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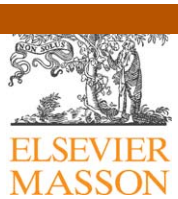

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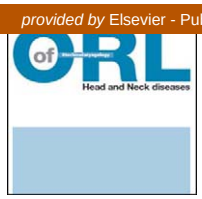

ORIGINAL ARTICLE

Medicoeconomic study of microsurgical head and neck reconstructions

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KEYWORDS
Medicoeconomic study;
Microsurgical reconstruction of facial bones;
Free flap

Summary
Objectives: The use of microanastomosed free flaps has become essential in the management of head and neck defects following cancer resection or other causes. However, this surgery is under-rated by the French case-mix based rating procedure. The purpose of this study was to evaluate the cost balance of this type of surgery in a patient cohort managed by free flap head and neck reconstruction in a polyvalent adult head and neck surgery department.
Material and methods: This retrospective study was based on 52 patients divided into two groups undergoing either mandibular or nonmandibular reconstruction. Possible prognostic factors were investigated in patients undergoing mandibular reconstruction. Kaplan-Meier survival analysis was also performed for both groups of patients. The Foch Hospital financial department's analytical accounting data for 2006 and 2007 were used to evaluate the costs related to these patients. A senior surgeon retrospectively reviewed the patients' charts with the Medical Informatics physician in order to optimize the choice of diagnosis-related group (DRG).
Results: The mean income generated by mandibular and nonmandibular reconstructions in 2006 and 2007 was 545 € /day and 526 € /day for hospitalisation including free flap and 828 € /day and 818 € /day for ''satellite'' hospitalisations for other procedures related to the reconstruction, respectively. After review of the rating by a senior surgeon, in order to optimize the choice of DRG, the mean income received by the hospital could have been improved by +6%.
Conclusion: Optimization of procedure and hospital stay rating associated with better collaboration with the Medical Informatics physician are essential in order to continue to provide this major surgery, which is essential for the patient's quality of life. A higher rating of this activity by the French health system is also necessary.

Introduction

Free flaps are an essential part of the management of head and neck defects, either after cancer surgery or in other settings.

In particular, free flaps are essential in the management of mandibular defects, as the mobile nature of this bone,

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the proximity of the highly septic oral cavity and the need for radiotherapy make all attempts of prosthetic reconstruction illusory [1—3]. However, this highly technical surgery is under-rated by the French case-mix based rating procedure. Mandibular swing approach for oropharyngeal cancer does not generate more income for the hospital when it is followed by microsurgical reconstruction than when it is closed without reconstruction, although reconstruction considerably improves the patient's quality of life and can allow curative resection.

In order to evaluate the cost and the income generated by the management of these patients, we studied a cohort of patients operated in a private hospital participating in the public hospital system. The population was divided into two groups of patients undergoing mandibular or nonmandibular reconstruction, as nonmandibular reconstructions have been found to be associated with a lower failure rate. Data from the Foch hospital analytical accounting system since 2006 were used to evaluate the costs related to management of these patients in a polyvalent adult head and neck surgery department. Risk factors for complications were identified by studying prognostic factors.

Material and methods

Material

This retrospective study was based on 52 patients managed in the Head and Neck Surgery department of Foch Hospital in Suresnes for microanastomosed free flap reconstruction of the facial bones between September 2003 and June 2009. Table 1 summarizes the characteristics of the study population in each patient group (mandibular/nonmandibular reconstruction).

Malignant tumours involving the mandible were squamous cell carcinomas classified as T4 N0 (50%), T4N1 (17%), T4 N2 (22%), T4 N3 (11%). Two tumours were reclassified as pT2 and one tumour was reclassified as pT3 after histological examination of the resection specimen.

Reconstruction concerned the symphysis menti in 44% of cases (12/27), the lateral mandible in 41% of cases (11/27) and was subtotal in 15% of cases (4/27).

Malignant tumours concerning other facial bones were more heterogeneous: one maxillary mucosal melanoma, one adenocarcinoma of lacrimal ducts, two osteosarcomas (one maxillary, one orbital), two maxillo-orbital squamous cell carcinomas, one undifferentiated carcinoma and one parotid sebaceous carcinoma with mastoid invasion, one orbital basal cell carcinoma. Benign tumours consisted of two cases of orbitofrontal neurofibromatosis type I, one meningioma with orbital extension, one cemento-ossifying fibroma of the maxilla. Secondary reconstructions concerned sequelae of tumour resection in the maxilla (four cases), ethmoid (one case), and temporal bones (one case) and sequelae of avulsion of the maxilla due to a motor vehicle accident (one case). Table 2 summarizes the indications for free flap reconstruction in this series.

Methods

A search for prognostic factors was performed on patients undergoing mandibular reconstruction. This study was not

Table 1 Study population.

	Mandibular reconstruction	Nonmandibular reconstruction
Sample size	27	25
Gender	6 F, 21 M	18 F, 7 M
Mean age (range)	59 (38—79)	40 (15—66)
Smoking	25 (93%)	6 (24%)
Alcoholism	20 (74%)	0
Cardiovascular history	12 (44%)	0
Diabetes	1 (4%)	0
Arterial disease of lower limbs	12 (44%)	0
History of radiotherapy	8 (30%)	11 (44%)
History of chemotherapy	8 (30%)	7 (28%)
History of surgery on the operated site	8 (30%)	18 (76%)
Surgery for malignant tumour	18 (67%)	9 (36%)
Surgery for benign tumour	0	4 (16%)
Surgery for sequelae/malformation	2 (7%)	12 (48%)
Surgery for radiation osteonecrosis	7 (26%)	0
Mean operating time	8 h (7—12)	10 h (5—14)
Median length of stay	22 days (13—112)	12 days (6—20)
Transfusion (number of units of packed cells)	22 (81%) 3.6 units (1—30)	10 (40%) 2.7 units (1—8)
Medical complications	8 (30%)	3 (12%)
Surgical complications	6 (22%)	5 (20%)
Stay in intensive care	2 (2 days, 5 days)	1 (2 days)

Table 2 Indications for reconstruction.

	Mandibular reconstruction	Nonmandibular reconstruction
Malignant tumour	18	9
Benign tumour	0	4
Radiation osteonecrosis	7	0
Secondary reconstruction	1	7
Malformation/facial paralysis	1	5

Table 3 Types of flaps used.

	Mandibular reconstruction	Nonmandibular reconstruction
Fibula	24	0
Scapula (+ serratus anterior or latissimus dorsi- or periscapular paddle)	3	6
Forearm	0	2
Latissimus dorsi	0	9 muscle flap, 1 musculocutaneous flap
Rectus abdomini	0	2
Pectoralis minor	0	4
Serratus anterior		0 1

relevant to nonmandibular reconstructions, for which the length of stay was homogeneous in this series and for which few significant complications were observed.

Risk factors for prolonged length of stay and delayed resumption of oral feeding were investigated by Wilcoxon's test for quantitative data (age) and by Fisher's exact test for binary covariables (gender, history, etc.). For this comparison, patients were divided into two groups: length of hospital stay $\leq$ 30 days versus > 30 days; time to oral feeding $\leq$ 30 days versus > 30 days. This 30-day period corresponds to the upper limit of a ''standard'' length of hospital stay and was defined in the study protocol. Kaplan-Meier survival analysis was also performed for both groups, among patients operated for malignant tumour.

Analytical accounting data for the years 2006 and 2007 obtained from the financial department of Foch Hospital, a private hospital participating in the public hospital system, were used to evaluate costs related to hospitalisation and the operations performed on these patients [4].

The Medical Informatics physician provided data concerning the sums paid to the hospital.

A senior surgeon retrospectively reviewed the patients' charts with the Medical Informatics physician to try to optimize the choice of Diagnosis-Related Group (DRG).

Results

The mean operating time was 8 hours (range: 7—12 hours) for mandibular reconstructions and 10 hours for nonmandibular reconstructions (range: 5—14 hours). Blood transfusion was required in 22 of the 27 mandibular reconstructions (81%) and 10 of the 25 nonmandibular reconstructions (40%). A mean of three units of packed cells were transfused per patient with a median of two units per patient (range: 0—30 units). Patients stayed overnight in the recovery ward. Three patients had to be transferred to the intensive care unit for 2 days, 2 days and 5 days, respectively. Table 3 illustrates the types of flaps used.

Surgical complications were observed in six patients (22%) undergoing mandibular reconstructions, requiring redo surgery: two patients with postoperative haematoma, four patients with free flap ischaemia requiring a second flap. Seven of the 27 patients (26%) developed a purulent discharge that did not require surgical revision. Medical complications were observed in eight patients (30%): one death in the intensive care unit following cardiorespiratory arrest, three cases of pneumonia, one case of pulmonary embolism, one case of essential thrombocytosis, one local infection of the implantable chamber, one case of decompensated diabetes.

Surgical complications were observed in five patients (20%) undergoing nonmandibular reconstructions and required redo surgery (three haematomas, one case of ischaemia, one cerebrospinal fluid leak). None of the flaps were lost. In addition to the two cases of local purulent discharge and cerebrospinal fluid leak not requiring surgical revision, medical complications were observed in another three patients (12%): one case of pulmonary embolism, one case of severe sepsis secondary to central catheter infection, one case of postoperative brachial plexus palsy.

Patients undergoing mandibular reconstruction

The median time to resumption of oral feeding was 15 days (range: 10—400 days). Postoperative radiotherapy was performed in 7% of patients (2/27) and concurrent chemoradiotherapy was performed in 48% of patients (13/27). Thirty-three per cent of patients were rehospitalised for a cause related to the reconstruction: oral fistula, plate removal, salvage segmental mandibulectomy, second cancer. The mean length of these second stays was 9 days (range: 2—19 days). The mean overall length of hospital stay was 29 days (range: 13—112 days) with a median of 22 days. The median time to resumption of oral feeding was 15 days (range: 10—399 days) and the mean follow-up was 16 months (range: 1—52 months).

The study of prognostic factors revealed a significant negative impact of cardiovascular risk factors (hypertension, heart disease) on the length of hospital stay ($P = 0.02$). In contrast, the length of hospital stay was significantly shorter following reconstruction for purely lateral mandibular defects ($P = 0.04$). No correlation was demonstrated between the other factors (age, gender, alcohol, smoking, history of surgery and chemoradiotherapy, type of reconstruction, reason for reconstruction) and length of hospital stay and no correlation was demonstrated between any of these factors and time to resumption of oral feeding. The mean 4-year survival rate was 68% for patients operated for a malignant tumour and 90% for patients operated for other lesions.

For patients undergoing nonmandibular reconstruction, the mean 5-year survival rate was 20% for patients operated for a malignant tumour and 100% for patients operated for other lesions.

Medicoeconomic analysis

The department's total expenditure was 5,161,890 € in 2006 and 5,458,418 € in 2007. This expenditure included medical and nonmedical salaries, medical costs (pharmaceutical products, blood products, dressings, etc.), general running costs, technical services costs, and hospital accommodation costs.

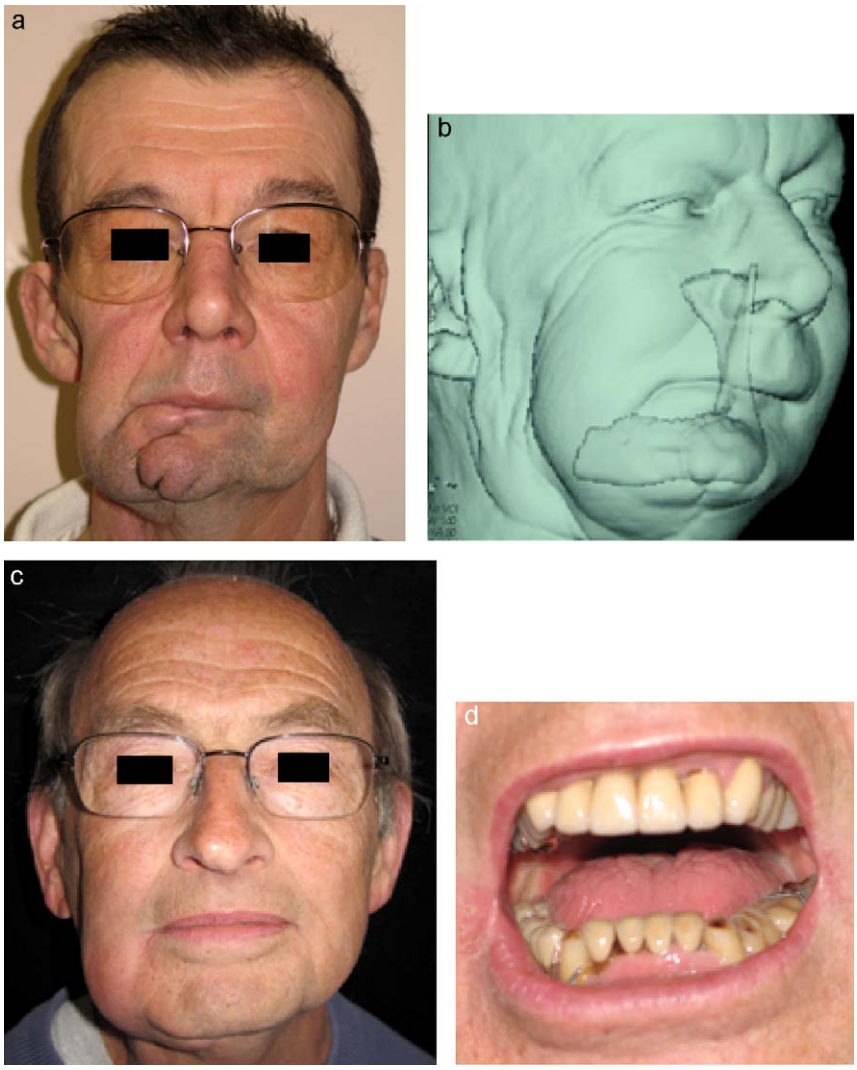

Figure 1 a, b: resection of oropharyngeal cancer without mandibular reconstruction; c, d: with mandibular reconstruction.

The mean cost of hospitalisation in the head and neck surgery department was 1,094 € per day in 2006 and 1,086 € per day in 2007. Annual income in 2006, based on 4719 days of hospitalisation, was 4,915,441 €. Annual income in 2007, based on 5027 days of hospitalisation was 5,184,131 €. The department's annual deficit was 246,449 € in 2006 and 274,287 € in 2007.

Over this period, income generated by 407 days of hospitalisation for mandibular reconstruction and a few ''satellite'' hospitalisations was 545 €/day for hospitalisation comprising a free flap (mean income per stay: 14,755 €) and 868 €/day for ''satellite'' hospitalisations related to other procedures.

Over the same period, income generated by 244 days of hospitalisations for free flap nonmandibular reconstruction surgery and ''satellite'' hospitalisations was 526 €/day for hospitalisation comprising a free flap (mean income per stay: 6882 €) and 818 €/day for ''satellite'' hospitalisations related to other procedures. After review of procedure ratings by a senior surgeon, in order to optimize the choice of DRG for these patients, the mean income received by the hospital would have been 7327 € per stay, i.e. a 6% improvement.

Over the same period, the mean income of all days of hospitalisation in the ENT department was 1036 €/day for a mean daily cost of 1090 €/day.

Discussion

Head and neck microsurgical reconstructions are underrated by the French case-mix based rating procedure. This highly technical surgery requires long operating room occupation times, as most procedures require an operating room and two surgical teams for an entire day. Microsurgical reconstruction surgery requires years of training, a long learning curve and complete investment of the nursing team. The costs of microsurgical reconstruction published in other studies are situated around 16,000 dollars [5—8]. The absolute necessity of these techniques in the management of head and neck cancers and their sequelae has been largely demonstrated [3]. Our 68% 4-year survival rate on stage T4 cancers of the oral cavity shows that this surgery is effective on the cancer, as

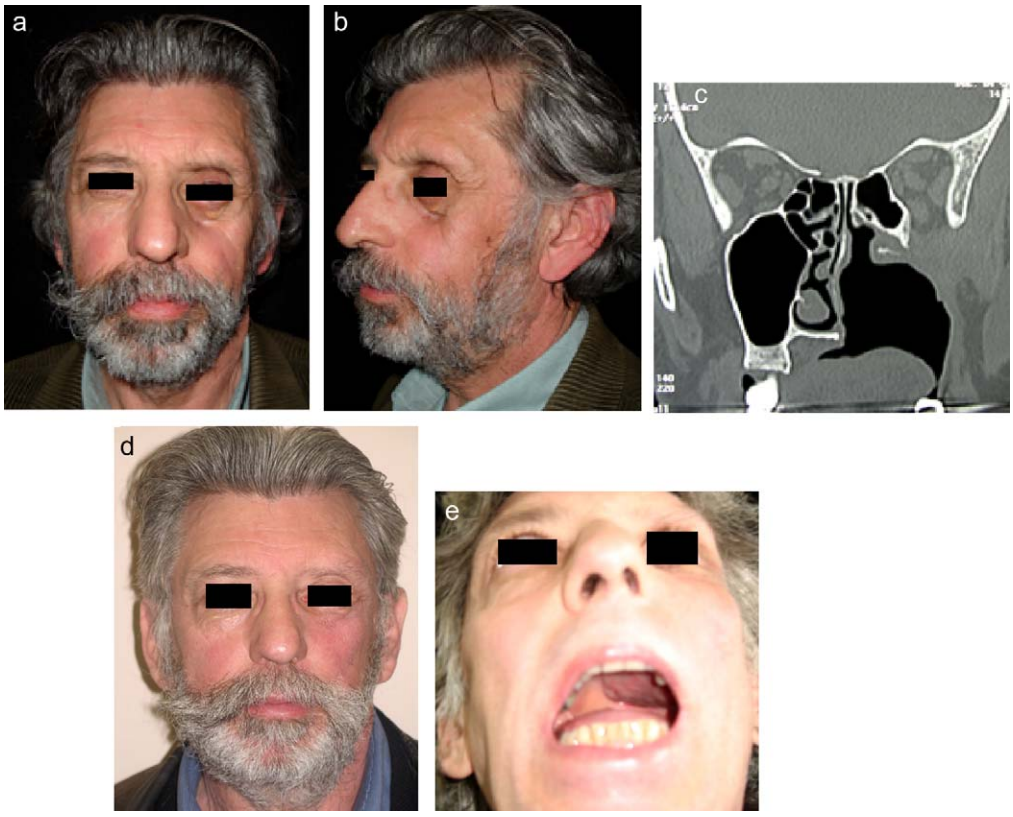

Figure 2 a, b, c: before reconstruction; d, e: after secondary reconstruction by latissimus dorsi + tip of scapula + orbital grafts (orbital floor and margins).

also confirmed by other series [1,9—11]. However, the reconstructive surgery procedure itself is not taken into account in the classification of the patient to a specific DRG group.

The funding received by the hospital depends exclusively on the type of resection, together with any associated medical complications, which may increase the income generated by the patient's stay. Mandibular resection approach for oropharyngeal cancer without reconstruction, performed by one surgeon in 4 hours would generate the same income for the hospital as the same operation followed by reconstruction, which would require two surgical teams working for 8 hours. The first operation leaves the patient with a laterally deviated mandible, making mastication impossible, and the second operation provides the patient with a symmetrical face and preserved mastication (Fig. 1).

Under-rating of this type of surgery is even more marked for nonmandibular reconstructions: maxillectomy not followed by reconstruction leaves major cosmetic and functional sequelae: impaction of the cheekbone, orbital dystrophy, need to use a palatine occlusion prosthesis to eat and speak, etc. However, after reconstruction, such patients have a normal face and quality of life (Fig. 2).

The ''satellite'' stays often necessary to complete the result of reconstruction or to remove fixation material only very partially compensate for this low rating.

Secondary reconstructions of primarily nonreconstructed defects are also very poorly rated, as the patient is classified in various DRGs, one of the lowest rated of which is that of patients hospitalised for skin graft.

In order to limit major financial losses that could prevent continuation of these essential surgical procedures, the rating of these procedures must be optimized by including the patient's comorbidities and any complications (haematoma, delayed healing with wound dehiscence, etc.). The classifying procedure must be chosen carefully, e.g. mandibulectomy (codes LBFA.) classifies the patient in a much lower rated DRG than segmental mandibulectomy (code HAFA004), while the procedure is technically almost identical.

Close collaboration with the hospital's Medical Informatics physician is essential to classify patients in the most appropriate DRG. Review of the patients' charts by a senior surgeon would have improved the rating by 6% for nonmandibular reconstructions in this series. The length of stay must be reduced to a minimum by rapidly organizing rehabilitation in a specialized institution, when accessible, which is not often the case in France.

This study shows that patients with a history of cardiovascular disease have a higher risk of a prolonged length of stay. An appropriate cardiovascular assessment must therefore be performed during the preoperative workup. Doppler ultrasound of neck vessels was systematically performed, CT angiography of the lower limbs was performed prior to harvesting the fibula and a cardiological consultation was performed in patients with cardiovascular risk factors. The nutritional status, although not reported in this study, is probably also an important factor impacting on the

postoperative course. The main risk factor for complications of this surgery is probably the septic nature of the oral cavity and the dependent nature of the floor of the mouth. The postoperative course was globally more favourable for lateral defects of the mandible than for anterior defect, as reconstruction is less exposed to saliva and oral fistulae.

Conclusion

The codes PZMA004 (Repair by cutaneous, fascial, fasciocutaneous or subcutaneous, muscle, musculocutaneous, musculotendinous or bone free flap with vascular anastomoses), PZMA005 (Repair by osteocutaneous musculoskeletal or osteomusculocutaneous free flap, with vascular anastomoses), HEMA006 (Reconstruction of the oesophagus by gastrointestinal free flap with vascular anastomoses), HPMA002 (Repair of a defect by greater omentum free flap with vascular anastomoses) are not ''classifying procedures'' corresponding to adequately rated DRGs, although they require a long surgical procedure by a double team, surveillance in the recovery ward or intensive care unit and can be associated with severe complications. To ensure the future of these surgical techniques, the free flap performed during the same hospital stay must be considered to be a level 4 associated medical complication, which would result in significantly higher funding, closer to real costs.

Finally, these procedures are performed by highly specialized teams, which should receive *Mission d'intérêt général et d'aide à la contractualisation* (MIGAC) special budget funding in order to ensure the future of these techniques in France.

Conflict of interest statement

None.

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