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Subinguinal Orchidectomy for Testicular Tumour: A Regional Analysis of Oncological Control and Postoperative Outcomes

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Abstract

Introduction

Radical inguinal orchidectomy (RIO) is the standard surgical approach to treating testicular tumours. Subinguinal orchidectomy (SIO) is a modified approach, wherein the inguinal canal is spared from exploration and the spermatic cord is ligated as close as possible to the superficial inguinal ring. Theoretically, it offers the advantage of avoiding the complications related to inguinal canal exploration whilst maintaining sufficient oncological control. However, contemporary primary data on both outcomes remain limited.

Methods

This is a retrospective single-arm study of 52 consecutive patients who underwent SIO at a tertiary urology centre from 2016 to 2025. Parameters explored included patient demographics, tumour laterality, and biochemical and histopathological staging. Primary outcomes were positive surgical margins, disease recurrence, and postoperative complications including wound infection, chronic pain, and phantom testis syndrome. Data analysis was carried out using SPSS v29 (IBM Corp., Armonk, NY).

Results

Fifty-two patients were analysed (median age: 42.5 years; IQR: 31.5-58.25 years). Bilateral and synchronous tumours were each reported in one case, yielding a total of 54 oncological units for analysis, of which 44 were malignant and 10 were benign Thirty out of the 44 malignant cases were germ cell tumours (seminoma and non-seminomatous germ cell tumours) on histology (68.2%). Postoperative staging revealed nodal disease in 31% and metastatic disease in 14.3%. All surgical margins were negative. Four patients had spermatic cord involvement (SCI; 7.7%). Three patients (5.8%) developed recurrence, exclusively nodal, at a mean of 20.3 ± 13.8 months; no local or scrotal recurrence was observed. Postoperative complications occurred in 10 patients (19.2%), including Clavien-Dindo grade IIIb complications in five patients (9.6%). No chronic pain or hernia was reported. Median follow-up was 1.35 years.

Conclusion

SIO provided good oncological control, with no positive surgical margins, a low recurrence rate, and acceptable morbidity. These results suggest that it may provide acceptable oncological and postoperative outcomes in selected patients.

Categories: Urology
Keywords: chronic pain, hernia, inguinal canal, positive margins, spermatic cord, surgery, surgery outcome, testicular cancer, tumor recurrence, urology

Introduction

Testicular cancer is the most common solid malignancy affecting young adult men, with increasing incidence worldwide [1,2]. Despite this, oncological outcomes remain positive, with cure rates exceeding 95% when biochemical and histological diagnosis is timely, followed by appropriate surgical management and chemotherapy [3,4]. Radical inguinal orchidectomy (RIO) remains the gold standard in terms of diagnosis and treatment of testicular cancer, offering both histological diagnosis and appropriate definitive local management whilst also guiding future respective surveillance and adjuvant treatment strategies [3,4].

Operative technique for RIO involves inguinal delivery of the testis with high ligation of the spermatic cord at the level of the internal inguinal ring [4]. This technique allows for adequate oncological control and facilitates easy identification if further surgery with retroperitoneal lymph node dissection is required [4]. Despite this approach being widely accepted, it brings about significant perioperative morbidity with notable risks. RIO involves high ligation of the cord at the internal inguinal ring, which is usually required as per

oncological principles to ensure resection of maximal cord length. However, in addition to complications of postoperative scrotal haematoma, infection and hernia, RIO risks damage to the ilioinguinal nerve, which can cause significant postoperative pain or paraesthesia, which could subsequently result in repeated consultations or revision surgery [4-6].

Subinguinal orchidectomy (SIO) is a modification of the conventional RIO approach, involving a subinguinal incision, delivery of the testis as done in RIO, and ligation of the spermatic cord at the level of the external inguinal ring instead. Theoretical advantages include avoiding the path of the ilioinguinal nerve and reducing the risk of postoperative neuralgia, as well as avoiding any possible complications related to exploring the inguinal canal [5]. However, the oncological clearance achieved with this procedure, including residual disease in the proximal spermatic cord and overall oncological outcomes, is under-reported in the literature [7]. The aim of this study is to evaluate the oncological and postoperative outcomes of SIO in patients undergoing surgery for suspected testicular malignancy. Specifically, we assessed surgical margin status, disease recurrence, and postoperative complications to determine whether SIO provides acceptable oncological control, with low treatment-related morbidity, in all patients undergoing this technique of surgery.

Materials And Methods

A retrospective single-arm study was conducted, which included all consecutive patients who underwent SIO for suspected or confirmed testicular tumour at a tertiary referral urology centre in the North of England between January 2016 and October 2025. SIO was performed as the default in the unit unless the patient had preoperative staging of T3 or higher. No RIO procedures were conducted during the study period. Exclusion criteria included patients undergoing orchidectomies for non-neoplastic indications and patients in whom relevant clinical or histopathological records were insufficient to be considered for analysis.

All cases at the centre were performed under general anaesthesia, with no routine antibiotics administered at induction. A majority of cases were performed by consultant urological surgeons or senior residents in urology (ST5 or above). The WHO checklist was completed, and the patient was positioned supine, then prepped and draped accordingly. A 3-4 cm subinguinal incision was made along Langer's lines lateral to the pubic tubercle and below the surface markings of the inguinal ligament. Dissection was carried out in layers with diathermy until the cord was identified and isolated. The testis was then delivered into the wound. The cord was then clamped and ligated at the level of the superficial inguinal ring with two clips, and the testis was released from the gubernaculum and surrounding adherent tissue. Orchidectomy is then performed, and transfixation is carried out with 0 and 2/0 Vicryl sutures. Meticulous bipolar haemostasis would be ensured. There was no routine testicular prosthesis insertion or routine insertion of surgical drains. Closure would be achieved in layers with appropriate local anaesthetic administration into the wound.

Data were collected using the e-record hospital database. Data parameters collected included patient demographics, tumour characteristics (size, histopathological variant, and laterality), presence of local invasion of the epididymis and spermatic cord (extracted from histopathology reports), lymphovascular invasion, preoperative serum alpha-fetoprotein (AFP), beta-human chorionic gonadotropin (β-hCG), and lactate dehydrogenase (LDH) levels, along with appropriate S-staging and tumour, node, metastasis (TNM) staging. The International Germ Cell Cancer Collaborative Group (IGCCCG) stratification was calculated for cases of seminoma and non-seminoma, with patients classified as having a good, intermediate, or poor prognosis.

Spermatic cord involvement (SCI) was assessed histopathologically using immunohistochemical staining and fluorescent in situ hybridisation (FISH). Contiguous invasion was classified as pT3 and discontinuous involvement as pM1, according to the eighth edition of the American Joint Committee on Cancer (AJCC).

Following surgery, patients were discussed at the urology multidisciplinary team (MDT), with testicular tumour markers checked seven days postoperatively. Patients with histologically confirmed testicular cancer were referred to oncology, and a subsequent decision was made regarding active surveillance versus adjuvant treatment, such as chemotherapy or radiotherapy. Follow-up schedules at the unit were conducted in accordance with guidance from the European Association of Urology (EAU) [8]. Follow-up continued for a minimum of five years and included a combination of physical examination, testicular tumour marker measurements, and imaging, including chest X-ray and computed tomography of the abdomen and pelvis.

Recurrence was defined as the re-appearance of disease following a reported disease-free state following initial treatment, identified by confirmed radiological evidence, histological findings, and/or a confirmed increase in serum tumour markers attributable to recurrent malignancy. Recurrences were classified by anatomical site, distinguishing local recurrence involving the surgical bed or spermatic cord remnant from nodal or distant relapse. Persistent disease and new contralateral primary tumours were not classified as recurrence.

The primary outcomes assessed in this study were positive surgical margins, disease recurrence (defined as biochemical, radiological, or histologically confirmed disease following primary surgery), and postoperative

complications such as wound infection, abscess formation, scrotal haematoma, chronic pain, phantom testis syndrome, and hernia. Complications were identified during clinical assessment at planned follow-up. Patients were also provided with departmental contact details to report any problems or possible postoperative complications necessitating prompt assessment. Chronic pain was defined as per the British Association of Urological Surgeons (BAUS) definition as ongoing intermittent or continuous ipsilateral scrotal pain lasting more than three months and significantly affecting activities of daily living [9]. Hernia was assessed clinically at the first instance before further radiological assessment with ultrasonography. Postoperative complications were graded using the Clavien-Dindo grading system [10].

Data were collated in Microsoft Excel (Microsoft Corp., Redmond, WA), with descriptive analysis carried out using IBM SPSS Statistics version 29 (IBM Corp., Armonk, NY).

This study was conducted as a retrospective analysis of routinely collected clinical data. No alteration to patient care, additional clinical intervention, or prospective patient recruitment was undertaken for the purposes of the study. In accordance with local institutional policy, formal research ethics committee approval and institutional research governance approval were not required for this retrospective analysis. The results of this study were reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. All data were handled in accordance with applicable data-protection requirements and were anonymised prior to analysis.

Results

Fifty-two patients were analysed: 26 (50%) and 25 (48.1%) had left and right testicular tumours, respectively. One patient (1.9%) had bilateral tumours; however, only a right orchidectomy was performed, with a mass excised from the left testicle. Median age at orchidectomy was 42.5 years (IQR: 31.5-58.25 years). Median tumour size was 31.5 mm (IQR: 18.8-51.3 mm). The median preoperative tumour markers were as follows: AFP 2.9 (IQR: 2.0-5.0), β-hCG 2.0 (IQR: 1.0-10.0), and LDH 200.0 (IQR: 176.8-240.5). In total, 20.8% of patients had elevated AFP, 34.0% had elevated hCG, and 33.3% had elevated LDH levels.

The total number of testes analysed was 52. One patient had two discrete tumours affecting the same testicle; hence, these tumours, in addition to the left excised testicular mass in the bilateral case, yielded a total of 54 oncological units for analysis. Histology comprised malignant pathology in 44/54 oncological units and benign pathology in 10/54 oncological units. In terms of malignant pathology, this comprised seminomatous germ cell tumour (SGCT) in 23/44, non-seminomatous germ cell tumour (NSGCT) in 7/44, mixed giant cell tumour (GCT) in 8/44, sex cord stromal tumour in 1/44, multiple myeloma in 1/44, leiomyosarcoma in 1/44, and diffuse large B-cell lymphoma (DLBCL) in 3/44. Benign pathology comprised inflammatory changes in 5/10, atrophic undescended testis in 2/10, Leydig cell hyperplasia in 1/10, adenomatoid paratesticular tumour in 1/10, and simple cystic transformation in 1/10.

All 44 malignant oncological units were deemed appropriate for TNM staging. According to the AJCC staging guidelines, the case with bilateral testicular tumours had separate T staging but combined N and M staging, and for the case with synchronous tumours, T, N, and M staging were combined. Results for TNM staging are thus reported as follows: pT0 in 2/43 cases, pT1 in 26/43, and pT2-3 in 15/43; nodal disease (N1-3) in 13/42; and distant metastases (M1) in 6/42. Of note, 28 out of 44 malignant units (63.6%) had germ cell neoplasia in situ (GCNIS). Details regarding tumour characteristics are summarised in Table *1*.

Tumour characteristics		
Histological subtype (malignant cases)	**n (N = 44)**	**%***
Seminoma only	23	52.3%
NSGCT	7	15.9%
Mixed GCT	8	18.2%
Sex-cord stromal tumours	1	2.3%
Multiple myeloma	1	2.3%
Leiomyosarcoma	1	2.3%
DLBCL	3	6.8%
Histological subtype (benign cases)	**n (N = 10)**	**%**
Inflammatory changes	5	50%
Atrophic undescended testis	2	20%
Leydig cell hyperplasia	1	10%
Adenomatoid paratesticular tumour	1	10%
Simple cystic transformation	1	10%
Tumour stage (T)	**n (N = 43)**	**%**
pT0	2	4.7%
pT1	26	60.5%
pT2-3	15	34.9%
Nodal involvement (N)	**n (N = 42)**	**%**
N0	29	69%
N1-3	13	31%
Metastatic disease (M)	**n (N = 42)**	**%**
M0	36	85.7%
M1	6	14.3%

TABLE 1: Tumour characteristics of the patient cohort

* Percentages were calculated using the total number (N) in the respective column as the denominator.

NSGCT: Non-seminomatous germ cell tumour; GCT: Giant cell tumour; DLBCL: Diffuse large B-cell lymphoma.

Further tumour characteristics were reported with the total number of patients in our cohort (52) for ease of comparison with the literature. Histologically proven lymphovascular invasion was present in nine out of the total 52 patients who underwent SIO (17.3%), epididymal involvement in 7/52 (13.5%), and SCI in 4/52 (7.7%). No positive surgical margins were observed. Notably, for the four cases of SCI, the resection margin was not involved in two of the cases, whereas in the other two cases, this was not reported clearly in the pathology report. Three out of the four cases of SCI had metastatic disease, all of whom are currently deceased.

Disease recurrence was observed in three out of the 52 patients in our cohort (5.8%). All recurrences were nodal, with no local, scrotal, or surgical site recurrences identified. Initial staging for the three patients with recurrence was T2N1M0, T2N0M0, and T2N0M0 for patients 1, 2, and 3, respectively. Tumour sizes for the patients with recurrence were 36, 33, and 49 mm for patients 1, 2, and 3, respectively. All three patients had germ cell tumours with GCNIS, and all three patients had no SCI or positive surgical margins. The mean time to recurrence was 20.3 ± 13.8 months.

Median follow-up was calculated for survivors only, given that dates of death of deceased patients were not available in the dataset. Median follow-up was calculated at 1.35 years (range: 0.03-8.96 years).

In terms of adjuvant treatment, in the cohort of 52 patients, eight underwent chemotherapy only, three patients underwent chemotherapy and radiotherapy, three patients underwent chemotherapy and retroperitoneal lymph node dissection (RPLND), and one patient underwent radiotherapy only. Notably, two patients underwent neoadjuvant chemotherapy.

Postoperative complications occurred in 10 patients (19.2%), which included wound infection in seven patients, abscess formation in two patients, and scrotal haematoma in one patient. No cases of chronic pain, hernia, or phantom testis syndrome were reported. According to the Clavien-Dindo classification, complications were Grade 1 in two patients, Grade 2 in three patients, and Grade 3b in five patients. Importantly, there were no cases of chronic pain or hernia reported in the cohort. Details regarding the primary outcomes of this study are summarised in Table 2.

Oncological and postoperative outcomes		
Surgical margins	**n (N = 52)**	**%**
Positive	0	0%
Negative	52	100%
Recurrence		
Nodal recurrence	3	5.8%
Local recurrence	0	0%
No recurrence	49	94.2%
Postoperative complications		
Wound infection	7	13.5%
Abscess formation	2	3.8%
Scrotal haematoma	1	1.9%
Chronic pain	0	0%
Phantom testis syndrome	0	0%
Hernia	0	0%
None	42	80.8%

TABLE 2: Primary outcomes of the patient cohort

Discussion

RIO with high ligation of the spermatic cord at the internal inguinal ring remains the recommended "gold standard" for managing testicular masses suspicious for malignancy [1,3]. An inguinal approach overall avoids potential tumour contamination of scrotal lymphatic pathways that usually drain into superficial inguinal nodes, which is a shared oncological principle between RIO and SIO [4,5]. While a RIO approach facilitates histopathological diagnosis and staging, the requirement to divide the external oblique aponeurosis is associated with specific perioperative morbidities including chronic pain and phantom-testis syndrome [2,4]. The SIO technique offers an anatomically conservative modification to the RIO approach that is designed to mitigate these risks by ligating the cord at the level of the superficial inguinal ring, thereby avoiding the need to open the inguinal canal and reducing manipulation or entrapment of the ilioinguinal nerve and disruption of inguinal structures [4,5]. This brings about reduction of postoperative neuropathic morbidity otherwise associated with RIO [5,7]. In our cohort, none of the patients reported chronic pain or hernia during follow-up. These findings are consistent with those of Anderson et al., whose 42-patient series reported no postoperative neuropathic complications [5]. The reduction in postoperative chronic pain with the SIO approach could also lead to a better quality of life. Persistent pain can have a negative impact on a patient's quality of life, as described by Pühse et al., who associated persistent pain with impaired sexual function in testicular cancer survivors post-orchidectomy [11]. However, neither study compared RIO versus SIO in terms of their respective impact on chronic pain or quality of life. A comparative study using patient-reported pain and quality-of-life measures is needed to better assess if SIO

improves these outcomes.

Despite the reduced perioperative morbidity, SIO still carries recognised orchidectomy complications including postoperative haemorrhage, haematoma formation, wound infection, and dehiscence [6]. In our cohort, we observed a general complication rate of 19.2%, consisting of wound infection, abscess formation, and haematoma. Anderson et al. reported four seromas in their SIO cohort, three of which required percutaneous drainage, which illustrates that avoiding inguinal canal dissection does not eliminate postoperative intervention [5]. Collectively, these events represent a notable clinical burden and preclude characterising morbidity as predominantly minor.

Oncological control remains the primary concern regarding the adoption of SIO, specifically the risk of leaving residual disease in the proximal spermatic cord [4]. Historically, high ligation was believed to better contain lymphatic spread, yet contemporary management relies more heavily on radiographic and serological markers than surgical margins alone [2]. Sarıkaya et al. found SCI in 22 of 196 high cord radical orchidectomy (HRCO) specimens (11.2%) with proximal SCI in 10 of 196 HRCO specimens (5.1%) [12]. Haroon et al. reported SCI at any level post-RIO in 3 of 121 specimens (2.5%), but no proximal involvement in a germ cell tumour; their only case of proximal involvement was B-cell lymphoma [13]. Anderson et al. reported SCI in 3 of 42 specimens (7.1%) [5]. The incidence of SCI in our cohort (7.7%; 4/52) cannot be directly compared with the SCI rates reported by Sarıkaya et al. and Haroon et al., given the differences in surgical approach and the length of cord available for analysis. However, this finding remains comparable with the SCI rate reported by Anderson et al. [5,12,13].

A notable finding in our cohort was the zero positive surgical margins (95% CI: 0%-6.8%), given that we traditionally ligate the spermatic cord as close as possible to the superficial inguinal ring. This is comparable to the positive margin rate of 2.4% (95% CI: 0.1%-12.6%) reported by Anderson et al. and further supports the feasibility of successfully achieving clearance through SIO [5]. In our cohort, three cases of RPLND were performed, with the remaining cord remnant excised. This is supported by Anderson et al., who removed residual cord tumour at RPLND in one patient after low-cord orchidectomy without technical difficulty [5]. However, although these findings are reassuring, negative margins in the resected specimens cannot exclude disease in the proximal cord left in situ. Larger comparative studies with longer follow-up are needed to determine whether SIO provides oncological control comparable to that achieved with high-cord ligation.

Following SIO, recurrence occurred in 5.8% of our patient cohort, all of which were nodal recurrences, with no evidence of local recurrence. The results compare favourably with the absence of local recurrence in Anderson et al.'s 42-patient series, as well as the absence of a statistically significant difference in relapse between cases of high- and low-cord orchidectomy for clinically stage 1 tumours reported by Ashdown et al. [5,14]. The results are notably modest when compared to reported relapse rates in the EAU and American Urological Association (AUA) guidelines, which report rates of 12%-20% [3,15]. However, these results need to be interpreted with caution as differences in risk factors, histology, staging, subsequent treatment, and follow-up preclude conclusions regarding surgical equivalence or superiority in oncological outcomes. The presence of exclusive nodal recurrence further underscores the importance of structured surveillance, including histology-appropriate tumour-marker monitoring as endorsed by the American Society of Clinical Oncology (ASCO) guidelines [16].

A key strength of this study lies in the consistency of surgical practice and MDT care. All procedures were carried out at a single centre, which standardises surgical technique and institutional practice. All patients in our cohort were reviewed by the same MDT, with access to the same uro-oncological services where clinically indicated. However, there are limitations that merit consideration. A retrospective, single-centre design could bring about information and selection biases while also limiting external validity. The relatively small sample size limits statistical power, detection of uncommon complications, and assessment of rare oncological events such as local recurrence. The absence of a control group, i.e., the lack of a RIO comparator, precludes direct assessment of equivalence or superiority between these respective surgical approaches. Frequency of neuropathic morbidity and other functional sequelae could be underestimated with retrospective documentation and limited long-term follow-up. To further explore and demonstrate comparability via high-quality evidence, and given the suggestion of oncological and functional safety from retrospective series, a randomised controlled trial (RCT) is definitely feasible to evaluate both outcomes of interest in the modern era.

Conclusions

In conclusion, our findings suggest that SIO may provide acceptable oncological and postoperative outcomes in selected patients, but comparative prospective studies are required before equivalence to RIO can be established.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Imaad Amanulla, Matthew Gibson, Gulzar Dhanoya, Mohamed Mubarak, Edgar Paez

Drafting of the manuscript: Imaad Amanulla, Matthew Gibson, Gulzar Dhanoya

Critical review of the manuscript for important intellectual content: Imaad Amanulla, Matthew Gibson, Gulzar Dhanoya, Mohamed Mubarak, Edgar Paez

Concept and design: Mohamed Mubarak, Edgar Paez

Supervision: Edgar Paez

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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Matthew Gibson and Imaad Amanulla contributed equally to the work and should be considered co-first authors. Data are available upon reasonable request. The data are stored as de-identified participant data and are available upon request from Imaad Amanulla (imaad.amanulla@nhs.net).

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