Eur J Plast Surg (2000) 23:1–6

EURAPS PAPER

G. Noever · R. Feurer

The free radial forearm flap for reconstruction of facial defects in noma patients

Received: 25 May 1999 / Accepted: 6 June 1999

Abstract Within a 2-year period ten patients aged 5–22 years were treated for facial sequelae of noma. In six cases free radial forearm flaps were used, combined with local and regional flaps. The indications were defects located in the midface and perioral area. There were no free or regional flap losses in this series. The aesthetic and functional results were appreciated by the patients and there were no functional problems related to the donor area because a suprafascial flap dissection technique was used. In our experience the free radial forearm flap is a valuable option for facial reconstruction in NOMA cases. The advantages include: (1) A very long and large calibre pedicle; (2) thin and pliable flaps of variable size and configuration; (3) the possibility of single stage reconstruction in selected cases. The disadvantages include the not always ideal colour match, both in black patients and in white, and the unsightly donor area which, however, has never led to functional problems.

Key words Free radial forearm flap · Facial reconstruction · Noma

Introduction

Noma, or cancrum oris, is a disease which has been known since antiquity. The term 'NOMA' is of Greek origin and means 'to devour'. Hippocrates, Galen and Celsus knew of this disease, but the first accurate and complete description was provided by Tourdes in 1848 [20]. He described a gangrenous infection of the oral cavity occurring mainly in small children with poor physical condition. Starting at the level of the oral mucosa it will rapidly spread to the perioral soft tissues and the facial skeleton.

More recent descriptions of the disease and its treatment were given by Tempest [19], Durrani [7], Adolph [1], Montandon [12, 13] and Dean [4]. Up until the 1960s, noma was not uncommon in Afghanistan, Vietnam and the Philippines. In Germany and Japan it was seen in prisoner-of-war camps during World War II [1], whereas nowadays it is virtually unknown in Western Europe and North America. There still are, however, many cases in certain areas in Africa. The exact incidence and mortality are not known. The youngest patient described by Eisele [8] was 7 weeks old while the oldest was aged 84 years.

The pathogenesis of this disease is still a matter of debate. Various bacteria such as *Borrelia vincentis*, *Bacillus fusiformis*, *Staphylococcus aureus* and non-haemolytic Streptococci were isolated from infected patients [8]. Other associated agents include endotoxin-producing *Fusobacterium necrophorum* and *Pseudomonas aeruginosa* [7]. Contributing factors are bad nutrient state, vitamin deficiency and poor oral hygiene. The disease may also accompany systemic conditions such as eruptive fever, measles [1], scarlet fever, typhus, diphtheria, syphilis and tuberculosis. Rare cases have been described in immunodeficient states, agranulocytosis, following chemotherapy and in AIDS patients [8, 9].

The condition begins with small, red, painful pustules of the oral mucosa, and rapidly spreads to the molar region. The mucosa becomes swollen and develops necrotic areas; following this the underlying skeleton is affected. The whole infected area turns into a malodourous black necrotic mass with bacterial superinfection. The necrosis can extend to the upper and lower lip, hard and soft palate, nose and orbital cavity, and even to the temporal, masseteric and platysmal muscles. Rare locations are the scalp, neck, shoulder, lower extremity and the genital area [19].

If antibiotic therapy is not available, 75% of the affected patients will die [19]. The use of penicillin, the first-choice antibiotic, can decrease the mortality rate to

Presented at the 10th Annual Meeting of the European Association of Plastic Surgeons (EURAPS), Madrid, Spain, May 20–22, 1999

G. Noever (✉) · R. Feurer
Department of Plastic and Reconstructive Surgery,
Cantonal Hospital, CH-5000 Aarau, Switzerland
e-mail: georg.noever@ksa.ch
Tel.: +41-62-838-4731, Fax: +41-62-838-4743

15%. Other primary treatment principles are fluid resuscitation and improvement of the nutritional status. Following adequate debridement of necrotic tissue, the defects close spontaneously by scar contraction leading to disfiguring and functionally disabling situations. Primary reconstruction is rarely performed because of the lack of available plastic surgical expertise.

One of the most significant functional problems is trismus [1, 15], a temporomandibular ankylosis, in most cases of extra-articular origin. Following tissue loss in the perioral area, scar contraction, tissue fibrosis and muscle contraction can lead to complete mandibular constriction with ensuing problems of food intake, loss of speech and constant salivation. Attempts have been made to categorise the defects following noma, allowing for systematic therapeutic approaches to restore form and function in these often difficult clinical settings [11]. However, there is no universally accepted system of de-

Fig. 1 A 5-year-old girl with loss of the upper lip, both commissures, adjacent cheek, part of the palate and most of the nose. **A** Frontal view. **B** Profile view. **C** Palate and alveolus reconstruction with rib grafts. **D** Radial forearm flap for the upper lip. **E**, **F** End result after nasal reconstruction with expanded forehead flap

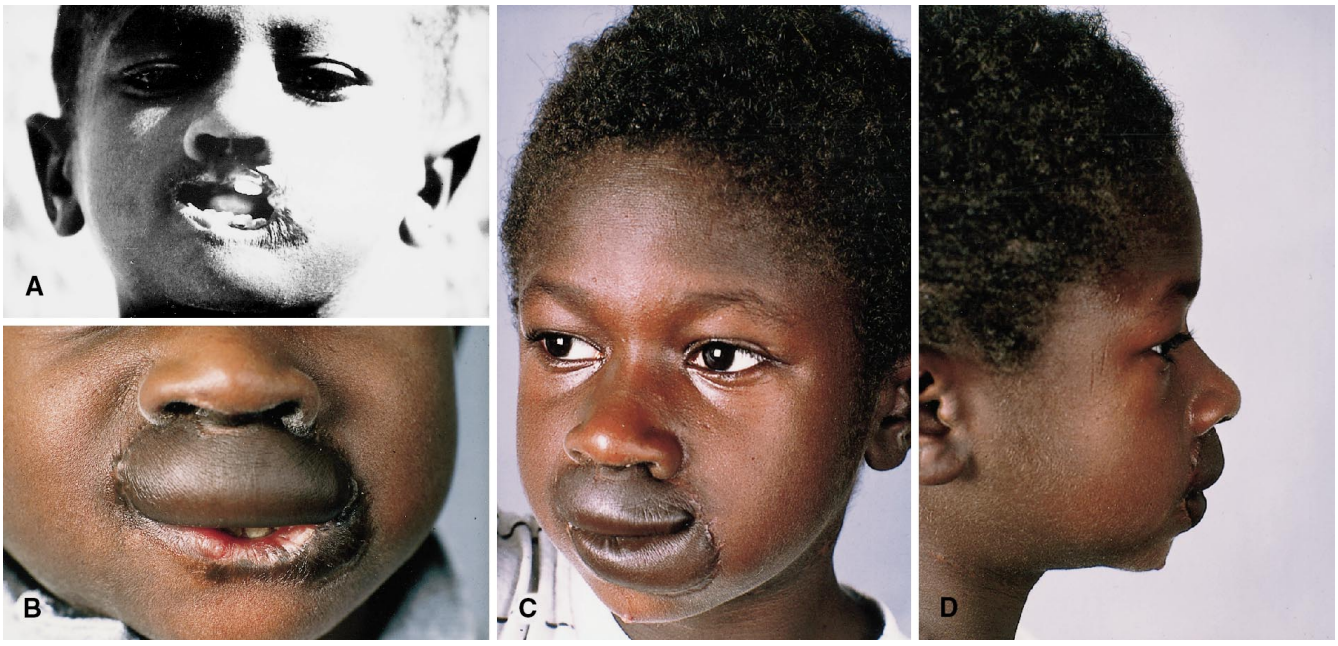

Fig. 2 An 8-year-old boy with defects of the upper and lower lip and columella. **A** Preoperative view. **B** After upper lip and columella reconstruction with free radial forearm flap. **C**, **D** Final result with upper and lower lip reconstruction

fect categories and treatment modalities, thus a wide variety of flaps and procedures are used.

Patients treated in local hospitals in Africa are generally reconstructed with local flaps and pedicled upper arm flaps, as well as frontal and scalp flaps [6, 19]. Dean [4] reports having used cervicofacial flaps in Nigeria. African patients treated in America by the same group were reconstructed using free scapular and radial forearm flaps. Adolph [1], a general surgeon in Niger, preferred deltopectoral and local flaps. Montandon [12,13] favoured and extended the use of the pedicled epicranial sandwich flap and pedicled latissimus dorsi flaps. Banic [2] reconstructed facial defects with free osteocutaneous scapular and iliac crest flaps. In our own experience pedicled latissimus dorsi flaps worked well for facial reconstruction in the lower third of the face; however, these will not reach the midface. In this situation the defects in the perioral and midface region were reconstructed with the free radial forearm flap. This flap has been used successfully in oral and facial reconstruction after tumour resection [16, 17].

Materials and methods

Between 1996 and 1998 ten patients with post-noma facial defects were treated. Ages ranged from 5 to 22 years, eight were children. The defects included the upper and lower lip, hard palate, maxilla, nose and central face. Three cases were reconstructed using latissimus dorsi myocutaneous pedicled flaps, in combination with temporalis muscle and temporalis fascia flaps. On one occasion a cervicofacial flap was needed. However, for all midfacial defects and for the perioral region in six cases free radial forearm flaps were used, in four cases combined with local rotation flaps and in three cases combined with forehead flaps for nasal reconstruction (Table 2). All forearm flaps were raised using the suprafascial dissection technique described by Lutz and Wei [10]. The donor areas were grafted and had no functional problems. All free flaps were anastomosed to branches of the external carotid artery and accompanying veins enabling the anastomoses to always be performed in a non- fibrotic area far from the originally infected and fibrosed tissues. There were no flap losses and the functional and aesthetic results were satisfactory. The number of operations ranged from one to seven per patient, depending on the complexity of the reconstruction.

Table 1 Classification of noma defects according to Montandon [10]

1. Localized lip, commissure or cheek defect that normally can be lined by local tissues and covered by a single flap
2. Upper lip and nose amputation
3. Lower lip and mandible amputation
4. Large defects involving the lips, the cheek, the palate, the maxillary bone, the floor of the orbit, etc.

Clinical cases

Case 1

A 5-year-old girl was admitted in 1997 for reconstruction of the midface following noma at the age of 2 years. There was complete loss of the upper lip, both oral commissures and adjacent buccal areas, the anterior part of the hard palate and the alveolus, as well as the distal part of the nose (Fig. 1). Her general state of health was satisfactory.

The reconstruction started with an expander implantation into the frontal area to provide a large forehead flap for nasal reconstruction. After adequate expansion of the forehead was achieved, the perioral scar tissue was debrided. The anterior part of the palate and the alveolus were reconstructed with rib grafts stabilized by miniplates. A free radial forearm flap was used to cover the rib grafts intraorally and reconstruct the upper lip. The remaining nasal skin was turned over to line the inner aspect of the nose, and the forehead flap was used to reconstruct the nasal and columellar skin. A rib graft fixed to the glabellar area with a miniplate provided a satisfactory nasal bridgeline and tip.


A
B
C
D
E
F
G
H

Table 2 Noma patients treated with free radial forearm flaps

Patient	Age	Defect	Reconstruction	Number of operations
D.G.	5	Upper lip, palate, nose	Radial forearm flap, rib grafts, forehead flap	3
Y.S.	8	Upper and lower lip	Two radial forearm flaps, galea had partial necrosis	3
I.G.	5	Partial upper lip, palate, maxilla, nose, orbital floor	Maxillary osteotomy, cranial bone graft, free radial forearm flap, local flaps, tibial bone graft, forehead flap	7
A.A.	6	Partial nose, cheek	Free radial forearm flap, local flaps	1
O.I.	22	Cheek, commissure, trismus	Free radial forearm flap, local flaps	2
I.K.	10	Upper lip, palate, nose	Free radial forearm flap, rib grafts, forehead flap	3

Case 2

An 8-year-old boy from Niger developed a noma lesion at the age of 3 years resulting in perioral scarring and restriction of mouth opening following the loss of the upper and lower lip and columella (Fig. 2). The first step in reconstruction of the upper lip and the columella was performed with a free radial forearm flap connected to the external carotid vessels. At the same operation an epicranial flap pedicled on the superficial temporal vessels was prelaminated with a full thickness skin graft for lower lip reconstruction.

After 3 weeks the lower lip was reconstructed with the prelaminated flap, which initially necrosed. In a third operation the lower lip was further reconstructed with a free radial forearm flap. After another 6 weeks, both forearm flaps were thinned to give better contour resulting in an acceptable functional and aesthetic result.

Case 3

A 5-year-old boy from Niger developed noma at the age 2 years. This led to a massive necrosis of the central face including the nose, upper lip, anterior part of the hard palate with a cleft from the palate into the left orbit (Fig. 3). The reconstructive procedure began with the implantation of a skin expander under the frontal skin to provide a large forehead flap. The left maxilla was then osteotomized and bone grafted to reconstruct the cleft and the hard palate. Intraoral soft tissue cover was achieved with a modified von Langenbeck procedure as in cleft palate reconstruction. External soft tissue cover was supplied by transplantation of a free radial forearm flap anastomosed to branches of the external carotid vessels. The upper lip was reconstructed using the existing lip remnants and a swingslide plasty from the buccal area.

The next step in nasal reconstruction was to raise the radial forearm flap and fold it on itself to provide inner lining of the nose. Bony support was provided by a tibial bone graft fixed to the glabellar area with a miniplate. The soft tissue cover, nasal dorsum and columella were created from the expanded forehead flap and small stents were used to prevent nostril collapse and keep the nasal airway open. A good functional and aesthetic result was achieved after a total of seven operations over a period of 9 months.

Fig. 3 A 5-year-old boy with a defect of the midface, nose, palate, left orbit and part of the upper lip. **A, B** Preoperative view. **C** Preoperative X-ray. **D** Midface reconstruction by maxillary osteotomy, cranial bone grafts, free radial forearm flap and local cheek flap. **E** Postoperative X-ray. **F** Inner lining of the nose reconstructed by infolding of the radial forearm flap, suspended to a tibial bone graft, expanded forehead flap for nasal soft tissues. **G, H** Final result, frontal and profile views

Discussion

Until about 15 years ago the horrific sequelae of noma were virtually unknown in the western world. Publications were limited in numbers, and thus there was no discussion about the methods and results of treatment. Tempest [19] reported on a series of 300 children suffering from the sequelae of NOMA and described the use of forehead flaps based on the superficial temporal vessels for facial reconstruction. However, his favourite technique was a two-stage procedure transferring upper arm skin to the face as the donor area could be easily concealed, which is not true of the forehead flap. For very large defects he recommended a combined abdominothoracic and upper arm flap.

Durrani [7] from Karachi preferred the forehead flap treating ten patients and reporting a high rate of complications using the upper arm flap. Treatment approaches changed dramatically with the advent of microsurgery, which allowed the number of operative steps to be reduced in the treatment of these complex defects. Banic [2] used a free osteocutaneous scapular flap and a free osteocutaneous iliac crest flap in two noma patients. Dean [4] used free scapular flaps and free radial forearm flaps in a number of African patients treated in America. Montandon et al. [12] presented a classification of facial defects caused by noma (Table 1) and outlined principles of treatment according to this classification. He favoured and extended the use and versatility of the epicranial sandwich flaps based on the superficial temporal vessels. In reconstruction of the lower third of the face classical reconstructive procedures such as the deltopectoral [1] and latissimus dorsi flap [12] have been used successfully.

These pedicled flaps, however, cannot reach the central face and thus other options have to be considered. The free radial forearm flap, originally described by Song [18], was used by Sadove [16] and Serletti [17] in reconstruction of the lower lip after resection of malignant tumours. It has one of the longest available vascular pedicles, thus the microsurgical anastomoses can be performed far away from the infected and fibrosed tissues,

preferentially in the neck area. This avoids the need for venous grafts. The flap is thin and pliable, and the size will generally be sufficient for facial defects. Its pliability allows for simultaneous restoration of internal lining and external skin cover by partial de-epithelialization and infolding of the flap. Del Bene [5] described this technique in the closure of a post-noma defect similar to that of a patient we treated in the same way.

The donor area is often regarded as the main drawback of this flap, but, in our series, healing of the split thickness grafts has not been a problem as the flaps were harvested in the suprafascial manner proposed by Lutz and Wei [10]. Taking into account the ethnic and cultural background of our patients where scars are not a major concern, the advantages of this flap far outweighed the potential disadvantages. There were no postoperative problems related to the microsurgical part of the procedure and all forearm flaps survived completely. In three cases thinning operations were performed to improve contour without compromising flap circulation. It was interesting to see that the colour match was also a problem in these patients. All flaps not harvested in the cervical or facial area were darker than the original skin although this did not seem to disturb the patients.

Conclusion

A series of six patients with facial defects following noma is presented. They were reconstructed using seven free radial forearm flaps, partly in combination with local and regional flaps. The defect location was in the midface and the perioral region. There were no complications related to the microsurgical procedures and the functional and aesthetic results were satisfying. The free radial forearm flap has become our favourite flap for midface soft tissue reconstruction because of its ease of harvesting, the long vascular pedicle, and size and pliability of the flap.

As with all flaps procured from distant areas other than from the head and neck, colour match to the face is not ideal. There were no functional problems related to the donor site. Patients with deformity resulting from noma sequelae may present varying reconstructive problems but generally require some kind of flap solution. The free radial forearm flap is recommended in those cases where pedicled flaps will not provide adequate coverage, especially in the central facial area.

References

1. Adolph M, Yugueros P, Woods JE (1996) NOMA: a review. Ann Plast Surg 37:657
2. Banic A (1996) Erste Erfahrungen bei der Behandlung von Noma-Kindern am Inselspital. Inselbote 3:26
3. Dawson J (1945) Cancrum oris. Br Dent J 79:151
4. Dean JA, Magee W (1997) One stage reconstruction for defects caused by cancrum oris (NOMA). Ann Plast Surg 38:29
5. Del Bene M, Amadei F, Petrolati M, Rovati LV, Confalonieri PL, Caronni EP (1999) Radial forearm fasciocutaneous free flap as a solution of NOMA. Microsurgery 19:3
6. Dijkstra R, Abate-Green C, Yoo MC (1986) NOMA. Eur J Plast Surg 9:46
7. Durrani K (1973) Surgical repair of defects from NOMA. Plast Reconstr Surg 52:629
8. Eisele DW, Inglis AF, Richardson AA (1990) NOMA and NOMA neonatorum. Ear Nose Throat J 69:119
9. Giovanni M (1989) Gangrenous stomatitis in a child with AIDS. Lancet 2:1400
10. Lutz BS, Wei FC, Chang SC, Yang KH, Chen ICH (1999) Donor site morbidity after suprafascial elevation of the radial forearm flap: a prospective study in 95 consecutive cases. Plast Reconstr Surg 103:132
11. Marck KW, de Bruijn HP, Schmid F, Meixner I, van Wijhe M, van Poppelen RHM (1998) NOMA: the Sokoto approach. Eur J Plast Surg 21:277
12. Montandon D, Lehmann C, Chami N (1991) The surgical treatment of NOMA. Plast Reconstr Surg 87:76
13. Montandon D, Gumener R, Pittet B (1996) The sandwich epicranial flaps. Plast Reconstr Surg 97:302
14. Mühlbauer W, Herndl E, Stock W (1982) The forearm flap. Plast Reconstr Surg 70:336
15. Oluwasanmi JO, Lagundoye SB, Akinyemi OO (1973) Ankylosis of the mandible from Cancrum oris. Plast Reconstr Surg 57:342
16. Sadove R, Luce EA, McGrath PC (1991) Reconstruction of the lower lip and chin with the composite radial forearm–palmaris longus free flap. Plast Reconstr Surg 88:209
17. Serletti JM, Tavin E, Moran SL, Coniglio JU (1997) Total lower lip reconstruction with a sensate composite radial forearm–palmaris longus free flap and a tongue flap. Plast Reconstr Surg 99:559
18. Song A (1982) The forearm flap. Discussion. Plast Reconstr Surg 70:343
19. Tempest MN (1966) Cancrum oris. Br J Surg 53:949
20. Tourdes J (1848) Thesis, Strasbourg; cited by Tempest MN, Cancrum oris. Br J Surg (1966) 53:949
21. Winkler JR, Murray PA, Hammerle C (1989) Gangrenous stomatitis in AIDS. Lancet 8:108