Turkish Journal of Pediatric Surgery 2026;40(3):159-168
https://doi.org/10.62114/JTAPS.2026.275

Turkish Journal of Pediatric Surgery

Original Article

OPEN ACCESS

Ipsilateral sliding findings and the burden of contralateral exploration in girls with unilateral inguinal hernia

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Abstract

Objectives: This study aims to describe the real-world consequences of bilateral and unilateral index exploration and to evaluate an intraoperative sliding-positive marker in a female-only cohort.

Patients and methods: We performed a single-center retrospective cohort study of female pediatric patients with unilateral clinical presentation undergoing open inguinal hernia repair between January 2014 and December 2024. Operative findings, including the presence of a sliding hernia, were extracted from operative notes. The index strategy reflected individual surgeon judgment.

Results: A total of 416 female pediatric patients (median age: 36 months; interquartile range, 12 to 72 months) met the inclusion criteria, of whom 99 underwent initial bilateral exploration and 317 underwent initial unilateral exploration. Metachronous contralateral operation occurred in 0/99 (0.0%) after bilateral and 18/317 (5.7%) after unilateral exploration; the 36-month cumulative incidence was 0.0% versus 7.1%. Within the bilateral-exploration subgroup (n = 99), 38 had ipsilateral sliding-positive findings, and 61 had sliding-negative findings; same-session contralateral hernia was detected in 36/38 (94.7%) and 44/61 (72.1%), respectively (adjusted odds ratio 5.39; 95% CI, 1.08-26.78). The sliding-positive rule showed positive predictive value 56.1%, specificity 90.9%, and number needed to explore 1.78.

Conclusion: Our study results suggest that the principal, hypothesis-generating contribution is that an ipsilateral sliding-positive finding may be a practical intraoperative marker enriching selective contralateral exploration in girls; prospective validation is required.

Keywords: Contralateral exploration, female child, inguinal hernia, metachronous hernia, reoperation, sliding hernia.

Inguinal hernia in children is generally regarded as an indirect pathology that develops predominantly based on a patent processus vaginalis (PPV). Routine exploration of the asymptomatic contralateral groin in children presenting with unilateral inguinal hernia has long been debated.[1] At the center of this debate are two distinct phenomena: the presence of a contralateral PPV and the subsequent development of a clinically significant metachronous contralateral inguinal hernia.[2,3] Since these phenomena are not identical, the decision regarding contralateral exploration cannot be resolved solely on the basis of PPV detection.[1-3] In girls, additional concerns beyond PPV, such as a cyst of the canal of Nuck, a sliding hernia containing the ovary or fallopian tube, concern about incarceration, and surgical timing, further complicate this decision.[4,5]

The risk of metachronous contralateral inguinal hernia after unilateral repair has generally been reported as low to moderate, with left-sided presentation emerging as one of the most consistent risk factors.[6-10] Beyond side and age, a positive family history of inguinal hernia has also been reported to influence metachronous risk.[2] The effect of age appears more heterogeneous, and differences in

Received: June 19, 2026
Accepted: June 23, 2026
Published online: July 15, 2026

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Citation:

Can M, Yılmaz G, Okur Ö, Şencan A. Ipsilateral sliding findings and the burden of contralateral exploration in girls with unilateral inguinal hernia. Turkish J Ped Surg 2026;40(3):159-168. doi: 10.62114/JTAPS.2026.275.

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follow-up duration make comparisons across studies difficult.[7-9] Although laparoscopic repair allows assessment of the contralateral internal ring during the same session, a detected contralateral PPV is not equivalent to a clinically meaningful metachronous hernia; therefore, the benefit of routine contralateral intervention remains uncertain.[9,11] Contralateral PPV can frequently be demonstrated, yet not all of these openings progress to a metachronous hernia requiring a second operation,[11-13] which keeps the risk of overtreatment relevant.[7,8,12]

Evidence specific to girls is more limited and heterogeneous. Many classic series are male-dominant, and the low number of female patients makes it difficult to develop decision algorithms for girls.[14,15] Marked heterogeneity also persists in guidelines and real-world practice, and the value of factors such as age, side of presentation, and intraoperative sliding findings remains unclear.[2,14,16,17]

Our primary aim was to describe, in girls presenting with unilateral clinical findings, the real-world burden of unnecessary contralateral exploration associated with a bilateral approach and the burden of metachronous contralateral hernia associated with a unilateral approach. Secondarily, we examined same-session contralateral hernia detection, a composite contralateral event, and the descriptive performance of candidate selective strategies, with particular emphasis on an ipsilateral sliding-positive intraoperative marker. The study is framed throughout as a descriptive account of operative findings and clinical decision consequences in a female-only cohort.

PATIENTS AND METHODS

This was a single-center, retrospective, observational cohort study evaluating surgical management in girls who underwent open surgery for inguinal hernia between January 2014 and December 2024. The data source consisted of routine clinical records, operative notes, and follow-up records. Records of girls who underwent surgery for inguinal hernia during the study period were screened. Inclusion criteria were documentation of side information for both groins at first presentation, a recorded date and surgical strategy for the index operation, and availability of the last follow-up date. When confirmation of a metachronous contralateral hernia was required, the second-operation date and side were verified from records and, when necessary, from the national electronic health database (e-Nabız) and telephone confirmation. Only open inguinal hernia repairs were included. Cases with insufficient file or operative information, those operated on for a cyst of the canal of Nuck, those undergoing laparoscopic repair or exploration, groin operations not confirming hernia repair, and duplicate records were excluded. The ethics committee waived the requirement for written informed consent due to the retrospective nature of the study. The study was approved by the institutional Non-Interventional Clinical Research Ethics Committee (Date: 04.12.2025, Decision No. 2025/19-08). The study was conducted in accordance with the Declaration of Helsinki. The analytical dataset was created from coded records using study-specific identifiers.

Within the primary cohort, patients were stratified by the index operative strategy actually performed: initial bilateral exploration (n = 99) or initial unilateral exploration (n = 317). The index strategy was not governed by a standardized institutional protocol; it reflected individual surgeon judgment at operation, typically informed by patient age and clinical suspicion of bilateral disease.

Variables and outcomes

The presenting side was classified as unilateral right, unilateral left, or bilateral. The exposure was the index operative strategy (bilateral or unilateral exploration; right and left unilateral exploration combined). At each open exploration, the presence of an inguinal hernia sac and its sac content were recorded from operative notes; the presence of an ovary, fallopian tube, ovary plus fallopian tube, or omentum adherent to the sac wall was classified as sliding-positive. Since every identified hernia sac in open repair represents, by anatomical definition, a PPV, the presence of PPV was not recorded as a separate variable; its content was instead characterized using the sliding criterion. Follow-up duration was calculated in months. By design, operative findings and sac-content fields for the non-explored contralateral side were structurally missing. The primary outcome was a second operation for a metachronous contralateral hernia after unilateral exploration. Secondary outcomes were same-session contralateral hernia detection at

bilateral exploration (contralateral yield), negative contralateral exploration (overtreatment), and a composite contralateral event (same-session detection at bilateral exploration or metachronous operation after unilateral exploration). Candidate rules for selective exploration were assessed: routine bilateral exploration, age < 24 months, left-sided presentation, age < 24 months plus left-sided presentation, and sliding-positive finding.

Statistical analysis

Continuous variables were summarized as medians with interquartile ranges (IQRs) and categorical variables as counts and percentages; baseline imbalance was described using absolute standardized mean differences rather than *p* values. Proportions were reported with Wilson 95% confidence intervals (CIs). The primary outcome over time was evaluated by Kaplan-Meier analysis, with 36-month cumulative incidence and a log-rank test comparing strategies. In the subgroup undergoing bilateral exploration, the association between sliding-positive findings and same-session detection was evaluated using the Fisher's exact test and logistic regression adjusted for age and presenting side. Candidate-strategy performance was summarized by sensitivity, specificity, positive predictive value, and number needed to explore (NNE), against the composite event, with bootstrap CIs for positive predictive value and NNE. Subgroup analyses for age < 24 months, left-sided presentation, and their combination were prespecified before analysis on the basis of consistent risk-factor signals in the prior literature; sliding status was prespecified as an intraoperative marker of interest. These analyses were considered exploratory. Structural missingness was left unimputed; adjusted models used complete cases. A sensitivity analysis raised the minimum event-free follow-up to 12 months. Analyses were performed using Python software (version 3.11.2; Python Software Foundation, Wilmington, DE, USA).

RESULTS

Cohort derivation and baseline characteristics

Of 486 girls assessed for eligibility, 18 were excluded (15 with insufficient information; 3 operated on for a cyst of the canal of Nuck),

TABLE 1
Baseline clinical profile by index operative strategy in the unilateral primary cohort

Variables	Overall (n = 416)				Bilateral exploration (n = 99)				Unilateral exploration (n = 317)				*p*
	n	%	Median	Q1-Q3	n	%	Median	Q1-Q3	n	%	Median	Q1-Q3	
Demographics													
Age (month)			36	12-72			5	2-24			48	36-72	0.82
Presentation and initial operative findings													
Left-sided presentation	143	34.4			46	46.5			97	30.6			0.33
Ipsilateral sliding-positive	66	15.9			38	38.4			28	8.8			0.74
Ipsilateral sliding-negative	350	84.1			61	61.6			289	91.2			0.74
Timing and follow-up													
Time to surgery (days)			10.5	4-41.2			12	4-27.5			10	4-46	0.04
Follow-up (months)			25	23-37.2			24	20-25			25	24-39	0.21

Q1-Q3, first to third quartile (25th-75th percentile). Sliding-positive indicates non-empty ipsilateral sac content (ovary, fallopian tube, ovary plus fallopian tube, or omentum), whereas sliding-negative indicates an empty ipsilateral sac.

leaving 468 in the analytic dataset. Of these, 416 female pediatric patients (median: 36 months; interquartile range, 12 to 72 months) formed the primary cohort, and 52 with bilateral clinical presentation were reported descriptively. Within the primary cohort, 99 underwent bilateral and 317 underwent unilateral exploration at the index operation; same-session contralateral hernia was detected in 80/99 bilaterally explored patients (negative in 19), and 18/317 unilaterally explored patients developed metachronous contralateral hernia (299 were censored). All event-free patients had at least six months of follow-up, as shown in Table 1 and Figure 1.

In the overall cohort, median age was 36 months (IQR, 12-72); time to surgery was 10.5 days (IQR, 4-41.2); and follow-up was 25 months (IQR, 23-37.2). Left-sided presentation occurred in 143/416 (34.4%) and sliding-positive findings in 66/416 (15.9%). The bilateral and unilateral exploration groups differed markedly: median age of five months (IQR, 2-24) versus 48 months (IQR, 36-72); left-sided presentation of 46/99 (46.5%) versus 97/317 (30.6%); and sliding-positive findings of 38/99 (38.4%) versus 28/317 (8.8%) (Table 1).

Primary outcome

Metachronous contralateral operation occurred in 0/99 (0.0%; 95% CI, 0.0-3.7) after initial bilateral exploration and 18/317 (5.7%; 95% CI, 3.6-8.8) after initial unilateral exploration; the 36-month cumulative incidence was 0.0% versus 7.1%, as shown in Table 2 and Figure 2. The log-rank test yielded

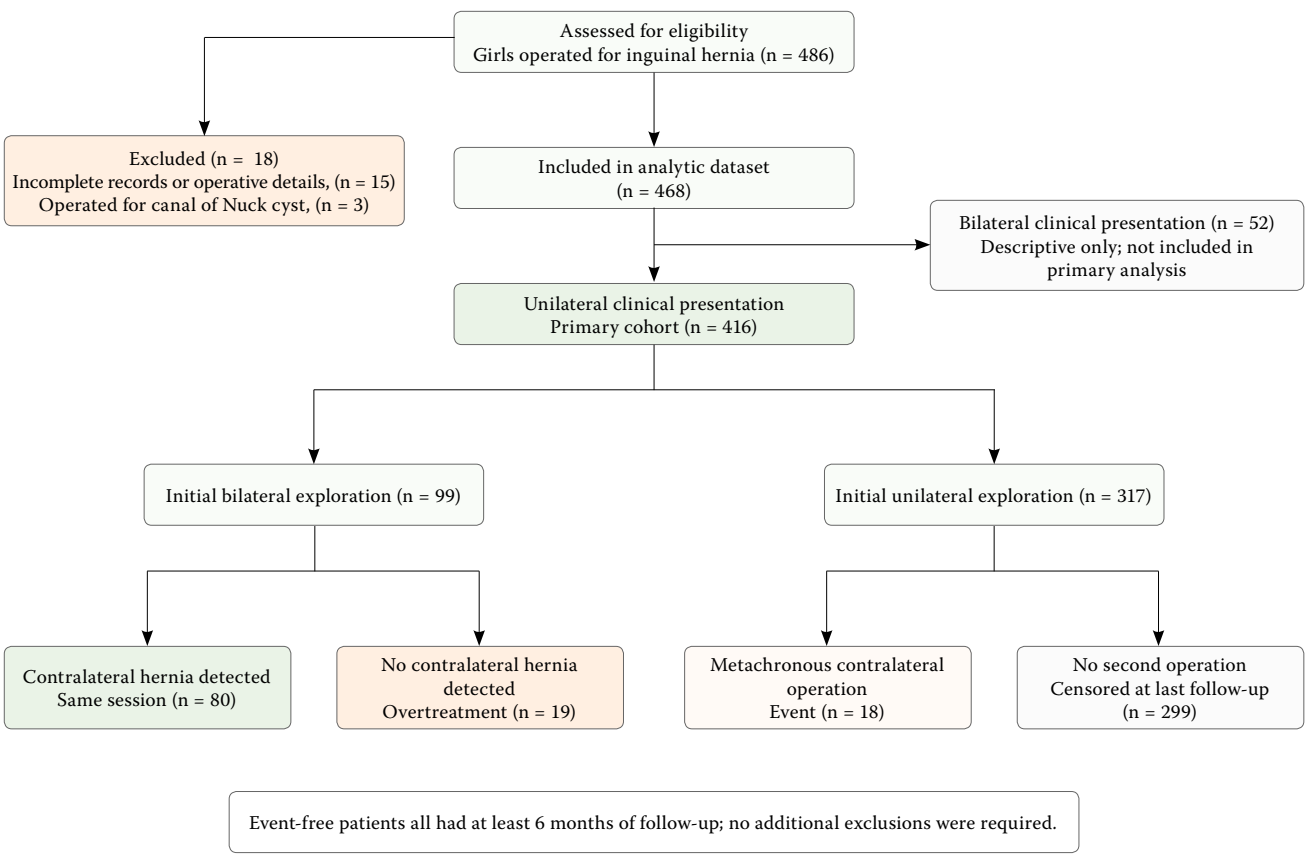


Figure 1. Study flow chart.

Cohort derivation and operative pathways. Of 486 girls assessed, 18 were excluded, and 468 entered the analytic dataset. The primary cohort comprised 416 girls with unilateral clinical presentation; 99 underwent initial bilateral and 317 initial unilateral explorations. A same-session contralateral hernia was identified in 80/99 bilaterally explored girls, whereas 18/317 unilaterally explored girls later underwent a metachronous contralateral operation.
Girls with bilateral clinical presentation (n = 52) were analyzed descriptively. No statistical test was applied.

TABLE 2
Real-world consequences of the index operative strategy

Panel A. Metachronous contralateral operation

		Metachronous contralateral operation			36-month cumulative incidence
Initial operative strategy	n	n/N	%	95% CI	%
Initial bilateral exploration	99	0/99	0.0	0.0-3.7	0.0
Initial unilateral exploration	317	18/317	5.7	3.6-8.8	7.1

Panel B. Benefit–harm profile

	Population		Result		
Metric		n	n/N	%	95% CI
Same-session contralateral hernia detected (contralateral yield)	Bilateral exploration	99	80/99	80.8	72.0-87.4
Negative contralateral exploration (overtreatment)	Bilateral exploration	99	19/99	19.2	12.6-28.0
Metachronous contralateral operation (undertreatment)	Unilateral exploration	317	18/317	5.7	3.6-8.8
Composite contralateral event	Overall unilateral cohort	416	98/416	23.6	19.7-27.9

CI, confidence interval. Data are n/N (%) unless otherwise stated; 36-month cumulative incidence was estimated by Kaplan-Meier analysis. A composite contralateral event denotes same-session contralateral hernia detection at initial bilateral exploration or a metachronous contralateral operation after initial unilateral exploration. The corresponding adjusted estimate for the between-strategy contrast is reported in Supplementary Table 2.

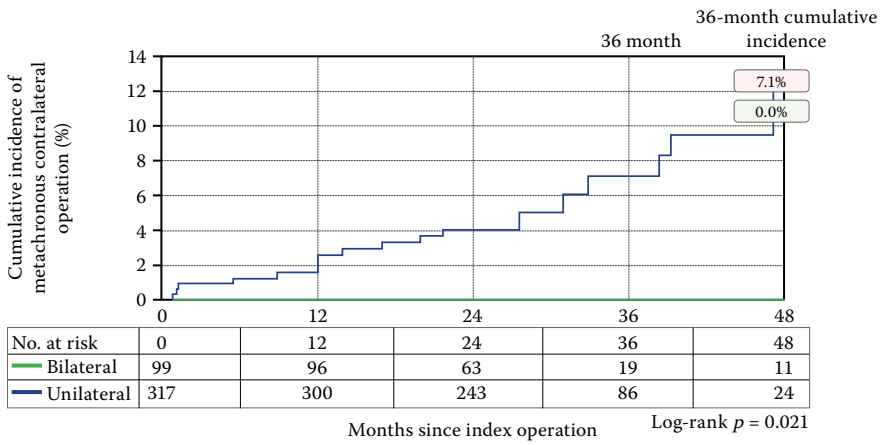


Figure 2. Time to metachronous contralateral operation by index operative strategy. Kaplan-Meier cumulative incidence in the unilateral primary cohort, measured from the index operation; event-free patients were censored at last follow-up. Numbers at risk and 12-, 24-, and 36-month landmark estimates are shown.
Log-rank test, p=0.021.

p = 0.021. An adjusted Firth penalized logistic regression model was fitted for the between-strategy contrast and is reported in Supplementary Table 1 for transparency.

Secondary outcomes

Among bilaterally explored patients, a contralateral hernia was detected in 80/99 (80.8%; 95% CI, 72.0-87.4), and exploration was

TABLE 3
Performance characteristics of candidate strategies for selective contralateral exploration

Panel A. Clinical yield of candidate strategies

	Patients identified by the rule		Composite events captured	Unnecessary bilateral explorations	PPV		NNE	
	n	%	n	n	%	95% CI	%	95% CI
Routine bilateral exploration	416	100.0	98	318	23.6	19.7-27.6	4.24	3.62-5.07
Age < 24 months	117	28.1	59	58	50.4	41.8-59.5	1.98	1.68-2.39
Left-sided presentation	143	34.4	46	97	32.2	24.7-39.7	3.11	2.52-4.05
Age < 24 months + left-sided	57	13.7	31	26	54.4	41.5-67.3	1.84	1.49-2.41
Sliding-positive finding	66	15.9	37	29	56.1	43.6-67.7	1.78	1.48-2.29

Panel B. Coverage of candidate strategies

	Missed composite events	Correctly spared bilateral exploration	Sensitivity	Specificity
Routine bilateral exploration	0	0	100.0	0.0
Age < 24 months	39	260	60.2	81.8
Left-sided presentation	52	221	46.9	69.5
Age < 24 months + left-sided	67	292	31.6	91.8
Sliding-positive finding	61	289	37.8	90.9

PPV, positive predictive value; NNE, number needed to explore; CI, confidence interval (bilateral explorations recommended per composite event captured). PPV and NNE 95% CIs were estimated by bootstrap. The first four strategies are preoperative rules; a sliding-positive finding is an intraoperative rule. Candidate strategies were evaluated against a composite contralateral event (same-session contralateral hernia detection at initial bilateral exploration or metachronous contralateral operation after initial unilateral exploration).

negative in 19/99 (19.2%; 95% CI, 12.6-28.0). The composite contralateral event was observed in 98/416 (23.6%; 95% CI, 19.7-27.9) of the overall primary cohort (Table 2).

Sliding findings within the bilateral-exploration subgroup

Of the 99 patients who underwent initial bilateral exploration, 38 had ipsilateral sliding-positive findings, and 61 had sliding-negative findings. A same-session contralateral hernia was detected in 36/38 (94.7%) with sliding-positive findings and 44/61 (72.1%) with sliding-negative findings; the odds ratio was 6.95 (95% CI, 1.47-65.01; p = 0.007) and the adjusted odds ratio was 5.39 (95% CI, 1.08-26.78; p = 0.04), as shown in Supplementary Table 2.

Subgroups and strategy performance

In prespecified subgroups, the composite contralateral event rate was 59/117 (50.4%; 95% CI, 41.5-59.3) for age < 24 months, 46/143 (32.2%; 95% CI, 25.1-40.2) for left-sided presentation, and 31/57 (54.4%; 95% CI, 41.6-66.6) for the combination; same-session/metachronous components were 54/5, 41/5, and 30/1, respectively, as shown in Supplementary Figure 1.

Against the composite event, routine bilateral exploration yielded a positive predictive value of 23.6% (95% CI, 19.7-27.6), NNE 4.24 (95% CI, 3.62-5.07), sensitivity 100.0%, and specificity 0.0%. Corresponding values were: age < 24 months 50.4%, 1.98, 60.2%, 81.8%; left-sided presentation 32.2%, 3.11, 46.9%, 69.5%; age < 24 months plus left-sided 54.4%, 1.84, 31.6%, 91.8%; and sliding-positive finding 56.1% (95% CI, 43.6-67.7), 1.78 (95% CI, 1.48-2.29), 37.8%, 90.9%, as shown in Table 3 and Figure 3.

Sensitivity analysis and descriptive bilateral-presentation cohort

Raising the minimum event-free follow-up to 12 months reduced the sample to 402 patients with 18 events; the Firth estimate was essentially

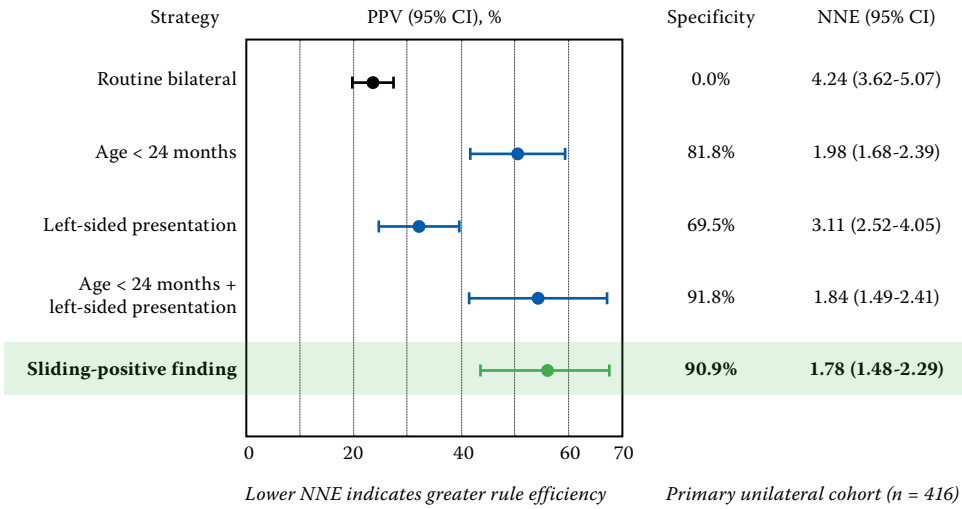


Figure 3. Decision efficiency of candidate strategies for selective contralateral exploration.

CI, confidence interval; NNE, number needed to explore.

Candidate strategies were evaluated against a composite contralateral event (same-session contralateral hernia at initial bilateral exploration or metachronous contralateral operation during follow-up). Points show positive predictive value with bootstrap 95% confidence intervals; specificity and number needed to explore are shown per row. The first four strategies are preoperative rules; a sliding-positive finding is an intraoperative rule. No formal hypothesis test was applied; precision is summarized by bootstrap 95% confidence intervals.

unchanged (Supplementary Table 1). There were no missing data in the key adjusted-model covariates. In the bilateral clinical presentation cohort, (n = 52), median age was 48 months (IQR, 12-72), time to surgery was 10 days (IQR, 4-30.5), and follow-up was 24 months (IQR, 24-27.2); all underwent bilateral exploration with bilateral hernia confirmed, sliding hernia was identified in 13/52 (25.0%), and no second groin operation occurred during follow-up, as shown in Supplementary Table 3.

DISCUSSION

Two features of the data shape how the between-strategy comparison should be read. Since the index strategy was chosen by individual surgeon judgment, the two groups are not exchangeable; and since contralateral exploration at the index operation by definition removes the possibility of a later metachronous contralateral operation, that outcome is structurally unobservable in the bilateral-exploration group (no ipsilateral recurrences were observed during follow-up). The comparison is therefore structurally constrained, and we present this study as a descriptive account of operative findings and the clinical decision consequences of two index strategies. The 0% metachronous rate after bilateral exploration largely reflects the definition of the outcome rather than biological or decision-quality differences; the adjusted Firth estimate (Supplementary Table 1) is reported for transparency. The clinically interpretable content of the contrast is the quantification of two real-world burdens-negative (unnecessary) exploration under a bilateral approach and a second operation under a unilateral approach.

The rate of metachronous contralateral second operation after unilateral exploration and the 36-month cumulative incidence are generally consistent with the low-to-moderate risk reported after open unilateral repair. Long-term cohorts and systematic reviews report this risk at approximately 4%-7%, while emphasizing that it remains markedly lower than the prevalence of PPV.[1,6-8,15] This supports our choice of the outcome "clinical event requiring a second operation" rather than "anatomical patency."

Same-session contralateral detection was high among bilaterally explored patients; this figure reflects the selective indication for bilateral exploration in this cohort, in which the bilateral group was younger and carried higher clinical and intraoperative risk and bilateral exploration

was chosen when bilateral pathology was already considered likely. The strategy analysis showed that applying routine bilateral exploration to the entire cohort would generate many unnecessary procedures, given the low positive predictive value and near-zero specificity, consistent with reviews reporting that prophylactic contralateral intervention reduces metachronous hernias only at the cost of many additional procedures and a high NNE.[7,8,18,19]

An important conceptual point concerns the terminology of PPV. In open repair, every identified hernia sac is, by anatomical definition, a PPV; the question is therefore not whether a PPV is present in an operated groin (it always is) but whether the contralateral side harbors clinically meaningful patency and how the magnitude of patency relates to clinical outcome. Detection rates of contralateral PPV in laparoscopic and transinguinal series consistently exceed rates of clinically metachronous hernia, the positive predictive value of binary PPV detection is low, and quantitative features such as diameter appear more informative.[2,11] Although laparoscopic or transinguinal assessment reduces the metachronous operation burden, not all detected patencies progress to clinical events, so unnecessary intervention remains an issue.[12,20] More selective intraoperative findings, such as sliding positivity, may therefore be more useful than a binary patency assessment.

A sliding component in girls (ovary, fallopian tube, or omentum incorporated into the sac wall) implies a processus vaginalis patent widely enough to admit a mobile viscus, and may therefore act as a surrogate for the magnitude of patency. It is also possible that the substrate underlying a sliding hernia is itself bilateral, with sliding positivity reflecting a constitutional predisposition to bilateral patency; this interpretation is compatible with the high contralateral yield observed.

This study should not be read as an argument against laparoscopy but as a descriptive analysis of a real decision problem in a female open-repair cohort. Although our cohort is exclusively open, whereas most morphology-based predictive work is laparoscopic, the open sliding-positive sign and laparoscopic markers (internal-ring morphology or veil type and patent-processus diameter) may be regarded as alternative surrogates for the same underlying construct, the magnitude of processus patency, rather than competing entities, the open proxy being binary and coarser than graded laparoscopic assessment.[3,9,11,21] Laparoscopic repair also largely circumvents the contralateral-exploration dilemma, since the contralateral side can be inspected during the same session and a patent processus closed simultaneously, particularly safely in girls, in whom there is no vas deferens at risk.[12,16,17] Our analysis is therefore most relevant to centers where open repair remains the dominant practice.

In prespecified subgroups, age < 24 months and left-sided presentation were associated with different composite event rates, consistent with studies showing higher metachronous risk with left-sided presentation,[1,6-10,22] while the literature on age is more heterogeneous.[6-9,15,22] These results describe risk-enhancing signals based on the composite outcome under non-randomized allocation. Our median follow-up may be insufficient to capture late events, so absolute incidences reflect early- to mid-term burden.[4,8,15,23]

An important contribution is the focus on an exclusively female cohort, under-represented in the largely male-dominant classic literature,[14,15] for which clear criteria supporting systematic contralateral exploration are lacking.[4,20] The main strengths are the quantification of unnecessary exploration and second-operation burdens within one descriptive framework and the joint presentation of efficiency and specificity for candidate selection strategies.

Several limitations constrain interpretation. First, the index strategy was not randomized and was strongly confounded by indication: the bilateral-exploration group was markedly younger (median 5 versus 48 months) and enriched for left-sided presentation and sliding-positive findings, reflecting selective surgeon judgment rather than exchangeable groups, so the two strategies occupy almost non-overlapping age strata. Second, the primary outcome is structurally linked to the exposure, since contralateral exploration definitionally removes the possibility of a later metachronous contralateral operation; statistical contrasts, including the adjusted estimate, are consequently driven by this design feature and are reported for completeness only. Third, the

high same-session yield (80.8%) in the bilateral group is itself a product of selection and cannot be generalized. Fourth, since the sliding-positive sign can only be verified in patients who underwent bilateral exploration, its performance is subject to verification (workup) bias and should be regarded as hypothesis-generating, particularly given the limited number of events. Fifth, a family history of inguinal hernia, previously reported to influence metachronous risk,[2] could not be captured. Finally, defining the outcome as a clinical event requiring a second operation, although patient-centered, excludes asymptomatic patencies, and the retrospective single-center design limits generalizability.

In conclusion, in girls presenting with unilateral clinical findings, the lower count of metachronous contralateral operations after initial bilateral exploration is, to a substantial degree, structurally determined and is reported here as a description of decision consequences rather than as evidence of strategy superiority; it is moreover offset by a substantial burden of negative contralateral exploration. The more clinically distinctive, hypothesis-generating message is that an ipsilateral sliding-positive finding may be a practical intraoperative marker for selective contralateral exploration, with an efficiency profile comparable to younger age and left-sided presentation and a favorable profile on positive predictive value and NNE. In girls, the contralateral decision may thus be approached within a selective framework that considers preoperative variables such as age and side together with the intraoperative sliding finding, ideally within a shared decision-making conversation with the family. Prospective studies focused on girls, comparing open selective strategies with laparoscopy-based assessment on the same basis and with adequate follow-up, are needed.

Data Sharing Statement: The data supporting the findings are openly available at https://doi.org/10.6084/m9.figshare.31868794.

Author Contributions: M.C.: Conceptualization, original draft; M.C., G.Y., Ö.O.: Data curation and investigation, formal analysis; M.C., A.Ş.: Review and editing.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

AI Disclosure: The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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