

CASE REPORT

Outcomes of Hemipelvectomy for Pelvic Chondrosarcoma: A Single-Institution Case Series of 15 Patients

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ABSTRAK

Kondrosarkoma ialah kanser tulang yang kebanyakannya refraktori terhadap kemoterapi dan radioterapi, menjadikan pembedahan sebagai satu-satunya rawatan yang berkesan. Kondrosarkoma pelvis memberikan cabaran unik disebabkan kerumitan anatomi, kelewatan pesakit mendapatkan rawatan serta kesukaran untuk mencapai margin pembedahan yang negatif. Siri kes ini meneliti 15 pesakit yang dirawat di sebuah pusat rujukan tertiar sepanjang tempoh sepuluh tahun, dengan memberi fokus kepada hasil pembedahan dan komplikasi bagi penyelamatan anggota (hemipelvektomi dalaman, IH) berbanding amputasi hindquarter (hemipelvektomi luaran, EH). Sebelas pesakit menjalani IH dan empat pesakit menjalani EH, dengan dua kes memerlukan penukaran dari IH ke EH akibat jangkitan berterusan. Tempoh purata gejala ialah 12.3 bulan. Margin pembedahan yang negatif dicapai dalam lapan pesakit (53.3%). Pada tempoh susulan purata selama 47.6 bulan, 10 pesakit masih hidup dengan lapan daripadanya bebas penyakit. Semua pesakit mengalami komplikasi, dengan jangkitan luka merupakan komplikasi yang paling kerap berlaku (13 daripada 15 pesakit). Hasil fungsi yang diukur menggunakan skor Musculoskeletal Tumor Society, adalah sangat pelbagai (min akhir: 59.6%, julat 6.7-100). Tempoh sehingga ambulasi pertama cenderung lebih lama bagi pesakit EH. Walaupun IH berpotensi memberikan hasil fungsi yang baik, ia mempunyai risiko komplikasi major yang tinggi. EH memberikan kawalan definitif bagi kes-kes kompleks tetapi mengakibatkan kecacatan fungsi yang ketara. Pemilihan pesakit yang teliti adalah amat penting dalam pengurusan penyakit yang sukar ini.

Kata kunci: Hemipelvektomi; komplikasi pascaoperasi; kondrosarkoma; margin pembedahan; neoplasma pelvis

ABSTRACT

Chondrosarcoma is a malignant bone tumour that is largely resistant to chemotherapy and radiotherapy, leaving surgery as the only effective treatment. Pelvic chondrosarcomas pose unique challenges due to anatomical complexity, delayed presentation, and the difficulty of achieving negative surgical margins. This case series reviews 15 patients treated at a tertiary referral centre over ten years, focusing on surgical outcomes and complications of limb-salvage (internal hemipelvectomy, IH) compared with hindquarter amputation (external hemipelvectomy, EH). Eleven patients underwent IH and four EH, with two

requiring conversions from IH to EH due to persistent infection. The mean symptom duration was 12.3 months. Clear surgical margins were achieved in eight patients (53.3%). At a mean follow-up of 47.6 months, 10 patients were alive, with eight of them being disease-free. Complications were universal, with wound infection being the most frequent (13 of 15 patients). Functional outcomes, measured by Musculoskeletal Tumor Society scores, were highly variable (final mean: 59.6%, range 6.7-100). Time to first ambulation tended to be longer for EH patients. While IH can yield good function, it carries a high risk of major complications. EH provides definitive control in complex cases but results in profound functional impairment. Careful patient selection is paramount in managing this difficult disease.

Keywords: Chondrosarcoma; hemipelvectomy; pelvic neoplasms; postoperative complications; surgical margins

INTRODUCTION

Chondrosarcoma represents the second most common primary malignant bone tumour, accounting for approximately one-fifth of all sarcomas (Brown et al. 2022; Giuffrida et al. 2009; Xu et al. 2024). Its biological hallmark is malignant cartilaginous differentiation, with a wide spectrum of subtypes and behaviours ranging from low-grade indolent lesions to aggressive high-grade tumours. Unlike osteosarcoma and Ewing sarcoma, chondrosarcoma is minimally responsive to chemotherapy and radiotherapy, making surgery the primary and often only curative modality (Brown et al. 2022; Giuffrida et al. 2009; Jami et al. 2021; Xu et al. 2024).

The pelvis is a common site for chondrosarcoma and poses formidable treatment challenges. Tumours often grow to a considerable size before detection due to the expansile pelvic anatomy (Brown et al. 2022; Jami et al. 2021; Núñez-Rocha et al. 2024). This is exacerbated in Southeast Asian settings like Malaysia, where socioeconomic and cultural barriers frequently lead to delayed medical care, resulting in late-stage presentations with bulky disease and higher metastatic potential (Ariff et al. 2013; Sharifudin et al. 2024). This delayed presentation, compounded by the anatomical complexity and proximity to critical neurovascular structures, makes achieving wide excision with negative margins, a critical factor for local control and survival, especially difficult (Brown et al. 2022; Jami et al. 2021; Laitinen et al. 2025). In cases arising from osteochondromatosis, the risk of

malignant transformation can be as high as 5-25%, with the pelvis being a predominant site for such secondary chondrosarcomas (Banoth et al. 2025; Jami et al. 2021). Consequently, advanced disease at diagnosis not only complicates surgical management but also critically influences the decision between limb-salvage and amputation. Historically, external hemipelvectomy (EH) or hindquarter amputation was the standard for pelvic sarcomas, providing oncologic clearance at the cost of profound functional and psychosocial morbidity. Advances in imaging, surgical navigation and reconstructive techniques have shifted management toward limb-salvage or internal hemipelvectomy (IH), which preserves the extremity when feasible (Kar et al. 2021; Laitinen et al. 2024). However, IH is associated with high complication rates, particularly infections, wound problems and mechanical instability. The trade-off between oncologic safety and functional preservation remains a subject of ongoing debate (Núñez-Rocha et al. 2024). The existing literature on outcomes is dominated by reports from high-volume Western centres, where patient demographics, healthcare resources and rehabilitation pathways differ significantly from those in Southeast Asia. This gap highlights the importance of local and regional case series in providing context-specific evidence to guide multidisciplinary management, patient counselling and resource allocation.

This paper reported a case series of 15 patients with pelvic chondrosarcoma treated surgically, either with IH or EH, at a single tertiary referral

centre over a decade. Comparing the oncologic outcomes, complications and functional results of both highlighted the complexities of surgical decision-making and the realities of managing this challenging disease in a regional context.

MATERIALS AND METHODS

Patient demographics, clinical presentation, tumour characteristics, surgical details and oncological outcomes were collected from a review of medical records. Surgical margin assessment was performed by dedicated musculoskeletal pathologists according to the standardised College of American Pathologists (CAP) protocol (Rubin et al. 2010). An R0 resection was defined as the absence of any tumour cells at the inked surgical resection margin. The distance from the tumour to the nearest margin was measured in millimetres, and margins were classified as R1 in cases of microscopic involvement and R2 when macroscopic residual tumour was present.

Functional outcomes were evaluated using the Musculoskeletal Tumor Society (MSTS) scoring system (Enneking et al. 1993). It is the standard practice of our tertiary sarcoma centre to prospectively document the MSTS score

for all patients undergoing tumour-related surgery during their routine pre-operative and post-operative follow-up clinic visits. The final available MSTS score was used for the analysis in this study. The MSTS score assesses six criteria: pain, function, emotional acceptance, use of supports, walking ability and gait, yielding a total score out of 30, which is often expressed as a percentage. The data were presented using descriptive statistics, with continuous variables reported as means and ranges, and categorical variables as frequencies and percentages.

CASE REPORT

Fifteen patients (seven males, eight females) with pelvic chondrosarcoma were included, with a mean age of 43.9 years (range 19–59). The mean duration of symptoms before presentation was 12.3 months (range 0–24), with one case being an incidental finding. The ilium (P1) was the most commonly involved site (11/15), often with extension to other pelvic regions. Most tumours were high-grade (grade 2 or 3, 13/15). Patient demographics and tumour characteristics were detailed in Table 1.

Eleven patients underwent primary IH, and four underwent EH. Two out of the four patients

TABLE 1: Demographic and tumour characteristics of 15 patients with pelvic chondrosarcoma

	Age (Years)	Sex	Duration of Symptoms (months)	Site	Grade	Stage	Metastasis at Diagnosis
1	49	M	12	P1+P2+P3	3	IIB	None
2	53	F	3	P1+P2+P3	2	III	Multiple skeletal metastases
3	50	M	12	P1+P2+P3	2	IIB	None
4	48	F	6	P1+P2	3	IIB	None
5	51	M	24 (misdiagnosed as hip AVN)	P1+P2+P3	2	IIB	None
6	58	M	18	P1+P2+P3	3	IIB	None
7	47	F	1	P2+P3	2	III	Lungs
8	29	M	18	P1	2	IIB	None

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	Age (Years)	Sex	Duration of Symptoms (months)	Site	Grade	Stage	Metastasis at Diagnosis
9	46	F	3	P1	2	IIB	None
10	27	F	24	P4	3	IIB	None
11	40	F	12	P1+P4	2	IIB	None
12	55	F	24	P4	1 (malignant transformation of osteochondroma)	IA	None
13	33	F	1	P1	2	IIB	None
14	59	F	0 (incidental finding during gynaecology check-up)	P3	1	IIA	None
15	19	M	2	P4	2	IIB	None

AVN: Avascular necrosis; F: Female; M: Male
Anatomical site: P1: Ilium; P2: Periacetabular; P3: Ischiopubic; P4: Sacrum

initially treated with IH required secondary conversion to EH due to uncontrollable infection and sepsis. All procedures were performed with curative intent, except for one palliative IH in a patient with widespread metastases (Case #2, Figure 1A and 1B). Reconstruction was tailored to the defect: techniques included hip transposition (2 patients) (e.g., Case #4, Figure 1C and 1D), endoprosthesis (2 patients) (e.g., Case #6, Figure 1E and 1F), non-vascularised fibular strut graft (2 patients) (e.g., Case #9, Figure 2A and 2B), and posterior iliolumbar instrumentation (1 patient) (Case #10, Figure 2C). Soft tissue coverage required pedicled flaps in six patients. Surgical details and oncologic outcomes were presented in Table 2.

Clear surgical margins (R0) were achieved in eight patients (53.3%). Local recurrence occurred in three patients (20%), and distant metastases developed in four (26.7%). At a mean follow-up of 47.6 months (range 2–110), 10 patients were alive. Of these, eight were disease-free (no evidence of disease), and two were alive with disease. Five patients died of disease.

The time to first ambulation varied widely. IH patients ambulated at a mean of 8.6 weeks

(range 2 weeks to 12 months), whereas two of the four EH patients never achieved ambulation. Complications were universal. Wound infection was the most common (13/15 patients), with other serious complications including flap necrosis, sciatic nerve injury, disseminated intravascular coagulation, and major depression. Functional outcomes showed a mean final score of 59.6% (range 6.7–100), indicating substantial functional impairment across the cohort. Complications and functional outcomes were summarised in Table 3.

DISCUSSION

This case series illustrates both the opportunities and limitations inherent in the surgical management of pelvic chondrosarcoma. The prolonged mean symptom duration of 12.3 months highlights the insidious growth of these tumours and the issue of delayed presentation, which is particularly relevant in the local and regional context and often leads to advanced, complex disease at diagnosis (Ariff et al. 2013; Pring et al. 2001; Sharifudin et al. 2024).

Achieving negative margins (R0), the

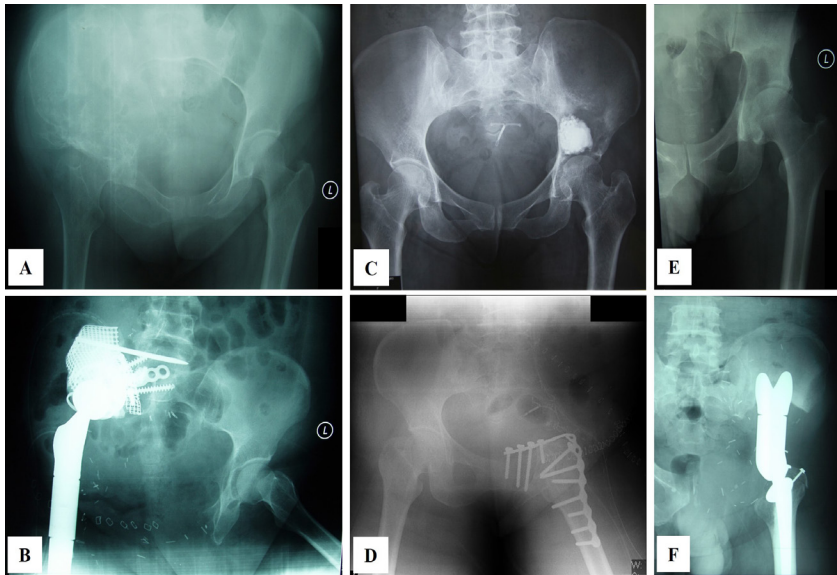


FIGURE 1: Reconstruction techniques following internal hemipelvectomy for periacetabular chondrosarcoma. Preoperative and postoperative plain radiographs demonstrated three different reconstructive approaches: (A, B) Modified total hip replacement (Case #2), (C, D) hip transposition with fusion (Case #4), and (E, F) saddle endoprosthesis (Case #6)

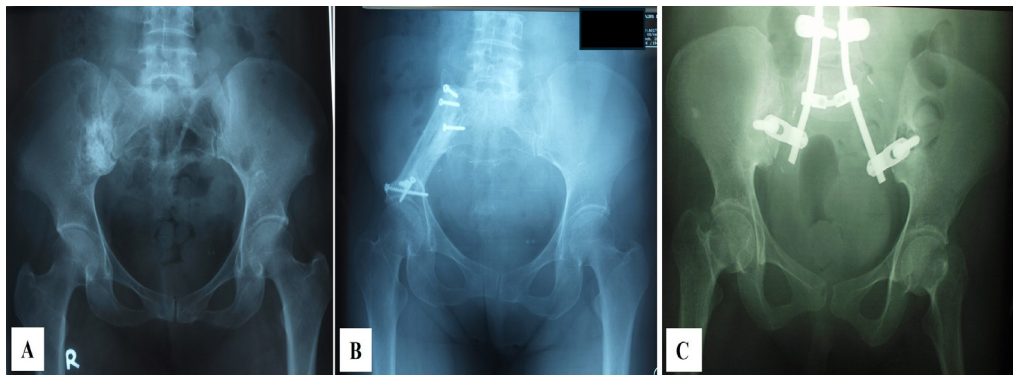


FIGURE 2: Reconstruction of the posterior pelvic ring following resection for chondrosarcoma. (A) Preoperative plain radiograph showing a tumour involving the ilium (P1) and (B) the postoperative plain radiograph after resection and reconstruction with a non-vascularised fibular strut autograft (Case #9). (C) Postoperative plain radiograph following sacral resection (P4) with reconstruction using posterior iliolumbar instrumentation and fusion (Case #10)

TABLE 2: Surgical and oncologic outcomes of patients (n = 15)

Type	Intent	Recon.	Wound Closure	Margin Status		Adj.	LR	DM	Oncologic Outcome (Last follow-up)	
				S	M					
1	EH	C	NA	Primary	W	P	C, R	None	None	NED (109mo)
2	IH	P	Modified THR	Primary	WC	N	None	None	Yes (Disseminated mets)	DOD (2mo)
3	EH	C	NA	Pedicled flap	W	P	None	None	None	DOD (4mo)
4	IH	C	HT	Primary	W	N	R	None	None	NED (22mo)
5	IH/ EH*	C	EP	Primary	W	P	R	None	None	AWD (38mo)
6	IH	C	EP	Primary	W	P	R	Yes (29mo)	None	AWD (32mo)
7	IH/ EH*	C	HT	Pedicled flap	WC	N	C	Yes (22mo)	Lungs	DOD (26mo)
8	IH	C	NVFS autograft	Primary	W	N	None	None	None	NED (24mo)
9	IH	C	NVFS autograft	Primary	WC	P	R	None	Yes (spine mets)	AWD (84mo)
10	IH	C	PILIF	Primary	WC	P	R	Yes (15mo)	Yes (multiple skeletal mets)	DOD (30mo)
11	IH	C	None	Primary	W	N	None	None	None	NED (110mo)
12	IH	C	None	Primary	W	N	None	None	None	NED (60mo)
13	IH	C	None	Pedicled flap	W	P	R	None	None	AWD (43mo)
14	IH	C	None	Primary	W	N	None	None	None	NED (32mo)
15	EH	C	NA	Pedicled flap	W	N	C, R	None	None	NED (24mo)

Adj.: Adjuvant therapy; DM: Distant metastasis; EH: External hemipelvectomy; EP: Endoprosthesis; HT: Hip transposition; IH: Internal hemipelvectomy; Micro.: Microscopic; NA: Not applicable; NVFS: Non-vascularised fibular strut; PILIF: Posterior iliolumbar instrumentation and fusion; Recon.: Reconstruction
 Intent: C: Curative; P: Palliative

Margin status: M: Microscopic; N: Negative; P: Positive; S: Surgical; W: Wide; WC: Wide-contaminated.

Adjuvant therapy: C: Chemotherapy, R: Radiotherapy

Oncologic outcome: AWD: Alive with disease; DOD: Died of disease; NED: No evidence of disease.

*Patient underwent EH after IH due to infection and sepsis.

TABLE 3: Functional outcome based on the MSTS scores and complications among patients (n = 15).

	Types of surgery	First ambulation (with or without aid) after surgery	MSTS score (%)		Complications
			Pre-surgery	During the last follow-up)	
1	EH	12 weeks	0.0	40.0	1. wound infection 2. DIVC 3. phantom limb 4. panic disorder with major depression 5. chronic pain
2	IH	Never ambulate	13.3	6.7	1. wound infection 2. wound dehiscence 3. septicaemia 4. DIVC
3	EH	2 weeks	6.7	13.3	1. wound infection 2. wound dehiscence
4	IH	4 weeks	60.0	60.0	1. wound infection 2. flap necrosis 3. neurogenic pain 4. chronic persistent diarrhoea/ pseudomembranous colitis 5. lymphoedema
5	IH/ EH*	4 weeks	53.3	56.7	1. wound infection 2. wound dehiscence 3. sciatic nerve injury (foot drop) 4. chronic diarrhoea 5. implant-related infection
6	IH	3 weeks	3.3	83.3	1. wound infection 2. lymphoedema
7	IH/ EH*	6 months	0.0	33.3	1. massive blood loss 2. flap necrosis 3. wound infection 4. septicaemic shock with DIVC
8	IH	3 weeks	16.7	90.0	1. wound infection 2. septicaemia
9	EH	Never ambulate	0.0	6.7	1. wound infection 2. wound dehiscence 3. flap necrosis 4. phantom limb
10	IH	12 months	16.7	23.3	1 wound infection 2. sciatic nerve injury (bilateral foot drop) 3. epidural tear
11	IH	10 days	73.3	90.0	1. wound infection
12	IH	2 weeks	36.7	100.0	None
13	IH	2 weeks	63.3	96.7	1. bowel and urinary problems
14	IH	2 weeks	80.0	96.7	1. wound infection 2. anxiety and depression
15	EH	4 weeks	6.7	26.7	1. wound infection 2. wound dehiscence 3. phantom pain

DIVC: Disseminated intravascular coagulation; EH: External hemipelvectomy, IH: Internal hemipelvectomy.

* Patient underwent EH after IH due to infection and sepsis.

cornerstone of curative intent, was possible in just over half of our patients (53.3%). This rate is consistent with other series reporting on pelvic sarcomas, where anatomical constraints compromise margin clearance. Our findings align with the known challenge that pelvic chondrosarcomas have a higher incidence of positive surgical margins and local recurrence compared to those located in the extremities (Lizcano-Suárez et al. 2023). Previous evidence quantifies the margin required for optimal outcomes; a margin of 1 mm is associated with significantly improved local recurrence-free survival in pelvic chondrosarcomas (Tsuda et al. 2019). Other studies recommend achieving surgical margins greater than 4 mm to minimise the risk of local recurrence in pelvic chondrosarcoma (Lizcano-Suárez et al. 2023; Stevenson et al. 2018). For high-grade central chondrosarcomas, a margin >2 mm may be necessary to minimise recurrence risk (Kurisunkal et al. 2021). Margin status was a critical determinant of outcome; local recurrence occurred exclusively in patients with positive margins (microscopic or macroscopic), reinforcing the paramount importance of surgical margin in chondrosarcoma management (Donati et al. 2005; Harati et al. 2017; Jami et al. 2021; Laitinen et al. 2019). The impact of local recurrence is profound, with recent evidence indicating that for grade 2 tumours, the size of the recurrence is a key prognostic factor; local recurrences larger than 5.3 cm are associated with significantly worse post-recurrence survival (Kask et al. 2025). This highlights the critical need to achieve local control at the initial surgery. Furthermore, in high-grade tumours, the vast majority of local recurrences are detected within the first five years, suggesting that the intensity of surveillance can be tailored after this period (Kask et al. 2025).

The functional outcomes and postoperative course differed between IH and EH. While IH offered the potential for limb preservation, it was fraught with complications, most notably a 100% complication rate in our cohort, dominated by deep wound infections. These complications were associated with a delayed recovery, illustrated by

a protracted mean time to ambulation (8.6 weeks) in the IH group. However, successful IH could result in excellent function, with three patients achieving final MSTS scores above 90%. This aligns with studies emphasising better functional outcomes after limb-salvage procedures (Han et al. 2010; Wirbel et al. 2000; Xu et al. 2024). In contrast, EH provided a more definitive solution for local control in very extensive tumours but was associated with profound functional loss. Half of the EH patients never ambulated, and those who did had poor MSTS scores, highlighting the severe functional cost of amputation. Beyond mobility, quality-of-life studies highlight chronic pain as a major determinant of outcome. Patients after IH often contend with chronic neuropathic or mechanical pain, whereas amputees face challenges with phantom limb pain (Donati et al. 2005; Jami et al. 2021; Sharifudin et al. 2024). The two cases of conversion from IH to EH due to life-threatening sepsis further illustrate the high stakes involved in attempting limb-salvage in complex scenarios. Although amputation reduces the risk of local recurrence by allowing wider clearance, one of the two amputees still had positive margins, highlighting that amputation does not always guarantee oncologic safety. Given the profound disability and social stigma associated with amputation, especially in Southeast Asian cultural contexts, it should be considered only when limb-salvage is not feasible.

The high infection rate (87%) aligns with the literature on major pelvic resections. It can be attributed to large dead space, prolonged operative times and compromised soft tissue envelopes (Jami et al. 2021). This complication directly impacts functional recovery and overall success. In our series, the specific reconstruction techniques employed may have contributed to this high rate. The use of large metal endoprostheses, while providing immediate stability, creates a potential nidus for biofilm formation (Angelini et al. 2014; Brown et al. 2018). Similarly, non-vascularised fibular strut grafts, used in two patients, require prolonged incorporation and may devitalise the surgical field (Ajit Singh et al. 2022; Wirbel et al. 2000). The

universal need for extensive soft tissue dissection and the frequent requirement for pedicled flaps (six patients in this series) further compound the risk of wound breakdown and subsequent deep infection. Meticulous surgical technique, advanced reconstructive planning with a preference for vascularised tissue where possible, and aggressive postoperative management are essential to mitigate this formidable challenge (Wang et al. 2024).

The choice between IH and EH remains a nuanced decision. IH should be pursued when a clear margin is achievable without compromising critical neurovascular structures, thereby offering the best chance for functional preservation (Núñez-Rocha et al. 2024). However, our experience suggests that in cases with extensive soft tissue involvement, poor baseline function, or substantial comorbidities, the elevated risk of major complications may outweigh the potential benefits of limb-salvage. In such situations, primary EH, despite its functional drawbacks, may be a more prudent oncologic and life-saving strategy.

This case series is limited by its retrospective design and small sample size, inherent to the rarity of pelvic chondrosarcoma. Tumour heterogeneity, variations in reconstruction and reliance on retrospective assessment further constrain generalisability. Nevertheless, the detailed long-term follow-up provides valuable insights into the real-world outcomes of these demanding procedures.

CONCLUSION

Hemipelvectomy for pelvic chondrosarcoma remains a high-morbidity procedure. While IH can result in excellent functional outcomes for selected patients, it is associated with a near-universal risk of major complications, particularly infection, which can compromise both the limb and patient survival. EH, though functionally devastating, provides a more reliable means of local control in the most advanced cases. The decision must be individualised, balancing the goal of oncologic cure with the risks of

morbidity and functional loss. Preoperative counselling should set realistic expectations, and management must be supported by a multidisciplinary team with expertise in sarcoma care, complex reconstruction and rehabilitation.

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Ethics statement: This case review was obtained from the institutional review board (FWA Reg. No: 00007718; IRB Reg. No: 00004494). As this was a retrospective review of existing patient data, the requirement for informed consent was waived by the ethics committee. Patient confidentiality was maintained through the anonymisation of all data used in the analysis.

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