

HEAD AND NECK

Cost analysis in oral cavity and oropharyngeal reconstructions with microvascular and pedicled flaps

Analisi dei costi nelle ricostruzioni orali e orofaringee con lembi microvascolari e pedunculati

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SUMMARY

Reconstructive surgery of the head and neck region has undergone tremendous advancement over the past three decades, and the success rate of free tissue transfers has risen to greater than 95%. It must always be considered that not all patients are ideal candidates for free flap reconstruction, and also that not every defect strictly requires a free flap transfer to achieve good functional results. At our institution, free flap reconstruction is first choice, although we use pedicled alternative flaps for most weak patients suffering from severe comorbidities, and for pretreated patients presenting a second primary or a recurrent cancer. From July 2006 to May 2010, 54 consecutive patients underwent soft tissue reconstruction of oral cavity and oropharyngeal defects. We divided the cohort in three groups: Group 1 (G1): 16 patients in good general conditions that received free radial forearm flap reconstruction; Group 2 (G2): 18 high-risk patients that received a reconstruction with infrahyoid flap; Group 3 (G3): 20 patients that received temporal flap (10 cases) or pectoral flap (10 cases) reconstruction. We must highlight that pedicled alternative flaps were used in elderly, unfavourable and weak patients, where usually the medical costs tend to rise rather than decrease. We compared the healthcare costs of the three groups, calculating real costs in each group from review of medical records and operating room registers, and calculating the corresponding DRG system reimbursement. For real costs, we found a statistically significant difference among groups: in G1 the average total cost per patient was € 22,924, in G2 it was € 18,037 and in G3 was € 19,872 ($p = 0.043$). The amount of the refund, based on the DRG system, was € 7,650 per patient, independently of the type of surgery. Our analysis shows that the use of alternative non-microvascular techniques, in high-risk patients, is functionally and oncologically sound, and can even produce a cost savings. In particular, the infrahyoid flap (G2) ensures excellent functional results, accompanied by the best economic savings in the worst group of patients. Our data reflect a large disconnection between the DRG system and actual treatment costs.

KEY WORDS: Healthcare costs • Cost analysis • Pedicled flap • Microvascular free flap • Infrahyoid flap • Head and neck reconstruction

RIASSUNTO

La chirurgia ricostruttiva del distretto testa-collo è avanzata enormemente nel corso degli ultimi tre decenni. Il tasso di successo dei lembi liberi rivascolarizzati supera il 95%. Si deve però considerare che non tutti i pazienti sono dei candidati ideali per la ricostruzione con lembi liberi; inoltre, non tutti i difetti necessitano strettamente di una ricostruzione microvascolare per ottenere buoni risultati funzionali. Presso il nostro Istituto, la ricostruzione con lembi liberi è solitamente la prima scelta, tuttavia usiamo lembi pedunculati come alternativa in pazienti con gravi comorbidità generali, e in pazienti pre-trattati nei quali ci attendiamo una compromessa affidabilità dei vasi del collo. Da luglio 2006 a maggio 2010, 54 pazienti consecutivi sono stati sottoposti a ricostruzione dei tessuti molli del cavo orale e/o orofaringee. Abbiamo diviso i pazienti in tre gruppi: Gruppo 1 (G1): 16 pazienti in buone condizioni generali che hanno ricevuto una ricostruzione con lembo libero di avambraccio; Gruppo 2 (G2): 18 pazienti ad alto rischio sottoposti a ricostruzione con lembo infraioideo; Gruppo 3 (G3): 20 pazienti che hanno ricevuto un lembo temporale (10 casi) o un lembo pettorale (10 casi). È importante sottolineare che i lembi pedunculati sono stati utilizzati in pazienti anziani, compromessi da un punto di vista generale, in cui di solito le spese mediche tendono ad aumentare piuttosto che diminuire. Abbiamo confrontato i costi sanitari dei tre gruppi, sia esaminando le cartelle cliniche e i registri di sala operatoria, sia calcolando i rimborsi previsti dal Servizio Sanitario Nazionale tramite il sistema DRG. Per quanto riguarda i costi reali, abbiamo trovato una differenza statisticamente significativa tra i gruppi: in G1 il costo medio totale per paziente è stato di € 22.924, in G2 di € 18.037, ed € 19.872 in G3 ($p = 0,043$). L'importo del rimborso, basato sul sistema DRG, è stato di € 7.650 per ogni paziente, indipendentemente dal tipo di intervento chirurgico. La nostra analisi mostra come l'utilizzo di lembi pedunculati alternativi, in pazienti ad alto rischio, non sia soltanto adeguato dal punto di vista funzionale ed oncologico, ma come sia in grado di produrre un risparmio economico. In particolare, il lembo infraioideo (G2) garantisce ottimi risultati funzionali accompagnati dai migliori risultati economici, questo nel gruppo di pazienti più fragili. I nostri dati riflettono un divario significativo tra il sistema DRG e i costi effettivi del trattamento.

PAROLE CHIAVE: Costi sanitari • Analisi dei costi • Lembo pedunculato • Lembo libero microvascolare • Costo • Lembo infraioideo • Ricostruzione testa-collo

Introduction

The application of microvascular free flaps is the most widespread method currently employed for the reconstruction of extensive defects after resection of head and neck cancer because of their versatility and reliability. The success rate of free tissue transfers has risen to greater than 95%, and fascio-cutaneous free flaps (i.e. free radial forearm flap, free antero-lateral thigh flap) are currently considered the gold standard for soft tissue reconstruction of oral cavity and oropharyngeal defects¹⁻³. A recent report showed that in the United States free flap reconstruction of the head and neck is even profitable, and generates substantial revenue for the hospital³. Is such a scenario also valid in Italy? In fact, the complexity of modern head and neck reconstruction is paralleled by consumption of large amounts of resources, provided by both treating physicians as well as the institution. In times of increasing economic constraints, analysis of the financial value of providing these services seems worthwhile. Free flap reconstruction requires special knowledge and surgical skills, dedicated personnel and tools, careful postoperative monitoring^{5,6}. Accordingly, it has been hypothesized that adopting microvascular reconstructive techniques could lead to an increase in healthcare costs^{7,8}. Our interest on this subject arises from our institutional policy of treating, with alternative pedicled flaps, most weak patients suffering from severe comorbidities^{9,10}, pretreated patients presenting a second primary or a recurrent cancer and patients with major vessel exposure^{11,12}. In fact, not all patients are ideal candidates for free flap reconstruction¹³, and not every defect strictly requires a free flap transfer to achieve good functional results^{14,15}, thereby minimizing medical complications and mortality¹⁶.

DRG is the acronym of "Diagnosis-Related Group", and indicates the remuneration system to the hospital based on healthcare activities. The system was created in the early 1980s by Professor Fetter of Yale University¹⁷, and has been utilized in Italy since 1995. In Fetter's prototype, the hospital is defined as a company that provides numerous products. The first step is to classify each clinical case in one of 467 groups. Next, starting from inputs represented by the available resources, the hospital develops a defined number of outputs for each patient that are fitted on the starting health status. All these outputs are directed to obtain a final product: diagnosis and/or treatment (defined as the evaluation and/or any change in the state of health of the patient). Fetter developed a classification system for discharged patients, identifying subgroups of patients receiving a similar pattern of outputs, and assuming that similar diseases, treated in similar institutions, need a similar consumption of human and material resources. With this system, the hospital is remunerated using predetermined rates. Each resigned

patient is attributed to a specific DRG, calculated using a Software Grouper that, through a process of hierarchical combination of information contained in the hospital discharge card (in Italy called *Scheda di Dimissione Ospedaliera*, SDO), automatically assigns each group. The SDO contains: the main discharge diagnosis (encoded with ICD9-CM, a classification system in which diseases and traumas are ordered with an epidemiological aim), any received treatment or procedure and the patient's general information.

The DRG code assignment is based on three steps:

- assignment to one of 25 "Major Diagnostic Categories" (MDCS), based on the ICD9-CM encoded main discharge diagnosis;
- assignment to a subgroup after surgical "Medical" or "Surgical".

Then consider:

- type of intervention (for surgical DRG);
- age;
- further disorders and/or complications related to the main discharge diagnosis;
- discharge status (alive, deceased, resigned against the advice of physicians, transferred to another Department).

Once codified, each DRG will have its weight, and the software will provide the fraction of DRG's value compared to a full DRG. Each DRG corresponds to a tariff.

To calculate the total reimbursement of a DRG, it is therefore necessary to apply the following formula:

$$\text{Cost} = (\text{fraction of DRG's value}) \times \text{DRG's point}$$

It must be specified that the DRG's point value, in Italy, varies from region to region, and that for each DRG there is a threshold value, expressed in days, which is the length of hospitalization considered outside the threshold. Outside this limit, the applied additional remuneration per day is much less consistent than within the threshold. In this study, we compared the real costs of microvascular vs. alternative pedicled flap reconstructions, and we calculated the reimbursement based upon the DRG system.

Materials and methods

From July 2006 to May 2010, 86 consecutive patients with oral cavity or oropharyngeal squamous cell carcinomas underwent head and neck reconstruction by a single operator (AD), using microvascular free flaps or alternative pedicled flaps. We selected cases where the surgical defect (resulting from pull-through or trans-mandibular approaches) put the oral cavity and/or the oropharynx in communication with neck spaces, and we excluded reconstructions after segmental bony resections (mandibular resections/maxillectomy), thus result-

Table I. Functional analysis.

Score	Diet	Speech
1	regular diet without restrictions	always understandable
2	moist or soft diet	usually understandable, but with frequent repetition or face to face contact required
3	liquid diet	difficult to understand, even with face to face contact
4	tube-dependent intake	never understandable, with written communication required

ing in a study population of 54 patients. After analysis of medical records and surgical registers, we recorded the following for each patient: all examinations and visits carried out during pre-operative evaluation; tumour site, clinical and pathological staging (in accordance with the 7th edition of TNM classification system)¹⁸; type of reconstructive procedure, surgical and reconstructive time, materials and drugs used during surgery; days of hospitalization in intensive care; global hospitalization time, consultations, medications, blood transfusions, and examinations performed in post-surgery or in protected respiration; time of tracheotomy closure, time of oral feeding restoration. The pre-operative risk of each patient was evaluated using the Classification of the American Society of Anesthesiology (ASA)¹⁹. Postoperative functional results were assessed by the physician at outpatient follow-up consultation and at 6 months after surgery using a score system; the type of diet was assessed in all cases. Options were numerically weighted from 1 to 4 as shown in Table I.

Patients

We divided patients into three groups. In Group 1 (G1), 16 patients in good general conditions receiving free radial forearm flap reconstruction; in Group 2 (G2), 18 high risk patients who received a reconstruction with infrahyoid flap; in Group 3 (G3), 20 patients who received temporal flap (10 cases) or pectoral flap (10 cases) reconstruction. G1 comprised 12 male and 4 female patients; 9 patients received a free radial forearm flap to reconstruct a defect of the oral cavity, while 7 patients had reconstruction of the oropharynx. The mean age in G1 was 58.2 years (median 58, range 45-70 years), and all patients were classified ASA I-II.

G2 included 12 male and 6 female patients, 12 receiving infrahyoid flap for oral cavity and 6 for oropharyngeal reconstruction. All flaps were harvested from the same neck side of the primary tumour during homolateral neck dissection; 10 patients had bilateral neck dissection. The mean age in G2 was 69.6 years (median 72, range 55-83 years), 3 patients were classified ASA II, and the remaining ASA III. Contraindications for free flap reconstruction in G2 were: severe comorbidities (diffuse atherosclerosis, diabetes mellitus, heart failure) in 15 cases, and age exceeding 80 years with moderate comorbidities in 3 cases. G3 had 16 male and 4 female patients, 11 reconstructions of the oral cavity (7 pectoralis major flaps and 4 tempo-

ral flaps) and 9 reconstructions of the oropharynx (3 pectoralis major flaps and 6 temporal flaps). The mean age in G3 was 69.6 years (median 70, range 64-81 years); 3 patients were classified ASA I, 14 patients ASA II, 2 patients ASA III and 1 ASA IV. The contraindications for free flap and infrahyoid flap in G3 were: age exceeding 80 years with severe comorbidities and contraindications for infrahyoid flap reconstruction in 3 cases; post surgical vessel-depleted neck and previous radiation in 10 cases, and previous chemoradiation in 7 cases. Ten patients with vessel-depleted neck had no neck dissection. However, even in these cases, tumour resection created a communication between the oral cavity or oropharynx and neck spaces.

Costs

We compared the healthcare costs of the three groups in two different ways:

- calculating the reimbursement following the DRG system;
- calculating real costs in each group from review of medical records and operating room registers.

To assess actual costs for each patient, we looked at:

- the cost of main materials and drugs actually consumed during diagnostic and therapeutic procedures, provided by the regional administrative institution for human and financial medical resources of Tuscany, Italy (ESTAV-Centro);
- the standard cost per hour of the physician and nurse (obtained by dividing the average salary per contractual hours, € 55 and € 23 respectively);
- the cost of each diagnostic procedure, retrieved from the regional tariff list (including personnel expenditure);
- the average hospital stay, according to the Institutional Business Accounting (€ 420 per day, all inclusive);
- the average cost of hospital intensive care unit stay, according to Institutional Business Accounting (€ 1,300 per day, all inclusive);
- the cost of operating theatre, estimated according to the Institutional Business Accounting (€ 200 per hour including all fees except those of the medical/paramedical staff).

Costs were divided into three categories: preoperative, operative and postoperative. Preoperative costs include only those required by the anesthesiologist for undertaking the surgical procedure. All diagnostic procedures requested

by the surgeon to determine the specific characteristics of the disease (CT, MRI) were excluded, since these belong and are charged within the outpatient path. Postoperative costs were calculated until discharge.

Statistical analysis

Differences among groups were tested with the ANOVA; for categorical variables we used a chi-square test of Pearson: P values less than 0.05 were considered statistically significant.

Results

Clinical results

Patient characteristics and results are shown in Table II. All reconstructions were successful. In all cases, a separation between oral cavity or oropharynx and neck spaces was obtained and none of the patients was re-admitted within 6 months from surgery. The mean operative time in G1 was 9 hr (range 7 h-12 h 40 min), in G2 it was 6 hr 40 min (range 5 hr 20 min-8 h), and in G3 it was 7 hr (range 5 hr 10 min-8 hr 30 min).

Table II. Patient characteristics and statistical analysis.

	Group			p*	Total (54)
	G1 (16)	G2 (18)	G3 (20)		
Age (yrs), mean (SD); Range	58.2 (6.32); 45-70	69.6 (9.41); 55-83	69.6 (6.8); 64-81	p < 0.01	64.7 (9.5); 45-83
Gender, n (%)					
male	12 (75)	12 (66)	16 (80)	p = 0.88	40 (74)
Female	4 (25)	6 (34)	4 (20)		14 (26)
Tumour Site	9 OC 7 OP	12 OC 6 OP	11 OC 9 OP	p = 0.61	32 OC 22 OP
Primary Tumour	12	15	3		30
Recurrent Tumour	2	2	7		11
Second Primary	2	1	10		13
pT					
1	-	-	4		4
2	7	5	5	p < 0.01	17
3	8	9	8		25
4a	1	4	3		8
pN (10 G3 patients had no neck dissection)					
0	4	8	2		14
1	2	2	-		4
2a	1	-	-	p = 0.07	1
2b	5	6	3		14
2c	4	2	2		8
3	-	-	3		3
Skin Paddle Surface (cm ²)					
mean (SD)	44.7 (15.5)	22.7 (4.5)	44 (16.9)	p < 0.01	34.7 (15.9)
range	20-63	18-40	32-56		18-63
Operating time, (h), mean (SD); range	9.5 (1.6); 7-12.4	6.6 (0.8); 5.2-8	7.4 (0.9); 6.1-8.3	p = 0.14	8 (1.8); 5.2-12.4
Blood loss (Hb g/dl), mean (SD); range	3.25 (1.4); 1.1-6.2	2.6 (1); 0.4-3.5	3.6 (2.6); 1.7-5.5	p = 0.59	3.04 (1.4); 0.4-6.2
Patients blood-transfused, n (%)					
Yes	3 (19)	3 (17)	4 (20)	p = 0.96	10 (19)
No	13 (81)	15 (83)	16 (80)		54 (81)
Tracheotomy closure, mean (days)	6 (4.2); 3-9	7.4 (2.7); 4-11	7 (2.1); 5-10	p = 0.83	7.3 (2.8); 3-11
Oral intake restoration, mean (days)	14.8 (10); 8-40	11.5 (5.9); 6-25	12.6 (4.7); 9-18	p = 0.63	13.2 (7.9); 6-40
Discharge, (days), mean (SD) range	23.2 (7.5); 16-39	21.8 (12); 12-61	26.5 (9.9); 16-38	p = 0.63	23.2 (9.8); 12-61
Diet score, n, mean (SD); range	1.33 (0.4); 1-2	1.28 (0.4); 1-2	1.6 (0.7); 1-3	p = 0.29	1.42 (0.6); 1-3
Speech score, mean, n	1 (0); 1-1	1.07 (0.2); 1-2	1.2 (0.4); 1-2	p = 0.28	1.06 (0.2); 1-2

SD: Standard deviation; ChT: Chemotherapy; RT: Radiotherapy; Hb: Haemoglobin; OC: Oral Cavity; OP: Oropharynx; * Differences in mean values among groups were tested with ANOVA, for categorical variables chi-square Pearson test was used.

Table III. Real costs in euro.

	Groups			p*
	G1	G2	G3	
Pre-operative	333	458	393	0.23
Operative	9,673	5,751	6,172	0.034
Post-operative	12,919	11,828	13,307	0.065
Total cost	22,924	18,037	19,872	0.043

* tested using ANOVA; for categorical variables, chi-square test of Pearson.

Postoperative intensive care recovery was used in 4 patients in G1 with a mean stay of 3.7 days, in 4 G2 patients with a mean stay of 3 days and in 3 G3 patients with a mean stay of one day.

All patients were discharged with complete restoration of oral intake (mean time 15 days, range 7-18) and tracheotomy closure (mean time 7 days, range 3-11). Mean discharge time after surgery was 23 days (range 12-39) with no differences among groups (23.2 days G1; 21.8 days G2; 26.5 days G3). No significant differences were found with regards to verbal intelligibility and diet score among groups. Nevertheless, patients in G3 receiving TMF had minimal diet restrictions, while all patients with PM flap reconstruction required soft or liquid diets.

Economic results

The DRG system has assigned all 54 patients to the main diagnostic category (MDC) #3 "Diseases and disorders of the ear, nose, mouth and throat", and class number 482: "Surgical tracheotomy for diagnosis concerning the face, the mouth and the neck". Since our Hospital is a tertiary referral centre, it receives a 3% increase on 1st tariff level for DRG high specialty (weight > 2.5). The amount of the refund, based on the DRG system, was € 7,650 for each patient. In fact, none of the patients had a hospital stay beyond the threshold of 72 days.

Looking at the real costs, we found a statistically significant difference among groups: in G1 the average total cost per patient was € 22,924, in G2 it was € 18,037, and € 19,872 in G3, ($p = 0.043$; Table III). Surgical expenses for G1 patients were significantly higher than those for G2 and G3 patients: € 9,673, € 5,751 and € 6,172 respectively ($p = 0.034$; Table III). No statistically significant differences were found for preoperative and postoperative costs among the 3 groups: € 333 and € 12,919, € 458 and € 11,828, € 393 and € 13,307, in G1, G2 and G3 respectively (p values were 0.23 and 0.065 respectively; Table III).

Discussion

The main goals in modern head and neck reconstructive surgery are restoration of form and function²⁰. In oral cavity and oropharyngeal reconstructions, the surgeon is faced with several challenges: ensuring optimal healing;

increasing residual function; preventing scar formation and ankylosis of mobile structures; ensuring effective deglutition, intelligible speech, and airway patency. Failure in some of these aspects, in addition to jeopardizing the patient's quality of life, produces an increase in health care costs. In the present study, we analyzed reconstructions performed by a single surgeon (AD) to avoid inter-operator differences, and focused on soft tissue reconstructions to obtain a homogeneous cohort. We selected oral cavity and oropharyngeal defects in communication with neck spaces to represent a similar level of complexity. In fact, transoral resections are mostly performed for small tumours, where the reconstruction in these cases is less difficult, employing primary closure, local flaps or skin grafts. Furthermore, since we focused our study on head and neck surgery, we excluded the costs of adjuvant therapies, since these are independent of the type of reconstructive procedure and could have created a bias (i.e. pre-irradiated patients). In recent years, at our Institution, the free radial forearm flap has represented the main reconstructive option for soft tissue reconstruction of oral cavity and oropharyngeal defects following cancer ablation. In fact, microvascular reconstructions represent a major advancement in the management of head and neck tumours; nevertheless, our philosophy of carefully considering all anatomical and general conditions for each patient drove us to reconsider pedicled alternative flaps in selected cases. With this study, we wanted to verify our preliminary impression that this philosophy was not only oncologically sound, but also cost effective. Indeed, the infrahyoid flap has proven to be a valuable alternative in elderly patients suffering from severe comorbidities (G2 patients), ensuring excellent functional results^{9 10 21 22}. The temporal flap and pectoralis major flap can still be useful in patients with a vessel depleted neck or when the expected quality of the recipient vessels is questionable (G3 patients)^{11 23}. Looking at our data, and calculating the total real costs in the three groups, we immediately realized the inadequacy of the DRG system, which always assigned the highest hierarchical remuneration to the tracheotomy, rather than any other accompanying demolition/reconstruction.

The advantages of the DRG system should consist in fixing an anticipated "price" for hospitalizations, but the DRG miserably fails when dealing with major head and

neck oncologic resections and reconstructions. In our series, the obtained refund per patient, based on the DRG, was € 7,650; the gap between the real costs and the refund has been as high as € 15,274 for G1 patients, € 10,387 for G2 and € 12,222 for G3 patients. These data reflect a large disconnection between the DRG system and true treatment costs; the DRG seems undeniably unsuitable to calculate and compare healthcare costs, and therefore to be used as a parameter for policy choices. The results of our analysis showed a significantly increased cost for microvascular procedures vs. pedicled alternatives. We must highlight that pedicled alternative flaps were used in elderly, unfavourable and weak patients, where medical costs usually tend to rise rather than decrease. In fact, the average preoperative costs for the more “fragile” patients of Group 2 and Group 3, requiring specific additional preoperative assessments were higher than preoperative costs in Group 1 (Table IV). These data show that our philosophy is not only valid from a medical point of view, but it is also economically sound. Nevertheless, our findings warrant further confirmation in a larger cohort of patients. It seems difficult to conduct a comparison with other studies because there are significant differences due to: the different criteria for choosing the type of reconstruction, the diverse systems of remuneration and the various costs of human and material supplies among different institutions and countries.

Kroll²⁴ in 1997 compared 145 oral cavity and oropharyngeal free flap reconstructions (using free radial forearm flaps or rectus abdominis free flaps) with 33 pectoralis major flap reconstructions. The operative costs were slightly higher for free flaps, but the total costs were lower: \$ 37,314 for free flaps and \$ 48,917 for pectoralis major flaps.

Ten years later, de Bree²⁵ matched 40 oral cavity/oropharyngeal reconstructions with free radial forearm flap with 40 patients receiving the pectoralis major flap for similar defects; total costs were lower for the free radial forearm flap group: € 38,709 vs. € 42,733. However, in both these studies, free flaps were tested against the pectoralis major flap, which unfortunately is known to cause some healing delay for frequent necrosis of the most distal edge of the skin paddle; this usually doesn't require further interventions, but it does increase hospital stay and costs. In fact, where conservative transmandibular approaches are employed, the bulkiness of the pectoralis major flap produces less than ideal functional outcomes, because the mandible presses upon the flap favouring hypovascularization and necrosis of the distal portion, and because the thickness and bulkiness of the flap hinders the motility of the preserved structures. According to previous studies, the incidence range of total necrosis and partial necrosis for the pectoralis major flap has been reported to be from 0-2.7% and 4-29%, respectively²⁶⁻³⁴.

It is our policy, however, to use the pectoralis major flap for defects mainly lying below an imaginary line between the labial commissure and tragus; instead, the temporal flap is chosen for defects mainly lying above this line. Furthermore, for reconstructions following mandibular sparing procedures, we prefer to use the pectoralis major flap as myofascial transposition, reducing its bulk, and consequently reducing the pressure of the mandible. These two specific indications decrease the occurrence of distal marginal necrosis and the related costs.

In our series, the mean length of hospitalization was 23.2 days in G1, 21.8 days in G2 and 26.5 in G3, which was not significantly different (p = 0.63). The intraoperative costs for G1 patients were significantly higher (p = 0.034) than costs for G2 and G3 patients: € 9,673, € 5,751, and € 6,172 respectively (Table V). The highest intraoperative costs for G1 patients are due to longer operative time, and, above all, to the simultaneous work of a double medical and paramedical team (flap harvest during tumour resection; Table V). Longer operative times in G1 were mainly dependent on the microvascular reconstruction times, not only technically related to preparation of the recipient vessels under microscopic magnification and revascularization times, but also to “meticulous” and “patient/delayed” surveillance of microanastomosis patency prior to definitive skin closure (of course this step could be omitted or quickened, but we feel that “it is better to be safe than sorry”). On the other hand, higher operative costs in G1 were less dependent on operative times and mainly related to personnel-related costs (medical and paramedical).

The analysis of postoperative expenses (Table VI) showed a substantial parity between G1 and G3, with slight best performance again for G2. The inappropriate use of post-

Table IV. Pre-operative costs in euro.

	Group		
	G1	G2	G3
Patient admission time			
Medical time (10 min)	6	6	6
Paramedical time (10 min)	2	2	2
Pre-operative exams			
Routine blood screenings	126	126	126
Extra blood screenings	36	113	102
Urinalysis	3	3	3
Chest X-ray	45	45	45
ECG	20	20	20
Paramedical time (15 min)	4	4	4
Pre-operative evaluations from various professionals			
Head and neck surgeon	22	11	11
Anaesthesiologist (20 min)	11	11	11
Nurse	9	4	6
Specific additional preoperative assessments	6	53	6
Other costs			
15% direct and indirect costs	43	60	51
Total	333	458	393

Table V. Operative costs in euro.

	Group		
	G1	G2	G3
Materials			
Intubation kit	5	5	5
Sterile gloves	288	96	96
Thread	73	52	57
Microsurgical kit	22	-	-
Gauze	24	16	12
Scalpel	2	1	1
Tracheal cannula	75	75	63
Syringe	5	4	4
Sterile drape	12	8	8
Surgery disposable mask and cuff	4	1	2
Drugs			
Anaesthesia (fluids included)	232	188	196
Sodic heparin	7	-	-
Antibiotics	6	6	6
Histology			
Frozen sections	320	344	315
Definitive pathological report	880	865	846
Transfusions	70	62	7
Blood gases analysis	97	55	70
Operative room costs	1,900	1,320	1,546
Personnel			
Surgeons	3,008	1,091	1,223
Anaesthesiologist	523	364	408
Paramedical staff	858	447	502
Other costs			
15% direct and indirect costs	1,262	751	805
Total	9,673	5,751	6,172

operative intensive care recovery (ICU) in 4 G1 patients did deny a saving in this group of healthier patients, and instead raised postoperative costs (Table VI). Postoperative ICU monitoring was not related to protracted operative times, but only for the lack of the appropriate sub-intensive facility and it was no longer used for the 12 more recent cases.

Our reconstructive philosophy has provided successful results in functional terms, also in terms of "cost-effectiveness". The use of alternative pedicled flaps in high-risk patients probably reduced the risk of flap failure, with consequent expenditure restraints. The use of microvascular techniques for these patients might have led to an increase in production costs linked to the increase of indirect costs arising from possible complications. The limits of our study are mainly represented by the retrospective setting and the small cohort. It would be beneficial, for subsequent analyses, a perspective evaluation with a larger cohort, possibly multi-institutional. In our opinion, satisfaction and quality of life of the patient must, however, precede any economical concern³⁵⁻³⁸.

Conclusions

Our analysis shows that the use of alternative non-microvascular techniques in high-risk patients, does not affect

Table VI. Postoperative costs in euro.

	Group		
	G1	G2	G3
Ordinary hospital stay	9,744	9,156	11,130
Hospital stay in ICU	1,219	867	195
Medications (hospital ward)			
Materials	97	79	81
Medical time	31	14	22
Paramedical time	16	7	19
Other specialists in consultation	63	98	38
Exams			
Imaging, ECG	30	26	38
Rehabilitation			
Speech therapy	27	24	31
Physiotherapy	8	14	16
Other costs	1,684	1,543	1,737
Total	12,919	11,828	13,307

the result in oncologic and functional terms, and can even produce a cost saving. In particular, the infrahyoid flap ensures excellent functional results accompanied by the best economic performance in the most fragile patients.

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