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Microvascular reconstructive surgery of the head and neck

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The favoured method of reconstruction for large head and neck defects after resection for cancer is microvascular free flaps. Success rates in excess of 95% can be achieved in major centers. Especially pharyngeal defects are very challenging to reconstruct functionally. For the major subsites within the pharynx we describe our preferred method, mainly based on the application of the thin pliable radial forearm flap. However, in some instances a bulky flap, such as the rectus abdominis flap is needed. For reconstruction of the pharyngo-esophagus the tubed forearm flap is currently most often used. Functional results and quality of life are very acceptable to good after these extensive procedures. Harvesting of the radial forearm flap yields mild but distinct morbidity and warrants addressing.

Chirurgia rekonstrukcyjna po operacjach w obrębie głowy i szyi z zastosowaniem technik mikronaczyniowych

Podczas rekonstrukcji rozległych ubytków, spowodowanych usunięciem nowotworów okolic głowy i szyi, postępowaniem z wyboru jest przenoszenie wolnych płatów z zastosowaniem technik mikrochirurgicznych. Liczące się ośrodki osiągają odsetek powyżej 95% operacji uwieńczonych sukcesem. Największy problem w zakresie zachowania czynności stanowią rekonstrukcje okolic gardła. W przypadku większości tych rekonstrukcji preferujemy w naszym ośrodk, cienkie płaty z przedramienia, oparte na tętnicy promieniowej. Niemniej, w wybranych przypadkach, skuteczniejsze okazują sie być bardziej rozbudowane płaty, na przykład z mięśnia prostego brzucha. Celem rekonstrukcji ubytków w obrębie gardła i przełyku w chwili obecnej najczęściej stosuje się zwinięty płat z przedramienia - wyniki oceniane są jako bardzo zadowalające do dobrych, zarówno w zakresie oceny czynnościowej, jak i jakości życia chorych. Pobranie płata promieniowego z przedramienia wiąże się z niezbyt poważnymi, niemniej znaczącymi powikłaniami, zostało zatem potraktowane jako niezależne zagadnienie.

Key words: head and neck cancer, microvascular reconstructive surgery, the radial forearm free flap
Słowa kluczowe: nowotwory głowy i szyi, mikrochirurgia, rekonstrukcyja, płat promieniowy z przedramienia

Introduction

Reconstructive objectives after major head and neck surgery include adequate wound healing, optimal residual function (*i.e.*, swallowing and speech), restoration of sensation and bulk replacement when necessary. With the techniques available it is not feasible to replace excised tissues with tissue that mimics its complex movements and changes in shape. We must therefore attempt to maximise the patient's possibility for compensatory mechanisms. The most appropriate means to achieve this is currently through the application of free flaps, *i.e.*, transfer of suitable distant tissue to the recipient site by means of microvascular anastomoses [1-3]. Our recent experience in selecting donor vessels in free flap reconstruction with a total of 370 free flaps performed in the last 72 months, include for arterial anastomosis the facial artery in 64% of cases, the remainder being the superior thyroid (25%), transverse cervical (10%), and superficial temporal arteries (1%). For venous anastomosis the internal jugular was by far the most commonly used donor vein (85%), followed by the facial (14%) and superficial temporal veins (1%) [4]. Almost always we preferred a single venous anastomosis end-to-side to the donor vein. In this article we present our clinical experience and research on free flap reconstruction in head and neck surgery, focussing on pharyngeal reconstruction, functional outcome, quality of life and donor site morbidity.

Pharyngeal reconstruction at VU University Medical Center

From this series 210 soft tissue flaps were performed at our center in the period 1996-2001. There were 151 (72%) males and 59 female (28%) with a mean age of 60.6 years. One hundred and eighty-six flaps were fasciocutaneous (89%), while 24 were myocutaneous (11%).

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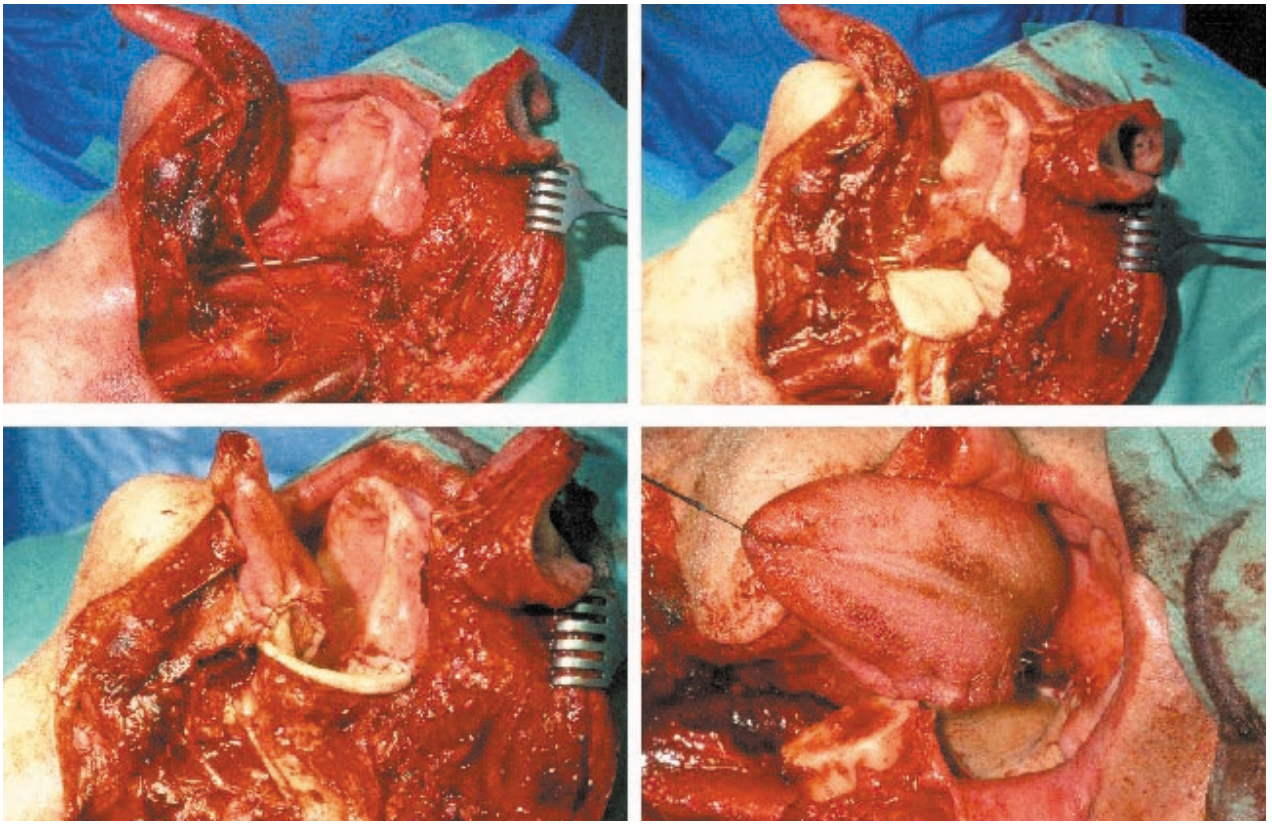

Figure 1. Composite resection cancer of left oropharynx reconstructed with free flap

Reexploration was necessary in 8.4% of cases yielding a total success rate of 96.5%. Defects were localised in the oral cavity (n=69; 33%), the pharynx (n=118; 56%), maxilla/ skull base (n=13; 6%), and skin/lip (n=10; 5%). The pharyngeal defects were further classified as oropharyngeal (n=101) and pharyngo-esophageal (n=17). Forty-seven flaps were performed for defects of the tonsil, 35 were localised at the base-of-tongue, 13 at the soft palate, and 6 at the posterior wall. Figure 1 depicts a typical example of a left lateral oropharyngeal defect reconstructed with a free forearm flap.

Soft palate reconstruction following oropharyngeal resection warrants special attention and is best performed by a pliable fasciocutaneous flap (*e.g.*, radial forearm free flap) with either no connection of its free border with the posterior pharyngeal wall, the creation of an adhesion between flap and posterior wall (Figure 2) or the use of a posterior pharyngeal flap [5, 6]. In this era of successful chemoradiation schemes total glossectomy is performed less frequently as primary treatment for squamous cell carcinoma of the base-of-tongue. In cases of recurrent disease or in non-squamous cancers (*e.g.*, salivary gland carcinomas) this procedure, however, offers the only chance of cure to the patients. As has been shown previously, total glossectomy with laryngeal preservation is feasible in selected patients and yields a reasonable quality of life (Figure 3) [7]. Preservation of the supraglottis and the continuity of the mandible greatly aids rehabilitation. Compared to previous experience, present day reconstruction by free myocutaneous flaps (*e.g.*, rectus abdominis) has markedly reduced post-

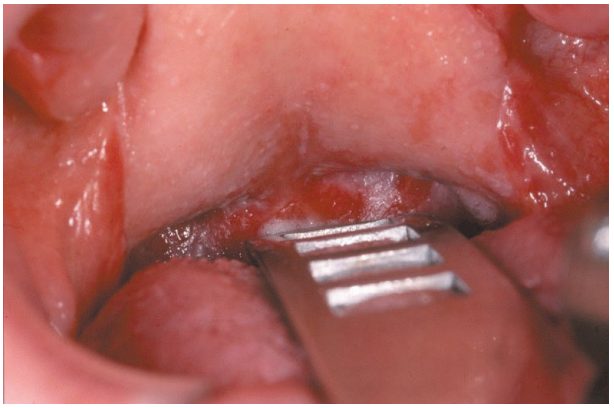

Figure 2. Total soft palate reconstruction with free forearm flap after creating an adhesion between posterior free border of the flap and the posterior pharyngeal wall

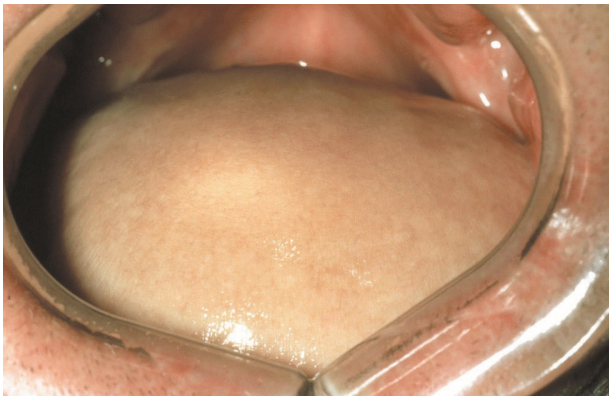

Figure 3. Total glossectomy with laryngeal suspension and reconstruction with free rectus abdominis flap

operative complications rate [8]. Posterior wall carcinoma, which has a poor prognosis with radiotherapy only, is often treated with combined modality treatment, including surgery. Reconstruction of the posterior pharyngeal wall poses a problem, since this area is vital in swallowing and a too bulky flap can easily induce untreatable aspiration and a poor quality of life. Even with thin free flap reconstruction only about one third of the patients will achieve sufficient oral intake without additional PEG-tube feeding (Figure 4) [9].

Microvascular methods to replace the pharyngo-esophagus are the jejunum graft and tubed fasciocutaneous flaps, such as the forearm or the lateral thigh flap (Figure 5). While we have used the jejunum flap in the past, we currently favour the forearm flap mainly because of two reasons [10]. First, it seems logical not to add

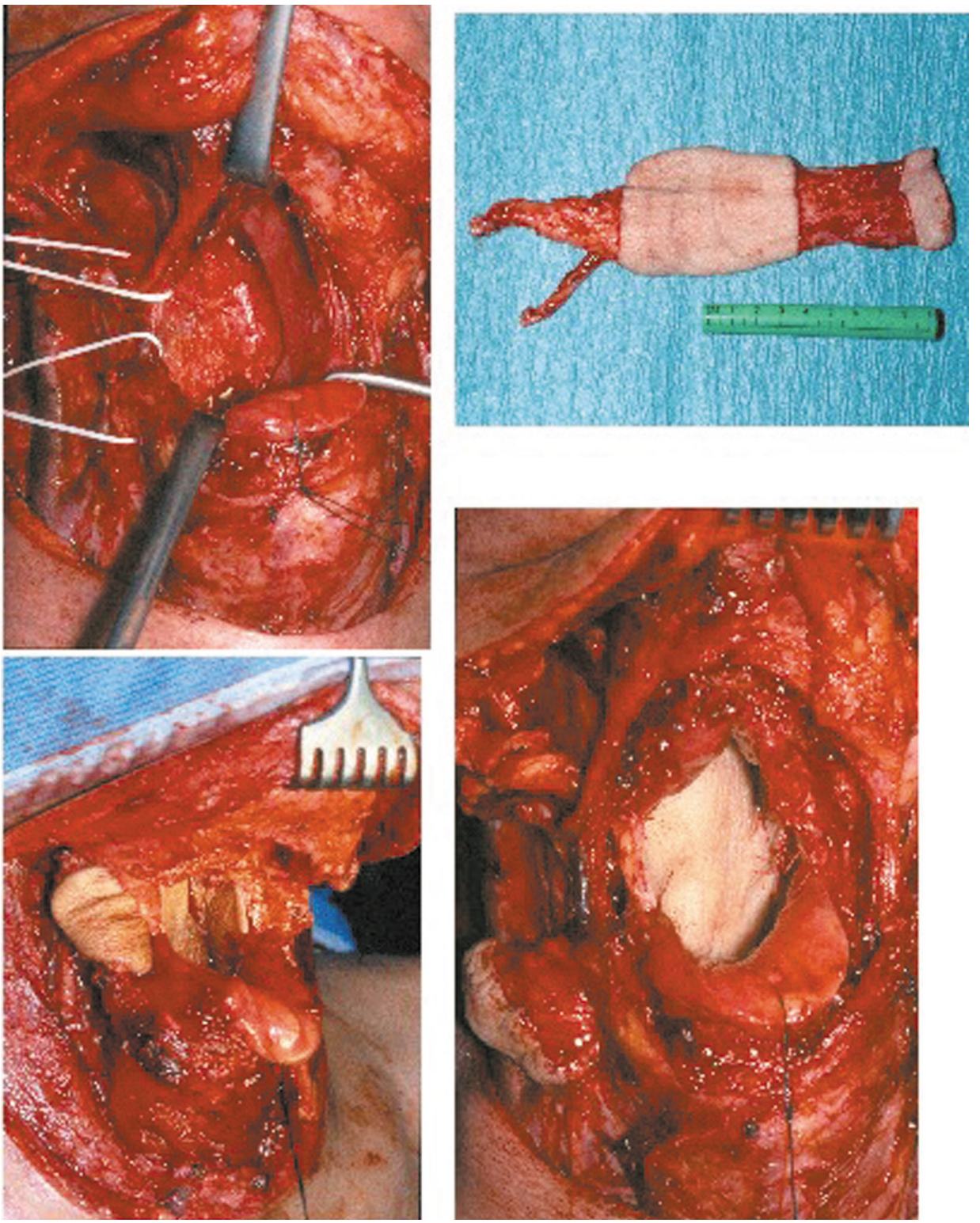

Figure 4. Suprahyoid approach of a posterior pharyngeal wall carcinoma reconstructed with a free forearm flap

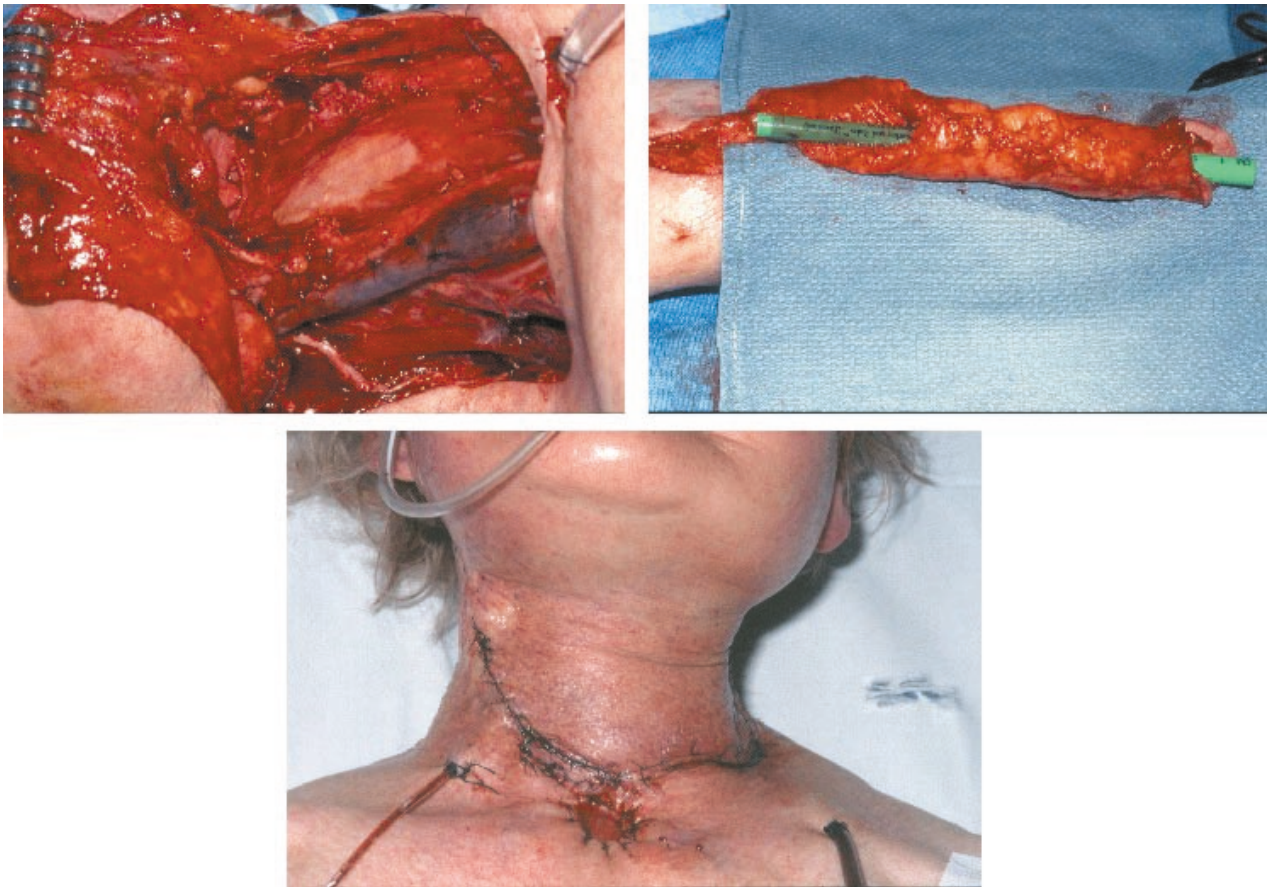

Figure 5. Female patient, previously treated by neck irradiation for TBC, developed a T3N0 hypopharynx carcinoma. Total laryngopharyngectomy and neck dissection was performed and reconstruction took place by a tubed radial forearm flap with monitor

abdominal surgery with its own potential complications to an already lengthy major procedure in these often debilitated group of patients. Second, in our experience the functional results in terms of swallowing and (prosthetic) speech seem to be better after cutaneous flap reconstructions as compared to enteric tissue [11-14]. An additional argument is that ample forearm skin is available and offers the potential for a bi-paddled flap when simultaneous defects of pharyngo-esophagus and skin of the neck need to be reconstructed (Figure 6).

Functional outcome and quality of life

Non-traditional outcome parameters are becoming increasingly important when end results of major head and neck surgery and reconstruction are reported [15, 16]. Information about both objective functioning and the patient's perspective is, however, still somewhat scarce [17-21].

To evaluate these factors we performed an in depth descriptive retrospective analysis of 33 long-term surviving patients after treatment for a T2-4N0-2c oropharynx carcinoma by a composite resection, reconstruction with or without radiotherapy. The patients were at least 15 months after treatment with a mean follow-up of 21 months. Swallowing was assessed by videofluoroscopy. Evaluation was performed by using a videorecorder with frame-by-frame and slow motion capabilities. A multi-disciplinary panel scored factors that included oral bolus propulsion, premature leakage of contrast, nasopharyngeal leakage, tongue base contact to posterior wall, laryngeal elevation, vallecula and pyriform sinus residue, laryngeal penetration and aspiration (Figure 7). Scoring was on a multiple point scale ranging from severely limited to normal. A total score was thus assigned to the swallowing act ranging from 0 to 100. Oral functions were measured by means of tongue mobility testing on a 0-100 scale. Speech was assessed by speech rate, articulation, and intelligibility. Speech rate was measured by counting words and syllables of a standardized text read by the patient in one minute. Articulation was assessed by a test of consonants in the Dutch language. Assessment of results was performed by the collective rating of a team of two speech-therapists listening to recorded words and sentences spoken by the patient. They scored articulation errors on a 5-point scale (in four predominant classes: plosives, fricatives, glides and nasals). A total score on a 0-100 scale was thus calculated. A "reverse speech intelligibility test" has been developed on the basis of experience with testing hearing-impaired patients. A panel of naive listeners with normal hearing listens to sentences spoken by the patients. These sentences contained different consonants of the Dutch language. The sentences were presented to the listener in quiet and noise. The members of the panel were asked to reproduce the sentences in different sound levels. In this

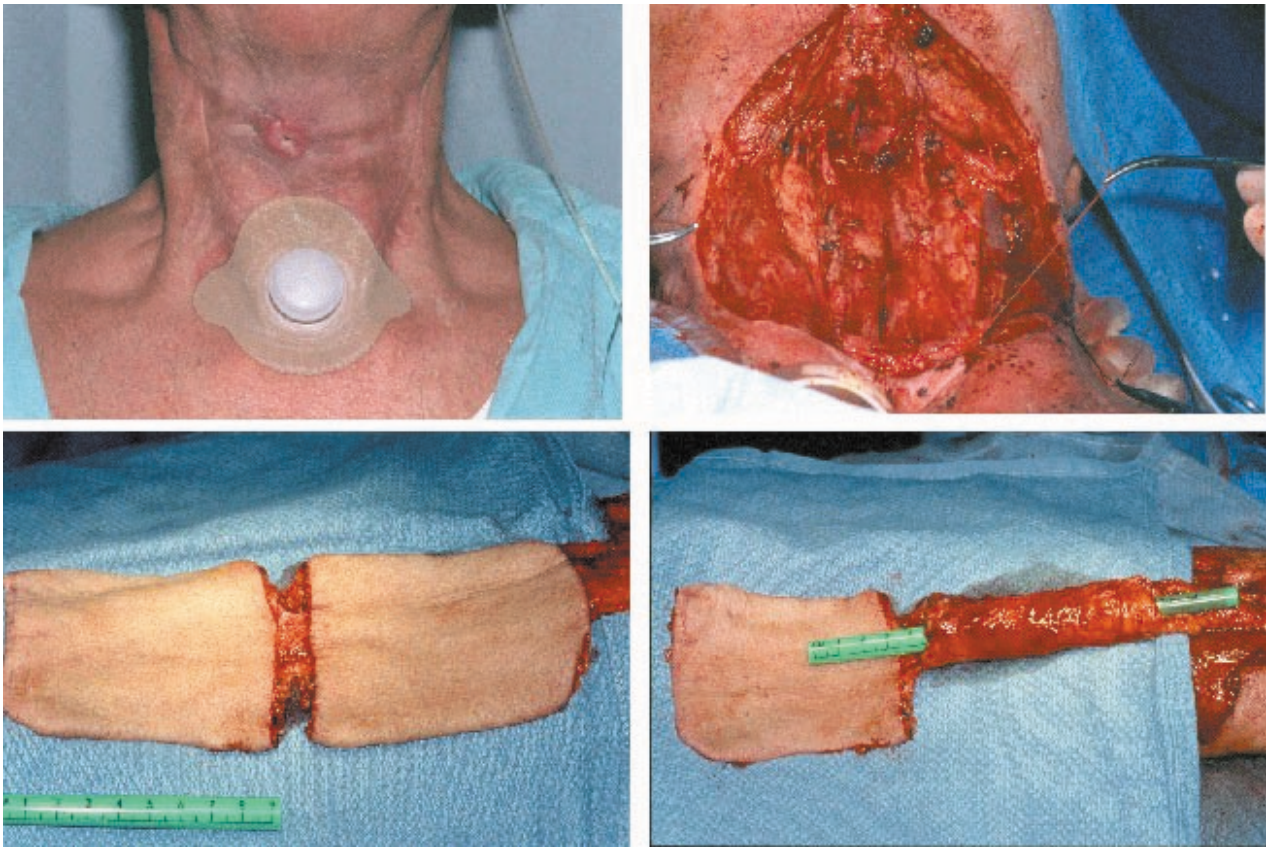

Figure 6. Male patient with neopharyngeal recurrence with skin involvement after radiotherapy and total laryngecomy. Neopharyngectomy and resection of cervical skin was performed and reconstructed with a double-paddle a tubed radial forearm flap with one paddle made into a tube

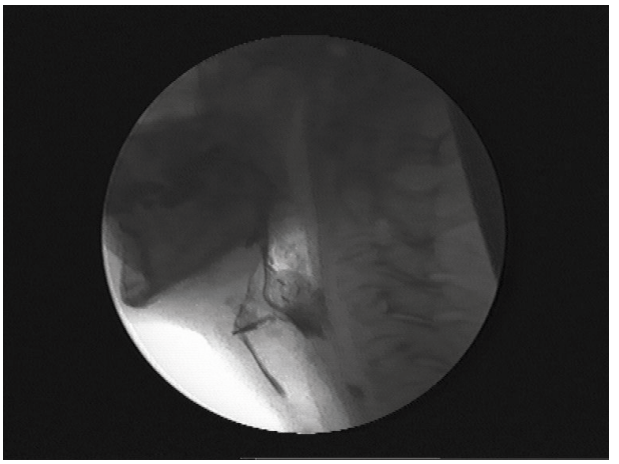

Figure 7. Videofluoroscopic image showing (silent) aspiration

way the speech-reception threshold (SRT), the sound-pressure level of speech for which 50% of sentences are correctly understood by listeners, was measured for each patient in quiet and in noise of 60 dB. These SRT values were thus compared with SRT values for normal speaking-hearing situations, the difference being the intelligibility loss for a given patient.

The functional and psychological status as experienced by the patient was assessed by administering the European Organization on the Research and Treatment of Cancer (EORTC) quality-of-life questionnaire. The EORTC QLQ C30 supplemented by the specific head and neck module (H&N 35) were administered. The core questionnaire consists of 30 items assessing 5 functional scales (physical, role, cognitive, emotional and social), 3 symptom scales (fatigue, pain, nausea and vomiting), a global health status/ quality-of-life scale, perceived financial impact of the disease and a number of single items assessing additional symptoms (dyspnea, sleep disturbance, loss of appetite, constipation, and diarrhea). The H&N 35 is directed to factors such as pain in the head and neck region and the use of pain killers, deglutition, upper aerodigestive tract capacities (saliva, taste, dentures, trismus, smell), social functioning (eating in public, having a conversation, being in public places, contact with relatives and friends, physical contact, and sexually), weight gain or loss, and nutritional supplements. The questionnaires were completed by the patient together with the interviewer. Ratings of the different questions were transformed into scores on a scale of 0-100 according to the scoring manual. Pearson's test was used to correlate objective and subjective findings.

Results were calculated for the total group of patients and median scores per item are shown. Due to small numbers it was not possible to compare subsite and type of flap. Table I shows the functional results as compared to normal values and table II the problem scores related to swallowing and speech and global quality of life. There was a good correlation between the videofluoroscopy score (especially aspiration) and the swallowing problem score from the H&N 35 questionnaire

Table I. Results of functional testing of 33 patients after surgery with or without postoperative radiotherapy for advanced oropharyngeal carcinoma

	Median	Normal Value
Videofluoroscopy score	69	100
Tongue mobility score	69	100
Acticulation score	83	100
Speech rate (w/min)	146	205
Intelligibility/quiet (dB)	29	18
Intelligibility/noise	+4	-5

Table II. Quality of life in 33 patients after surgery with or without postoperative radiotherapy for advanced oropharyngeal carcinoma. Only items concerning swallowing and speech problems and the global quality of life score are shown

	Median	Ideal score
Swallowing problems	25	0
Speech problems	11	0
Quality of life (global)	83	100

(R=-0.60; p= 0.0002) and between tongue mobility and the swallowing problem score (R = 0.60; p= 0.0003). Articulation (R= -0.57; p= 0.0006) and tongue mobility (R= -0.39; p= 0.0260) as assessed objectively also correlated with the speech problem score from the H&N 35 questionnaire. No correlation was found between intelligibility and speech rate with the speech problem score.

From these preliminary results we can deduct a generally reasonable functioning relating in a very acceptable quality of life albeit with several distinct problems to cope with. Patients are good judges of their own functioning in terms of swallowing and articulation, whereas this was not the case for intelligibility.

Donor site morbidity of the free forearm flap

In view of the high success rate and good outcome of free flap reconstruction current research focuses more on diminishing donor site problems after these procedures [22]. Although few patients actually complain spontaneously after harvesting of a forearm flap we decided to look into this problem and to evaluate a consecutive series of 37 patients who visited the outpatients clinic and who were treated more than one year previously and who were willing to subject themselves to tests and questionnaire [23].

Patients underwent harvesting of the flap under tourniquet and simultaneously with the ablative procedure whenever possible. The non-dominant forearm was chosen as the donor arm in 29 patients, and the dominant arm was the donor arm in the remaining eight. Seventeen patients were smokers, 16 patients had stopped their habit and four were non-smokers. All patients underwent Allen's occlusion test to rule out inadequate blood supply from the ulnar artery. The fasciocutaneous flap was elevated including the radial artery with its concomitant veins, the cephalic vein or another major skin vein. Closure was achieved with a split thickness (0.4-0.6 mm) skin graft in 30, an ulnar flap in six and a full thickness skin graft in one patient (Figure 8). A vacuum drain was left behind for maximum two days and the arm was kept in a splint cast for seven days. All tests were performed on both arms (operated and non-operated

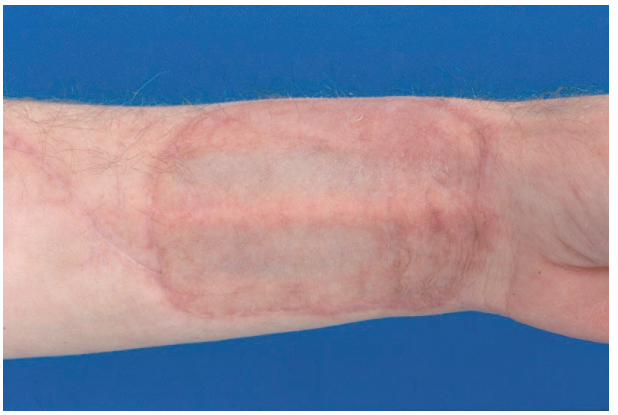

Figure 8. Long term aspect of volar forearm after harvest of a free forearm flap and closure by a split thickness skin graft

sides). Skin temperature was assessed by application of temperature probe connected to a digital multimeter to the skin surface with the hand at room temperature. Both hands were independently submersed in iced water for two minutes. The skin temperature was measured on digits one and five at one, two and three minutes using the same device mentioned earlier. Range of wrist movement was measured for flexion, extension, ulnar deviation, radial deviation, pronation and supination. Grip and pinch strength were measured. Parametric and non-parametric tests were used.

Statistic differences were found only for resting temperature in Dig. I of the operated arm (0.69° C lower) and in Dig V (0.31° C lower). Cold tolerance and wrist mobility were unchanged. The results of the questionnaire showed 9 patients that reported slightly impaired function, 14 could not wear their watch or bracelet, 17 complained of numbness, 5 of soreness, 5 of itching, 6 of cold intolerance, 5 of bad cosmetic appearance and 9 expressed the opinion that they were insufficiently counselled.

Although there does not seem to be a significant morbidity after using a forearm flap there is room for improvement and the search for comparable reliable, thin and pliable flaps with even less donor sequelae continues.

Conclusions

Contrary to some opinions progress has been made during last decade as to the surgical treatment of patients with advanced squamous cell carcinoma of the head and neck, especially in the realm of reconstructive procedures to retain as much as possible patient's quality of life. It is

also possible to perform resections that were previously impossible. Ongoing research into longitudinal assessment of quality of life and function after major surgery and reconstruction with a free flap will yield significant information in the near future.

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