different degrees of total motile sperm count: a systematic review and meta-analysis. *Syst Biol Reprod Med* 2019;65:430-6.
381. Cuijpers P, Weitz E, Cristea IA, Twisk J. Pre-post effect sizes should be avoided in meta-analyses. *Epidemiol Psychiatr Sci* 2017;26:364-8.
382. Hinkelmann K, Kempthorne O. Design and analysis of experiments. 2nd ed. Vol. 1, Introduction to experimental design. Hoboken (NJ): Wiley; 2007.