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REVIEW

Evaluating hormonal differences in post-orchidopexy patients: A meta-analysis of palpable vs. nonpalpable undescended testis

Marshal Harvy Wicaksono, Anak Agung Ngurah Krisnanta Adnyana, Gede Wirya Kusuma Duarsa

Surgery Department Prof. Dr. I.G.N.G. Ngoerah General Hospital, Bali, Indonesia.

Summary ***Introduction: Cryptorchidism or undescended testis (UDT) is one of the most common congenital anomalies in male infants. Based on the physical examination, UDT can be classified into palpable and non-palpable. However, despite successful repositioning, the long-term function of the testis is still a concern. This meta-analysis aims to compare the testicular function of palpable UDT and non-palpable UDT post-orchidopexy using hormonal markers such as FSH, LH, and testosterone.***

Materials and methods: A comprehensive literature search was performed using PubMed, ScienceDirect, and Google Scholar databases up to March 2025. Statistical analyses were conducted using Review Manager (RevMan).

Result: Four eligible studies were included in the analysis, involving 207 patients who underwent orchidopexy for UDT, including 160 with palpable UDT and 47 with non-palpable UDT. There is no significant difference between palpable compared to non-palpable in terms of FSH (MD 0.78 IU/L [95% CI: -0.34 to 1.90], p = 0.14); LH (MD -0.17 IU/L [95% CI: -0.45 to 0.12], p = 0.25); and testosterone (-0.08 IU/L [95% CI: -0.64 to 0.48], p = 0.78).

Conclusions: Testicular functions, including FSH, LH, and testosterone, in palpable UDT did not differ significantly from those in non-palpable UDT.

KEY WORDS: Palpable; Nonpalpable; Undescended testis; Post-orchidopexy; Testicular function.

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INTRODUCTION

Cryptorchidism or *undescended testis* (UDT) is one of the most common congenital anomalies in male infants. Based on the physical examination, UDT can be classified into palpable and non-palpable. Palpable UDT can be detected in clinical assessment, typically in the inguinal region, and non-palpable UDT is not detected by palpation, which can be intra-abdominal or atrophied (1). The prevalences of undescended testis are 1.6%- 9% at birth and 0.9-1.8% at 3 months (2).

Orchidopexy is the standard management for patients with UDT. Its aim is to reposition the testis into the scrotum and preserve the testicular functions (1). However, despite successful repositioning, the long-term function of the testis is still a concern. We found that some articles analyze the mTESE success with orchidopexy, but none analyze the outcomes in relation to the location of the UDT.

This meta-analysis aims to compare the testicular function of palpable UDT and non-palpable UDT post-orchidopexy using hormonal markers such as FSH, LH, and testosterone in order to provide valuable information for clinical decisions and information on long-term effects for post-orchidopexy patients.

METHODS

Study sesign

This study is a systematic review with meta-analysis to evaluate the testicular function following orchidopexy in palpable and non-palpable UDT. The study followed the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines to ensure comprehensive research.

The literature search was conducted using *PubMed*, *Google Scholar*, *Science Direct*, and *Scopus* databases. The search strategy for the articles included [("*orchidopexy*") OR ("*orchiopexy*")] AND [("*undescended testis*") OR ("*UDT*") OR ("*cryptorchidism*")] AND ("*location*") AND [("*testosterone*") OR ("*FSH*") OR ("*LH*") OR ("*infertility*")]. All search results will be screened for duplicates and assessed based on title and abstract relevance. Full-text articles are retrieved for detailed evaluation, and the references of the selected studies are manually reviewed to identify additional relevant articles.

Original research articles were included if they met the following criteria: (a) diagnosis of undescended testis that underwent orchidopexy for the definitive treatment, (b) stated the location of the testis before orchidopexy, (c) assessed the FSH, LH, and Testosterone post-orchidopexy. We excluded animal studies, review articles, and consensus documents. The exclusion criteria were as follows: (a) the study was a review article, letter to the editor, animal study, commentary, or consensus document, (b) the study did not focus on undescended testis. The study protocol was registered in the international prospective register of systematic reviews (PROSPERO) to ensure transparency and adherence to established standards: PROSPERO CRD420251015285.

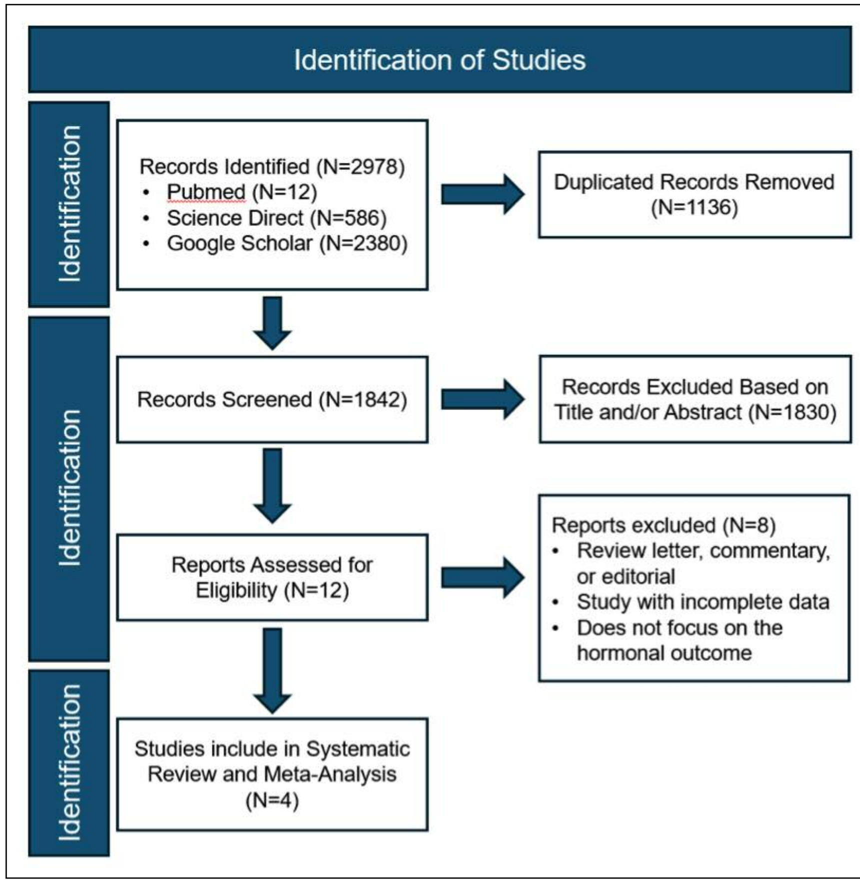


Figure 1.
PRISMA flow chart.

Data extraction and synthesis

The data extraction was conducted by two independent reviewers.

The discrepancies of the reviewers were resolved through discussion and consultation with a third reviewer. All extracted data included were extracted and pooled using the Excel program, including study characteristics such as author, year of publication, sample size, age, palpability of UDT, and outcome such as FSH, LH, and testosterone levels.

Risk of bias was assessed using *Newcastle-Ottawa Scale* (NOS).

Statistical analysis

Primary outcomes in this study are post-orchidopexy FSH, LH, and testosterone levels, as these serve as key indicators of testicular endocrine function. We conduct the meta-analysis using *Review Manager* (RevMan) to synthesize the results of the included studies and using I^2 statistic and Chi^2 test to perform the heterogeneity assessment. A fixed-effects model was used when I2 was < 50%, and when I2 was > 50%, a random-effects model was chosen. In the fixed-effects model, population effect sizes were assumed to be the same for all studies. In contrast, the random-effects model attempted to generalize the results beyond the included studies by assuming that the selected studies were random samples from a larger population. If there was statistical heterogeneity in the results, a further sensitivity analysis was performed to determine the source of heterogeneity. A sensitivity analysis was performed to assess the robustness of the findings by excluding studies with a high risk of bias or those with extreme outlier results. Meta-regression was also employed to explore potential moderators affecting testicular function outcomes post-orchidopexy

RESULTS

The search strategy identified 2,978 studies. Following a full-text evaluation of 12 studies that potentially met the criteria, 4 studies were included in the systematic review and meta-analysis (Figure 1).

The basic characteristics of the included studies are presented in Tables 1, 2. This meta-analysis includes four studies with 207 patients who underwent orchiopexy for *undescended testis* (UDT). 160 patients had palpable UDT, and 47 had non-palpable UDT. The study outcomes included in this meta-analysis are *follicle-stimulating hormone* (FSH), *luteinizing hormone* (LH), and testosterone.

The included study consisted of three retrospective cohorts and one prospective cohort.

The quality assessment and risk of bias were evaluated

Table 1.
Study characteristic for palpable undescended testis.

Author	N	Age Mean/SD	FSH Mean/SD	LH Mean/SD	Testosterone Mean/SD
Chiba (2009) (3)	12	29.6 ± 3.08	24.23 ± 16.1	8.57 ± 4.31	4.5 ± 1.78
Lee (2000) (4)	64	N/A	7.15 ± 1.46	4.21 ± 0.77	5.68 ± 0.68
Jedrzejowska (2025) (5)	78	4.12 ± 2.3	1.28 ± 0.78	0.42 ± 0.34	0.2 ± 0.19
Sangster (2019) (6)	6	26.5 ± 5.96	21.33 ± 10.33	N/A	13.36 ± 2.53

Table 2.
Study characteristic for non-palpable undescended testis.

Author	N	Age Mean/SD	FSH Mean/SD	LH Mean/SD	Testosterone Mean/SD
Chiba (2009) (3)	8	32.57 ± 2.9	24.97 ± 9.89	9.68 ± 4.63	3.46 ± 1.41
Lee (2000) (4)	21	N/A	5.4 ± 2.75	3.9 ± 1.83	6.39 ± 1.87
Jedrzejowska (2025) (5)	12	1.4 ± 0.4	1.0 ± 0.5	0.65 ± 0.52	0.22 ± 0.02
Sangster (2019) (6)	6	32.16 ± 4.9	24.18 ± 10.38	N/A	14.6 ± 7.02

Table 3.
Risk of bias in included studies based on the Newcastle-Ottawa Scale.

Author	Selection	Comparability	Outcome	Total	Risk of Bias
Lee et al., 2000 (4)	4	2	3	8	Low
Sangster et al., 2019 (6)	3	1	3	6	Moderate
Walczak-Jędrzejowska et al., 2024 (5)	4	2	3	9	Low
Chiba et al., 2009 (3)	2	1	2	5	Moderate

using the Newcastle-Ottawa Scale in four studies (Table 3). None of the studies was categorized as having a high risk of bias; two were categorized as having a low risk of bias, and two were categorized as having a moderate risk of bias.
The forest plot revealed that FSH levels were higher in non-palpable UDT compared to palpable UDT, with a *mean difference* (MD) of 0.78 IU/L (95% CI: -0.34 to 1.90, p = NS). This result suggests potential testicular dysfunction in non-palpable UDT. However, the result was not statistically significant. Moderate heterogeneity (I^2 = 45%) indicated some variability between studies (Figure 2).
The result for the LH levels did not significantly differ between palpable and non-palpable UDT, with an MD of -0.17 IU/L (95% CI: -0.45 to 0.12, p = 0.25). The heterogeneity was low (I^2 = 0%), suggesting high consistency across studies, indicating that Leydig's cell function is comparable between palpable and non-palpable UDT (Figure 3).
Testosterone levels also showed no significant difference between palpable and non-palpable UDT, with a mean difference of -0.08 IU/L (95% CI: -0.64 to 0.48, p = 0.78). Moderate heterogeneity was also observed (I^2 = 41%), suggesting some variability across studies.
These findings indicate that serum testosterone does not significantly impact in palpable and non-palpable testis (Figure 4).

Discussion

Our meta-analysis involved four studies and 207 patients and revealed no significant differences in FSH, LH, and testosterone levels between palpable and non-palpable patients post-orchidopexy. FSH results were slightly higher in non-palpable UDT, but difference was not statistically significant. LH and testosterone levels showed no significant difference between palpable and non-palpable UDT. This result suggests that Leydig and Sertoli cell functions are comparable regardless of the testicular location.
Non-palpable UDTs may be more susceptible to testicu-

Figure 2.
Forest plot for follicle-stimulating hormone (FSH) levels in palpable and non-palpable UDT post orchidopexy.

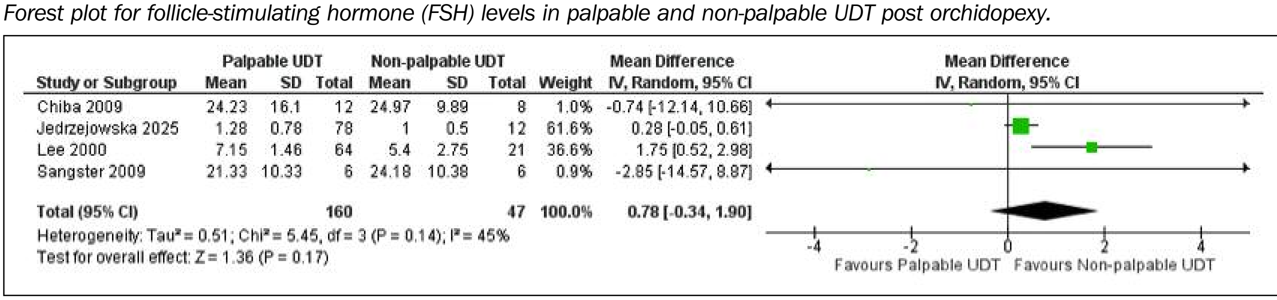


Figure 3.
Forest plot for luteinizing hormone (LH) levels in palpable and non-palpable UDT post orchidopexy.

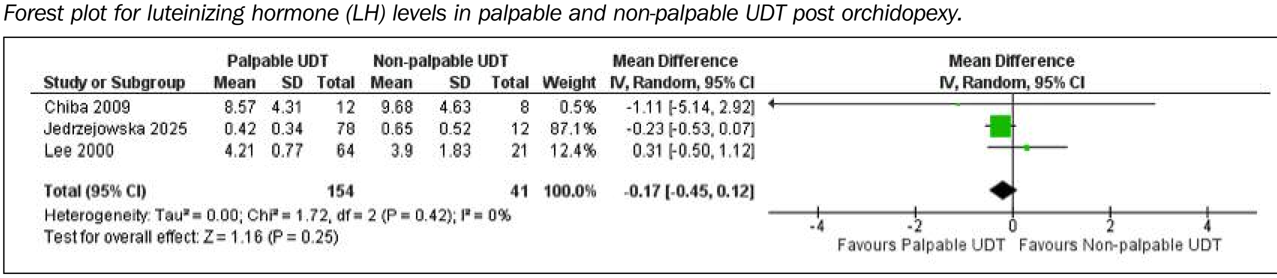
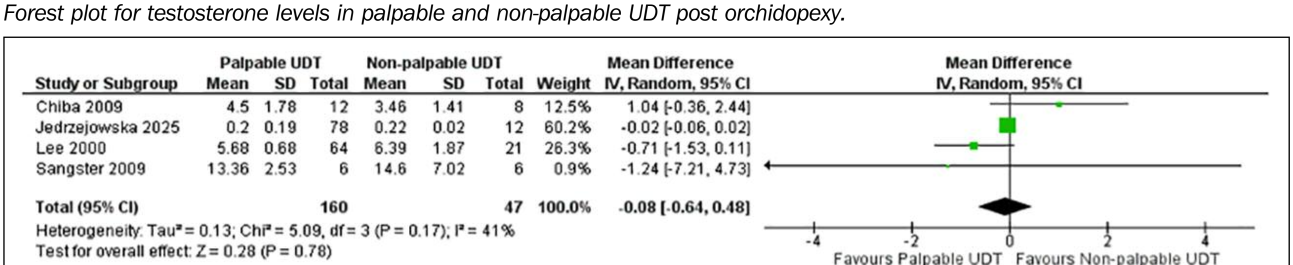


Figure 4.
Forest plot for testosterone levels in palpable and non-palpable UDT post orchidopexy.



lar atrophy because of intra-abdominal exposure. Jedrzejowska et al. compared canalicular and intraabdominal UDTs and found no significant differences in hormone levels between the UDT groups (5). Another study by *Lee et al.* (2000) shows that there are no statistical differences in FSH, LH, and testosterone levels between the different testis locations (4).

However, various studies have found that the laterality of UDT can affect the fertility outcome. *Trsinar et al.* found that bilateral UDT has a worse fertility prognosis than unilateral UDT (7). An older study by *Brakel et al.* also found that bilateral UDT had significantly lower Sertoli function, represented by high FSH and low Inhibin B.

Trsinar et al. also show that the age of orchidopexy is critical to fertility outcomes for UDT patients (7). They found significant differences between orchidopexy for children under 8 years and those over 8 years. International guidelines also agree that early orchidopexy had its benefit, The *American Urological Association* (AUA) recommends orchidopexy at the age of 6 months to 1 year (8). The European Association of Urology also recommends orchidopexy at the age of 1 year to 18 months (9).

These results reinforce the clinical notion that early orchidopexy and laterality, regardless of UDT location, are critical for optimizing hormonal function. However, future research should aim to expand on these findings by incorporating long-term follow-up data, including semen analysis and fertility outcomes, to further assess the functional integrity of orchidopexy-treated testes.

Conclusions

This meta-analysis provides evidence that the testicular endocrine function, as evaluated by serum levels of FSH, LH, and testosterone, does not significantly differ between palpable and non-palpable undescended testes following orchidopexy. From a clinical standpoint, these results highlight the importance of early diagnosis and timely orchidopexy as endorsed by both the AUA and EAU guidelines. These insights are vital in guiding parental counselling and surgical planning and support the current standards of care, emphasizing early intervention.

Declarations

Ethical approval: *Ethical approval was not crucial for this study, as it did not involve direct patients, and all included data were previously published.*

Availability of data and material: *Availability of data and materials used in our study are available to access by request.*

Competing interests: *The authors declare that they have no competing interests.*

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Authors' contributions: *MHWP, investigation, writing - original draft, perform statistical analysis; AANKA, investigation, writing - original draft, perform statistical analysis; GWKD, conceptualization, supervision, writing-review and editing, validation. All authors read and approved the final manuscript.*

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Correspondence

Marshal Harvy Wicaksono Pantjoro (Corresponding Author)
marshalharvy@gmail.com

Anak Agung Ngurah Krisnanta Adnyana
krisnanta.adnyana@gmail.com

Gede Wirya Kusuma Duarsa
gwkduarsa@gmail.com

Intern Doctor of Urology Surgery Department Prof. Dr. I.G.N.G. Ngoerah General Hospital, Jalan Diponegoro, Kota Denpasar 80113, Bali, Indonesia