Diploma Thesis

Donor Site Morbidity and Quality of Life After Microvascular Head and Neck Reconstruction with a Chimeric, Thoracodorsal, Perforator-Scapular Flap Based on the Angular Artery (TDAP-Scap-aa flap)

submitted by

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Graz, 28th January 2022

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List of Abbreviations

% .... Percent
CBCT .... Cone Beam Computed Tomography
cm .... Centimetres
DASH .... Disabilities of Arm, Shoulder and Hand
DCIA .... Deep circumflex iliac artery
DPR .... Dental Panoramic Radiograph
eg .... *exempli gratia*
etc. .... *et cetera*
Fig. .... Figure
HCL .... Hemimandibular (H), Central (C), and Lateral (L)
HNSCC .... Head and Neck Squamous Cell Carcinoma
MEDOCS .... Styrian Medical-Nursing Documentation and Communication Network
n .... Number
ORN .... Osteoradionecrosis
p .... Significance
pTNM .... Pathological: Tumour, Lymph Node Metastasis, Distant Metastasis, Status of Resection
SD/± .... Standard Deviation
SF-36 .... Short Form Health 36
TDAP flap .... Thoracodorsal Artery Perforator Flap
TDAP-Scap flap Thoracodorsal, Perforator-Scapular Flap Based on the Circumflex Scapular Artery
TDAP-Scap-aa flap .... Thoracodorsal, Perforator-Scapular Flap Based on the Angular Artery
U.S. .... United States

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Zusammenfassung

Hintergrund: Ausgedehnte Defekte im Kopf-Halsbereich erfordern zur Rekonstruktion häufig eine ausgedehnte mikrovaskuläre Lappenplastik. In solchen Fällen, in denen sowohl das Hart- als auch das Weichgewebe betroffen ist, können freie Transplantate wie der neu beschriebene thorakodorsale Perforator-Scapular-Lappen auf Basis der *arteria angularis* (TDAP-Scap-aa-Transplantat) eine vielversprechende Behandlungsoption zur Rekonstruktion von Defekten im Kopf-Hals-Bereich sein. Jedoch wurden sowohl die mit dieser neuen Rekonstruktionstechnik einhergehende Morbidität der Entnahmestelle als auch die postoperative Lebensqualität bisher noch nicht untersucht.

Material und Methoden: In dieser retrospektiven Studie wurden über einen Fünfjahreszeitraum (2016–2020) die postoperative Lebensqualität und die Morbidität der Entnahmestelle mithilfe des standardisierten SF-36- und DASH-Fragebögens evaluiert. Das Patientenkollektiv (n = 20) wurde zirka ein Jahr (10–14 Monate) nach der Rekonstruktion (TDAP-Scap-aa-Transplantat) der ausgedehnten Kopf-Hals Defekte untersucht. Die Ergebnisse wurden mit bereits erhobenen und etablierten Normdaten der gesunden, deutschen beziehungsweise U.S.-amerikanischen Bevölkerung verglichen (gesunde Kontrollgruppe). Die demografischen Daten der eingeschlossenen Patient*innen sowie die Operationsdetails wurden durch eine elektronische Überprüfung der Krankenakten in Erfahrung gebracht.

Ergebnisse: Die mikrovaskulären freien Transplante bestanden im Durschnitt aus 7,8 ± 2,1 cm Knochen und 86 ± 49,8 cm^2 Weichgewebe. An der Spenderstelle des Transplantats (Subscapularregion) wurde eine nur geringgradige Morbidität mit einem mittleren DASH-Score von 21,74 ± 7,3 Punkten festgestellt. Dieses Ergebnis kann der zweitniedrigsten Stufe in einer fünfstufigen Bewertung der Morbidität zugeordnet werden (sehr leicht bis sehr schwer). Beim Vergleich der postoperativen Lebensqualität der Patient*innen mit der gesunden deutschen Normpopulation lagen die beobachten SF-36-Werte in fast allen Unterkategorien im oberen Drittel (> 66 %) der Normwerte.

Schlussfolgerung: Der tatsächliche Einfluss einer Entnahme eines mikrovaskulären Transplantats auf die individuelle Lebensqualität kann aufgrund verschiedener Störfaktoren, die in der klinischen Routine oder im präoperativen Umfeld auftreten können, nicht mit Sicherheit beurteilt werden. Jedoch deuten die geringe Morbidität an der Entnahmestelle und die beobachtete Lebensqualität, die im oberen Drittel der gesunden Normpopulation liegt, auf eine nur geringe postoperative Beeinträchtigung bei der

Verwendung des neuen TDAP-Scap-aa-Rekonstruktionslappens hin. Dieses Transplantat eignet sich somit für die Behandlung von fortgeschrittenen kombinierten Weich- und Hartgewebedefekten im Kopf- und Halsbereich.

Abstract

Background: Extensive defects in the head and neck area often require the use of advanced free flap reconstruction techniques. In such cases, where both soft and hard tissues are part of the defect, the thoracodorsal perforator-scapular free flap based on the angular artery (TDAP-Scap-aa flap) has recently been described as a novel microvascular treatment option in the head and neck reconstruction. However, postoperative donor site morbidity and/or quality of life assessments associated with this novel reconstruction technique have not been investigated yet.

Materials and Methods: In this retrospective study, the quality of life and donor site morbidity were postoperatively evaluated over a five-year period (2016–2020) using the standardized SF-36 and the DASH questionnaires in 20 selected cases (n = 20). The postoperative quality of life and donor site morbidity were assessed approximately one year (10–14 months) after extensive head and neck defect reconstruction with the TDAP-Scap-aa flap. The acquired results were compared with the already established data of the healthy German and U.S. norm population (healthy control group). Furthermore, an electronic clinical chart review of the included patients was conducted to collect the demographic data and the harvesting details of the surgery.

Results: On average, the harvested microvascular free flaps consisted of 7,8 ± 2,1 cm bone and 86 ± 49,8 cm^2 soft tissue components. At the donor site (subscapular region) only mild morbidity was observed postoperatively with a mean DASH score of 21,74 ± 7,3 points. This result can be assigned to the second lowest tier in the five-tier category rating of donor site morbidity (very mild to very severe). When comparing the patients' postoperative quality of life to the healthy German norm population, the observed SF-36 values were within the upper third (> 66 %) of the established norm values in almost all quality of life subcategories.

Conclusions: The actual impact of microvascular flap harvest on the patients' quality of life is hardly assessable due to various confounders that occur or may occur within the clinical routine or the preoperative environment. However, the mild donor site morbidity and the observed quality of life located in the upper third of the healthy norm population indicates only minor postoperative impairment when using the novel TDAP-Scap-aa free flap. This flap is therefore suitable for the treatment of advanced combined soft and hard tissue head and neck defects.

1 Introduction

1.1 Reconstruction in Head and Neck Surgery

Surgery is the first choice for head and neck cancer treatment, although numerous modality treatments, including radiation and chemotherapy, are available in parallel. The applied surgical procedures can lead to an extensive range of defects, especially in advanced oral cancer resections (Gupta *et al*., 2016). These kinds of extended defects are also common after the treatment of advanced osteoradionecrosis (Rice et al., 2015). Due to the close anatomical proximity of the soft and the hard tissue, multiple components such as the oral mucosa, parts of the tongue, the floor of the mouth, the mandible, or the maxilla are regularly part of the ablation. The reconstruction of these three-dimensional oromandibular defects, especially in cases where advanced head and neck cancer or osteoradionecrosis and the resulting extensive surgical procedure have been present, is a challenging part of the daily clinical routine and a life-changing experience for every patient (Dolderer *et al*., 2010). The surgical procedures often lead to serious psychologically and physically disabling consequences for the patients. In planning and performing the plastic reconstruction, attention should not only be paid to aesthetics but also to functional aspects to ensure an adequate postoperative outcome and patient satisfaction. Numerous functions such as ingestion, articulation, facial expression, and maintenance of a sufficient airway must be considered. However, when considering all important aspects in head and neck defect reconstruction, the long-term preservation of the patient's quality of life is the principal treatment goal in every case. This confirms that modern state of the art treatment is not focused on mere survival but on rehabilitation (Gupta *et al*., 2016).

1.1.1 Types/Classification of Defects in the Head and Neck Area

1.1.1.1 Mandibular Defects and Their Classification

Oromandibular defect reconstruction is more difficult in cases that either need large osseous defects to treat or include the condyle. Moreover, different defect types need different reconstruction methods to obtain a good aesthetic outcome and function. Unfortunately, a lack of consensus about the classification in the past has led to a situation where different reconstruction options could not be compared. Until 2016, the most cited mandibular classification systems had been presented by Urken *et al.* and Jewer *et al.* (Jewer *et al*., 1989, Urken *et al*., 1991). The nomenclature by Urken *et al.* is purely descriptive and does not include the varying difficulties with cosmetic restoration (C=condyle, R=ramus, B=body, S=symphysis, SH= hemisymphysis/ stops at the midline) (Fig. 1).

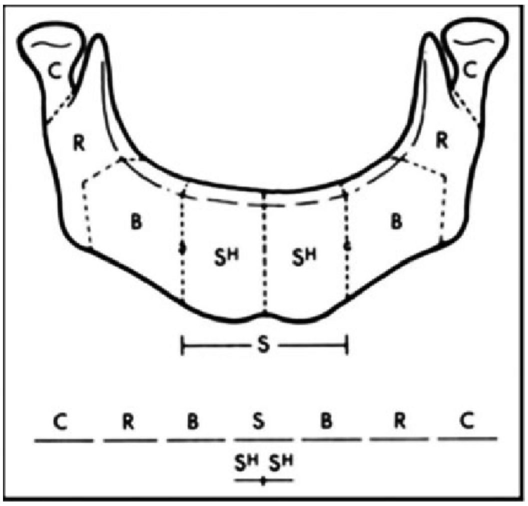

Figure 1: Urken's classification of mandibular defects (Urken et al., 1991)

Although the complexity of oromandibular reconstruction was considered by Jewer *et al.*, significant clinical differences, such as those between a complete hemimandibulectomy and a lateral body defect, cannot be distinguished by the HCL classification (Type H: lateral defect of any length, including the condyle, but not crossing the midline. Type L: defect of the same type without the condyle. Type C: defect consisting of the entire central segment containing four incisors and two canines. Type LC: lateral angle-to-bilateral canines. Type LCL: lateral defect-to-bilateral angle defect) (Fig. 2) (Jewer *et al*., 1989).

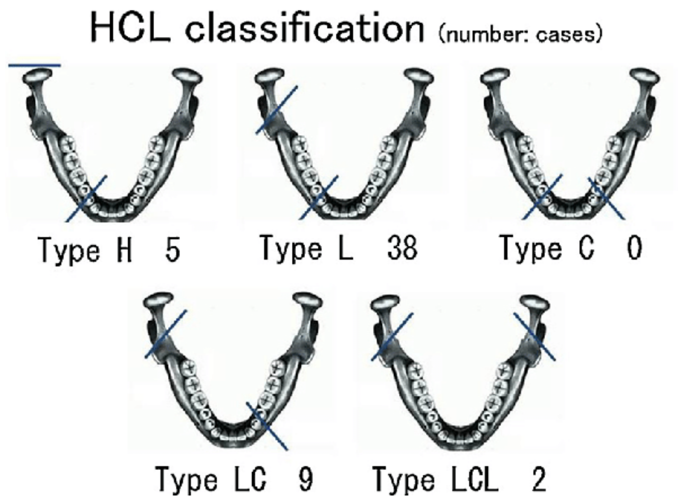

Figure 2: HCL classification of mandibular defects (Jewer et al., 1989)

In 2016, Brown *et al.* introduced a new nomenclature system for mandibular defects to achieve better comparability between the osseous defect, the flap selection, the osteotomies needed and the complications. This classification system is based on the premise that the mandible has four corners: two horizontal corners centred at the canine teeth on each side and two vertical corners that make the angles of the mandible. These corners represent the changing points of the mandibular shape, which also demonstrate the possible need to mould a graft with osteotomies. Based on these corners, defects can be divided into four general classes (Class I – Class IV). Lateral defects, which include neither the ipsilateral canine nor the condyle, belong to Class I. Class II stands for hemimandibulectomy, which includes removing the ipsilateral but not contralateral canine or condyle. Class III defects include both canines but neither angle. Extensive ablations of the mandible, which take in both horizontal corners and at least one angle, are classified as Class IV defects. There is a distinct classification for defects that require the condyle to be part of the resection (Class Ic, IIc, IVc) because in such cases retaining occlusion and mandibular form is exceptionally challenging (Fig. 3) (Brown *et al*., 2016).

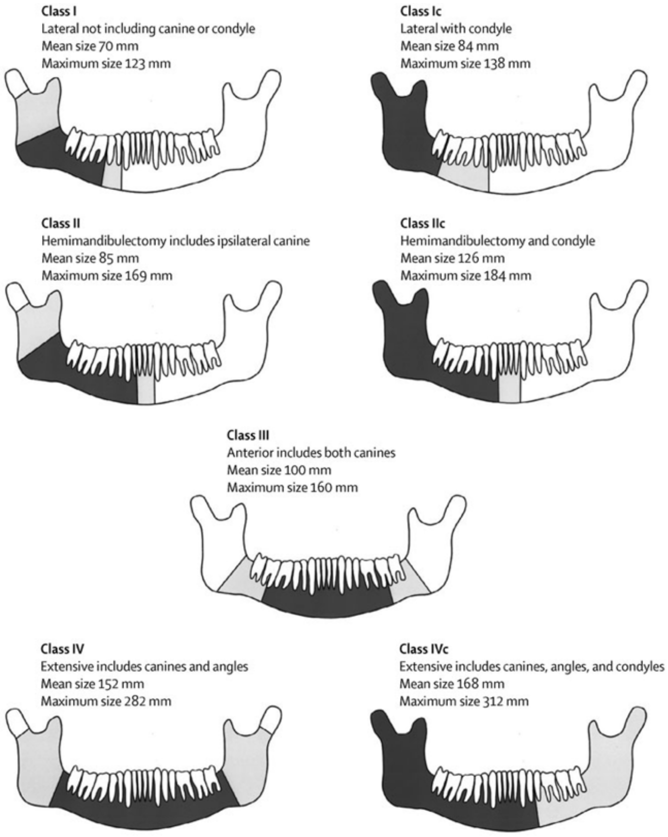

Figure 3: Brown's classification of mandibular defects (Brown et al., 2016)

Although the extent of required soft tissue plays a crucial role in flap selection, all these classifications only describe the osseous defect morphology. In 2018, Cordeiro *et al.* proposed a mandibular defect nomenclature system which places equivalent importance on the quality and the location of the soft-tissue ablation. Furthermore, this system offers surgeons a management algorithm created through the experience of 202 reconstruction cases. The system includes a roman numeral, a subdividing letter, and in some cases, an accessory number. The roman numeral (I – III) characterises the type of bony defect (I: anterior [= any defect that includes the symphysis]; II, hemimandible [= includes the body, angle, and ascending ramus, with or without the condyle]; and III, lateral [= includes one or two out of the body, angle, and ascending ramus, but not all three]). The letter following the roman numeral describes the soft-tissue defect. (A: none, B: intraoral only, C: skin only, D: intraoral and skin). Due to the clinical importance of defect type IIB, a subclassification of IIB1 and IIB2 was created. This subdivision depends on how many different soft tissue zones are affected (Fig. 4) (Cordeiro *et al.*, 2018).

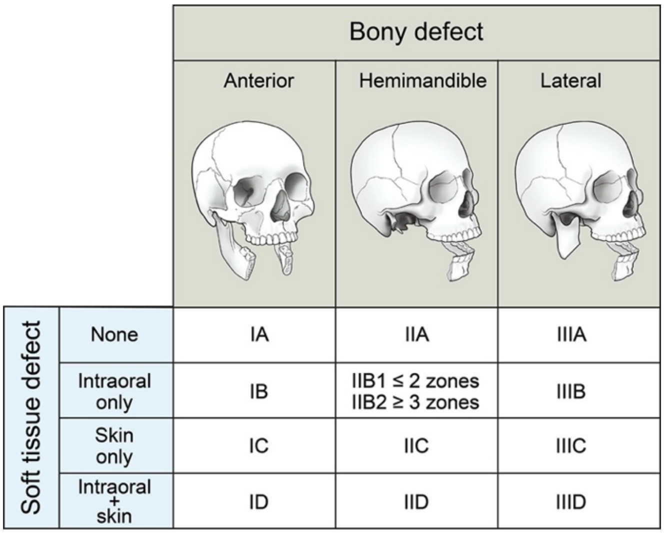

Figure 4: Cordeiro's classification of mandibular defects (Cordeiro et al., 2018)

1.1.1.2 Maxillary Defects and Their Classification

The maxillary bone plays a vital part in creating the major portion of the midfacial skeleton, which is essential to both form and function in the midface. The midfacial soft tissue structures are comprehensively linked to the osseous structure. Ablation of different portions of the maxilla with the overlying soft tissue, skin, periorbital, and intraoral structures generates particular patterns of defects (Cordeiro, 2019). Traditionally, maxillary defects have been managed with a prosthetic option, but the role of free flaps has become increasingly important over the past 20 years (Siemionow *et al*., 2009, Ferri *et al*., 2021, Wilkman e*t al*., 2019). Whether reconstruction or prosthetics, the choice requires consideration among the ablative and reconstructive teams, maxillofacial technician, the prosthodontist, and the patient. This implies that all cases involving loss or ablation of the midface and/or the maxilla should be subject to multidisciplinary discussion (Ragbir *et al*., 2016).

In 2010, Brown *et al.* proposed a classification system that describes the midface/maxillary defect by subdividing it into horizontal and vertical components (Brown *et al.*, 2010). The vertical classification is further divided into six classes: I: maxillectomy without oronasal fistula, II: maxillectomy – not involving the orbit, III: maxillectomy – involving the orbital *adnexae* with orbital retention, IV: maxillectomy – with orbital exenteration or enucleation, V: orbitomaxillary defect, VI: nasomaxillary defect.

The horizontal component of the nomenclature system is described by means of the letters a–d: a: palatal defect only, b: less than or equal to 1/2 of the unilateral palate, c: less than or equal to 1/2 of the bilateral or transverse anterior palate; d: greater than 1/2 maxillectomy. Letters a–d relate to the increasing size of the dentoalveolar and palatal defect, indicating growing difficulty in obtaining good results with obturations (Fig 5.). Moreover, Brown *et al.* recommended specific reconstruction methods according to the maxillary and midface defect classification (Brown and Shaw, 2010). In 2020 Sun *et al.* demonstrated that the class of the maxillectomy defect can be utilised to assess the prognosis. This was shown in comparison with the T stage of the TNM classification (Sun *et al*., 2020).

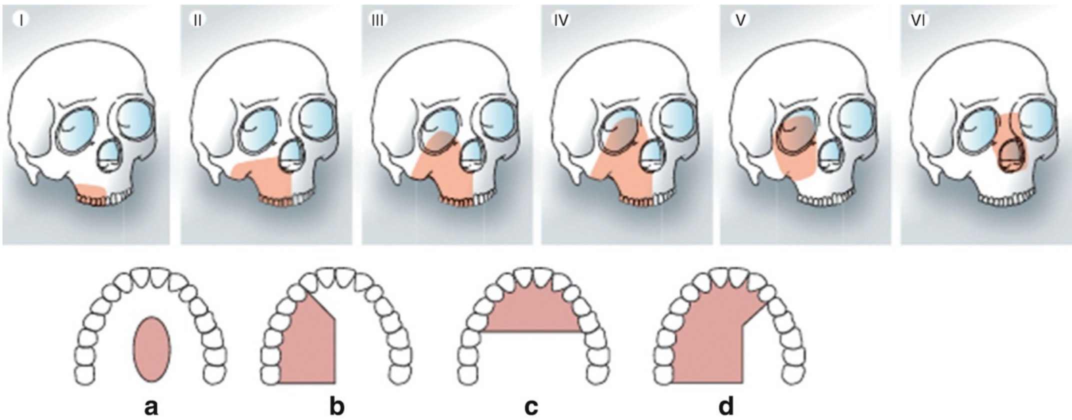

Figure 5: Brown's classification of maxillectomy and midface defect (Brown and Shaw, 2010)

1.2 Microvascular Free Flap Reconstruction in Head and Neck Surgery

Managing extensive head and neck surgery defects caused by trauma, osteoradionecrosis, cysts, or tumours often warrants free tissue transfer due to limited local tissue alternatives. Microvascular free flap operation methods represent the indisputable standard of reconstruction nowadays and are the first choice in complex head and neck reconstruction. Microvascular free tissue transfer offers a safe and reliable approach to cover soft and hard tissue defects both in young and old patients (Husso *et al*., 2016, Ferri *et al*., 2019). The selection of the best suited free flap depends on the varying specific clinical parameters,

including size of the defect, patient's health status, prognosis, surgeon's preference, donor site morbidity, and postoperative quality of life (Bianchi *et al*., 2010, Gibber *et al*., 2015). Especially quality of life and the donor site morbidity are of growing importance in the whole field of reconstructive surgery but especially in oromandibular defect reconstruction due to strong correlating aesthetical and functional aspects (Schardt *et al*., 2017).
Although the fibula, the iliac crest, and the forearm are the most used donor sites in the last decades, the utilisation of the subscapular system has increased significantly since 2000. This system offers the widest array of both hard and soft tissue components that can be used to reconstruct highly complex defects created by extended oncological resections or traumas (Gibber *et al*., 2015). Over five dozen permutations of free flaps, based on the subscapular system, are possible.

1.2.1 Types and Classification of Microvascular Free Flaps

Microvascular free flaps are the gold standard in oromandibular defect reconstruction. A free flap operation is a surgical procedure that consists of the harvesting of tissue from a donor site and its transferral to a different part of the body. During surgery, the tissue is completely disconnected from the body and thereafter reconnected to the vascular system under the microscope. There are varying nomenclature systems regarding free flaps that have been developed over time. However, these systems have been criticised due to their complexity and inconsistency (Hallock, 2004). As a matter of principle, there are numerous ways of classifying flaps, but the essential characteristic to determine flap nomenclature is the source of flap circulation. At the beginning of the twenty-first century, Hallock tried to simplify the nomenclature of flaps to enhance the acceptance and application of new flap types. Some preexisting systems were analysed and unified (Hallock, 2004).
The fundamental nomenclature system consists of the six Cs of Cormack and Lamberty which stand for the following parameters: Circulation, Constituents, Contiguity, Construction, Conditioning, Conformation (Molloy and Crowley, 1995) (Fig. 6).

General	Free flap-specific
1. Circulation (blood supply)	
Direct vessels	Direct vessels
Axial	Axial
Septocutaneous	Septocutaneous
Endosteal	Endosteal
Indirect vessels	Indirect vessels
Myocutaneous	Myocutaneous
Periosteal	Periosteal
2. Constituents (composition)	
Fasciocutaneous	Fasciocutaneous
Muscle/myocutaneous	Muscle/myocutaneous
Visceral	Visceral
Nerve	Nerve
Bone	Bone
Cartilage	Cartilage
Other	Other
3. Contiguity (destination)	
Local	Free flap
Regional	
Distant	
4. Construction (flow)	
Unipedicled	Orthograde flow[a]
Bipedicled	Retrograde flow
Orthograde flow[a]	Turbocharged
Retrograde flow	Supercharged
Turbocharged	
Supercharged	
5. Conditioning (preparation)	
Delay	Delay
Tissue expansion	Tissue expansion
Prefabrication	Prefabrication (none)[a]
6. Conformation (geometry)	
Special shapes	Tubed
Tubed	Combined flaps
Combined flaps	None[a]

Figure 6: Hallock's modified 6 Cs of Cormack und Lamberty (Hallock, 2004)

Any general or free flap can be assigned to subgroups of these six parameters by its specific feature. This subdivision allows for the description of any flap that leads to a uniform systematic nomenclature by the following basic format (Fig. 7) (Hallock, 2004).

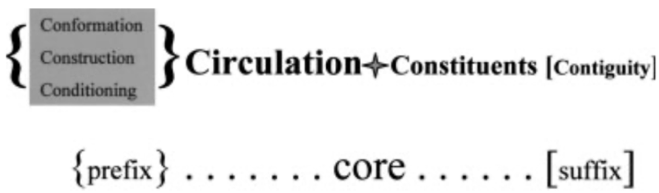

Figure 7: Format for determining a systematic name for any flap (Hallock, 2004)

Two amendments to this nomenclature system by Hallock were made in 2006 and 2011, which specified the classification of compound and combined perforator flaps.

There are two major divisions of compound flaps. The vascular supply of the first group is defined as a solitary source, whereas the second group is defined as a combination of different sources of vascularisation. Multiple flap territories which are physically

connected and nourished by one vessel, like a composite flap, belong to the first division. Conjoined flaps and chimeric flaps are the subdivisions of those with combined vascularisation sources.
Chimeric flaps are defined as multiple flap territories, each with an independent blood supply and without any physical interconnection except the common source vessel. The microsurgical transfer of these combined multiple flaps only requires a single recipient site, which is a tremendous advantage over two separate free flaps. The difference between conjoined and chimeric flaps is that conjoined flaps have a common physical junction, limiting the overall application spectrum.
Chimeric flaps can be further divided into three subgroups: branch-based, perforator-based, and fabricated. With multiple relatively large subfascial branches based on a common mother vessel, the branch-based type allows for the simultaneous transfer of varied tissue components from a single donor site. The most frequently used branched-based type is vascularised from the subscapular system, which offers a vast variety of both hard and soft tissue components (Hallock, 2006).
If the common boundaries of a conjoined perforator flap are split apart, it turns into a perforator-based chimeric flap. This type of flap is often harvested from the anterolateral thigh and used for simultaneous reconstruction of intraoral and cheek defects in head and neck surgery. To create a fabricated chimeric flap, a microvascular anastomosis is needed. It connects an independent flap to either a side branch of the main source vessel or its distal continuation (Hallock, 2006, Koshima *et al*., 1993).
To accurately describe perforator-based flaps, at least three essential specifics are needed. As suggested by Hallock, the name of the proximal vessel has to be included in the name of the perforator flap (Hallock, 2011). The extent of vascular dissection is the second criterion to properly describe the perforator flap (source vessel level or perforator level). This characteristic forms the basis of the flap nomenclature and distinguishes a perforator-based flap, which is truly based on the perforator itself with the source vessel saved (perforator level), from a perforator flap (source vessel level) (Kim, 2005) (Fig. 8).

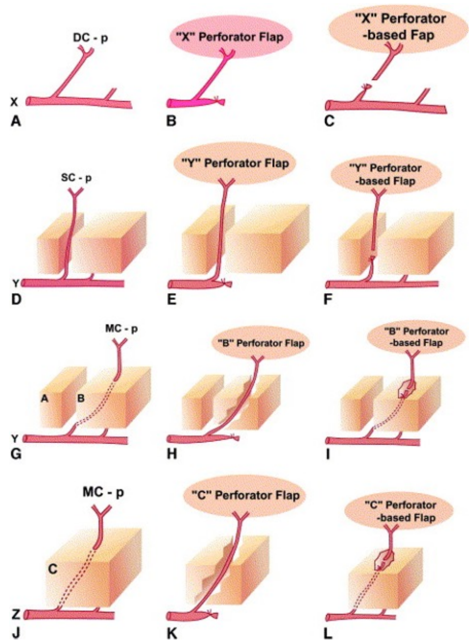

Figure 8: Illustration of the nomenclature concept of perforator free flaps (Kim, 2005)

The last essential specific is the basic type of the perforator as suggested by the Gent consensus. Perforators can be subdivided into direct cutaneous perforators, which are pure arteries that sprout from the source vessel to the skin without traversing the muscle, or impure perforators that penetrate the muscle (musculocutaneous perforator) or the septum (septocutaneous perforator) and then nourish the skin. Harvesting musculocutaneous and septocutaneous perforator flaps always requires intramuscular dissection (Blondeel *et al*., 2003). According to Kim’s classification, direct and septocutaneous perforator flaps are named according to the proximal vessel name and the musculocutaneous perforator flap according to the muscle it perforates (Kim, 2005).
Independently from their classification, there are about 120 different free flaps spread all over the whole body described that follow specific operation techniques and indications.

1.3 The Subscapular Vascular System as a Donor Site

The key to understanding the range of the subscapular arterial system as a donor site is anatomy. Although the variability of the arterial system in the axillary region is tremendously high, the subscapular artery commonly originates from the mid-third of the axillary artery (Pellini and Molteni, 2020). The mean internal diameter of this vessel is 3,3 mm, and the length averages out at 2,4 cm (Malikov *et al*., 2005). The subscapular artery branches into the circumflex scapular artery and the thoracodorsal artery, which is the continuation vessel (Fanghänel, 2003). The circumflex scapular artery splits up into a periosteal branch and two cutaneous branches (transverse and descending). This vessel alone renders the following microvascular flap patterns: the scapular fasciocutaneous flap, the parascapular fasciocutaneous flap, and the scapular-parascapular osteofasciocutaneous flap (dos Santos, 1984). The thoracodorsal artery branches into the angular artery, the serratus anterior artery and the two branches to the latissimus dorsi muscle (vertical and transverse). The angular branch offers scapular bone, the latissimus dorsi branch offers both muscle and skin, and the serratus branch offers all types of hard and soft tissue components (Pellini and Molteni, 2020). Due to the common origin of all these vessels, a simultaneous transfer of up to five tissue islands is possible.

1.4 Evolution of the Scapular Free Flap

The invention of the operating microscope in 1962 and surgical instruments suitable for microvascular surgery were the indispensable presuppositions to accomplish the realisation of free flaps (Goldwyn *et al*., 1963, Acland, 1972). Fourteen years after the invention of the operating microscope, Baudet *et al.* reported the first successful transfer of a free flap based on the lateral thoracic artery (Baudet *et al*., 1976). This study paved the way developing the scapular donor site based on the subscapular vessel system. In 1982, Gilbert and Teot performed a successful clinical free scapular flap to reconstruct defects located at the lower limb (Gilbert and Teot, 1982). Swartz *et al.* utilised the subscapular system to reconstruct complex facial defects resulting from maxillectomy and mandibular ablation and published the results with the first large report including eight cadavers and 26 clinical cases (Swartz *et al*., 1986). Throughout the 1980s and 1990s, a notable variety of flaps, based on the subscapular vessel system, were described (Baker and Sullivan, 1988, Granick *et al*., 1986, Aviv *et al*., 1991). Unfortunately, all flap configurations based on the circumflex scapular vessel share the shortcomings of a relatively short pedicle and high donor site morbidity (Tracy *et al*., 2019, Pau *et al*., 2019). Deraemaecker *et al.* described the utilisation of the angular branch of the thoracodorsal artery and vein as the only vascular supply for the same lateral scapular bone segment to overcome the drawback of the short pedicle (Deraemaecker *et al*., 1989). Harvesting scapular flaps based on the angular artery to reconstruct facial defects was first described in the early 1990s by different authors (Kärcher, 1991, Coleman and Sultan, 1991). One of the articles proved the potential of the angular branch of the thoracodorsal artery to be the sole blood supply to the bone. This was accomplished with technetium-99m scans which demonstrated the intact perfusion. This new method allowed for the harvesting of two independent bone flaps nourished by only one microvascular anastomosis (Coleman and Sultan, 1991). Further, recent anatomical studies showed that the angular branch of the thoracodorsal artery is consistently between 2.5 and 8 cm in length from the bony branch to the circumflex scapular artery (Coeugniet *et al*., 2007).

In 1995, Angrigiani *et al.* described the thoracodorsal artery perforator flap (TDAP flap), which reduces donor site morbidity to reconstruct defects when the bulk of the skin paddle is not required (Angrigiani *et al*., 1995, Shaw *et al*., 2015). The advantages of this flap variant are well documented in head and neck surgery (Guerra *et al*., 2005, Bach *et al*., 2012). Shaw *et al.* described a chimeric flap of the subscapular vessels combining the TDAP flap with a scapular flap (circumflex scapular artery) and suggested the name TDAP-Scap flap (Shaw *et al*., 2015). Pau *et al.* exchanged the osseous pedicle with the angular branch of the thoracodorsal artery to overcome the circumflex artery's drawbacks.

This novel technique, clinically first described by Pau *et al*. in 2019, is called the thoracodorsal, perforator-scapular flap based on the angular artery (TDAP-Scap-aa flap) and offers several advantages in advanced head and neck reconstruction (Pau *et al*., 2019).

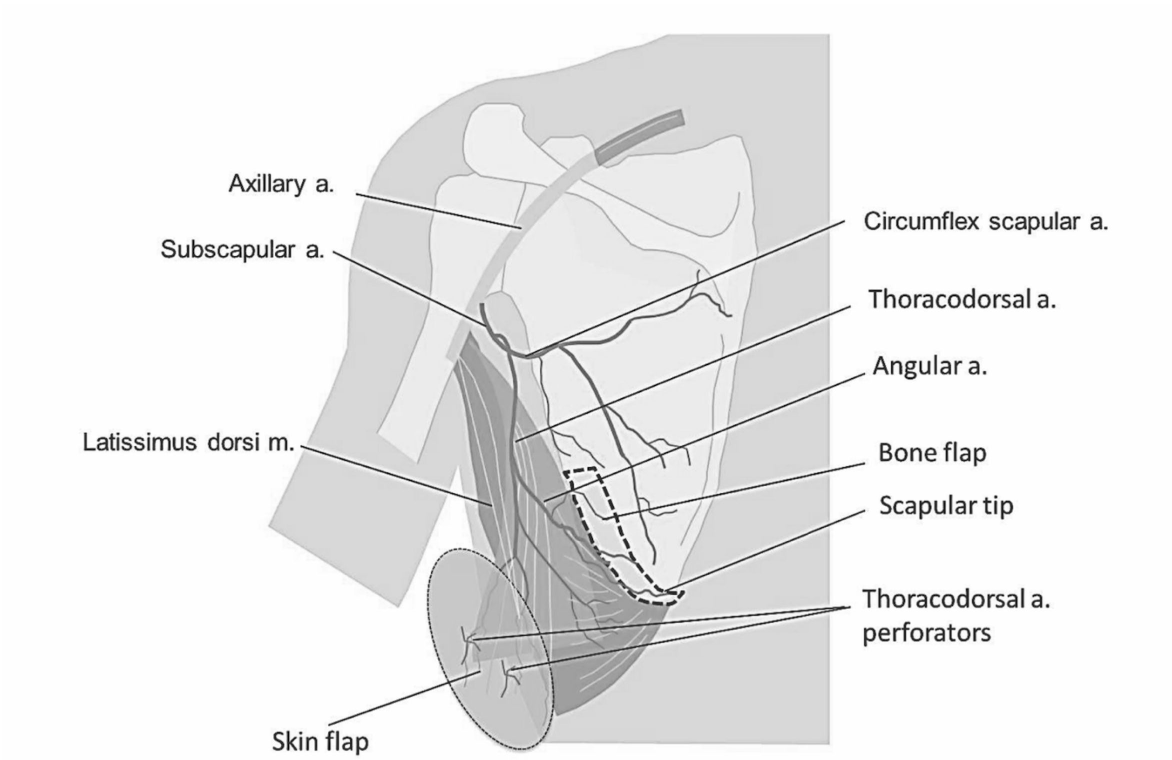

Figure 9:Modified illustration of the hard and soft tissue components of the TDAP-Scap-aa free flap. a. = artery, m. = muscle (Pau et al., 2019)

1.5 The TDAP-Scap-aa Free Flap in Head and Neck Reconstruction

The thoracodorsal, perforator-scapular microvascular free flap based on the angular artery is a chimeric flap consisting of an osseous and a cutaneous component. This microvascular free flap technique is a novel combination from the TDAP flap described by Angrigiani and a bony scapular flap based on the angular artery simultaneously described by Kärcher and Coleman and Sultan (Angrigiani *et al*., 1995, Kärcher, 1991, Coleman and Sultan, 1991). This novel method was first described by Pau *et al.* in 2019. The lateral border of the scapula based on the angular branch of the thoracodorsal artery is the osseous fragment. The skin paddle nourished by the thoracodorsal perforator is the soft tissue component.

The principal goals of the TDAP-Scap-aa flap are on the one hand to offer multiple reconstruction benefits and on the other to reduce the donor site morbidity and maintain quality of life. This is especially relevant in extensive oral mandibular defects following advanced HNSCC or ORN surgery.

This chimeric flap enables the reconstruction of sizable three-dimensional defects due to the hight amount of available hard and soft tissue components. Furthermore, the long pedicle, the reduced thickness skin graft, and the bone shape are ideal to cover extensive defects by using only one flap. This avoids the need for a vein grafting and a second anastomosis (Pau *et al*., 2019).

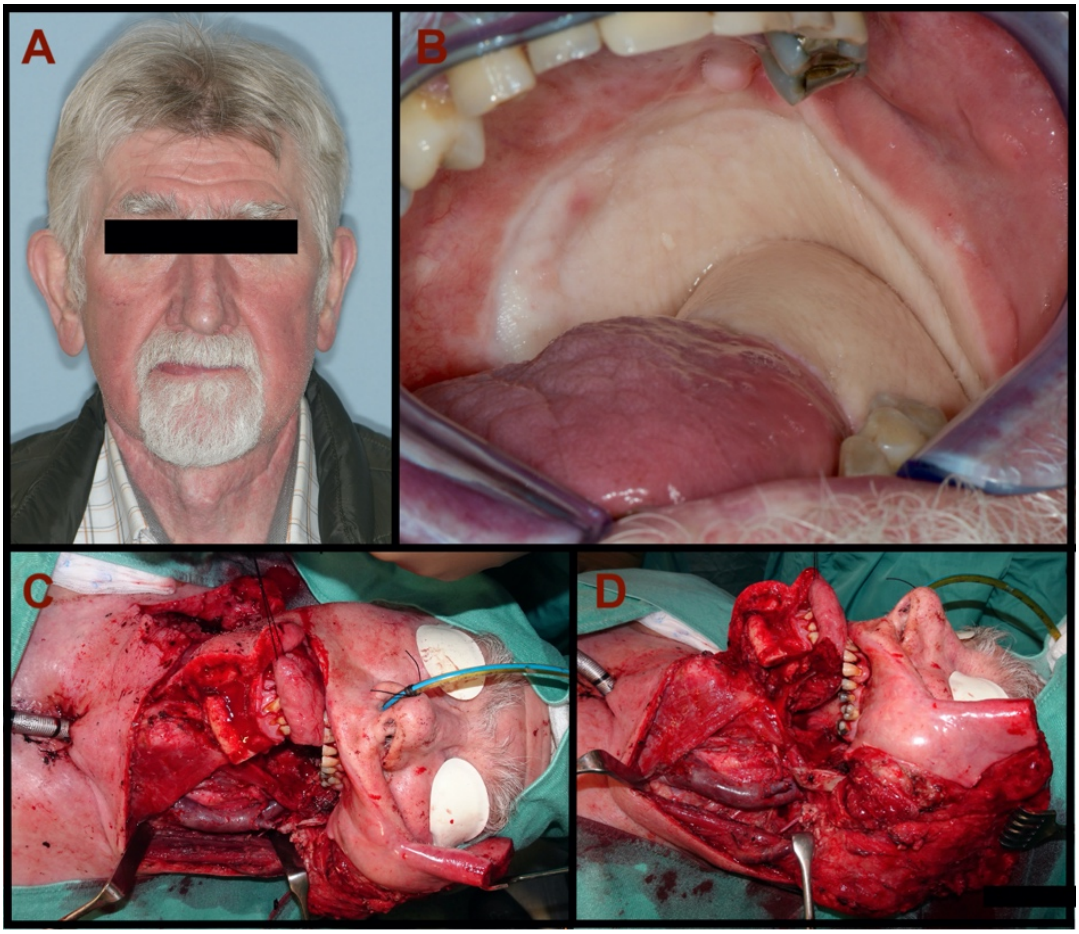

Figure 10: Seventy-four-year-old male patient with squamous cell carcinoma of the oral cavity; (A) Postoperative frontal view 8 months after reconstruction with the TDAP-Scap-aa flap; (B) intraoral postoperative clinical view depicting the totally inserted transplant involving the mandible, the tongue and the pharyngeal wall 8 months after reconstruction with a microvascular free flap (TDAP-Scap-aa free flap); (C,D) Intraoperative view after ablation of the squamous cell carcinoma of the oral cavity and modified radical neck dissection.

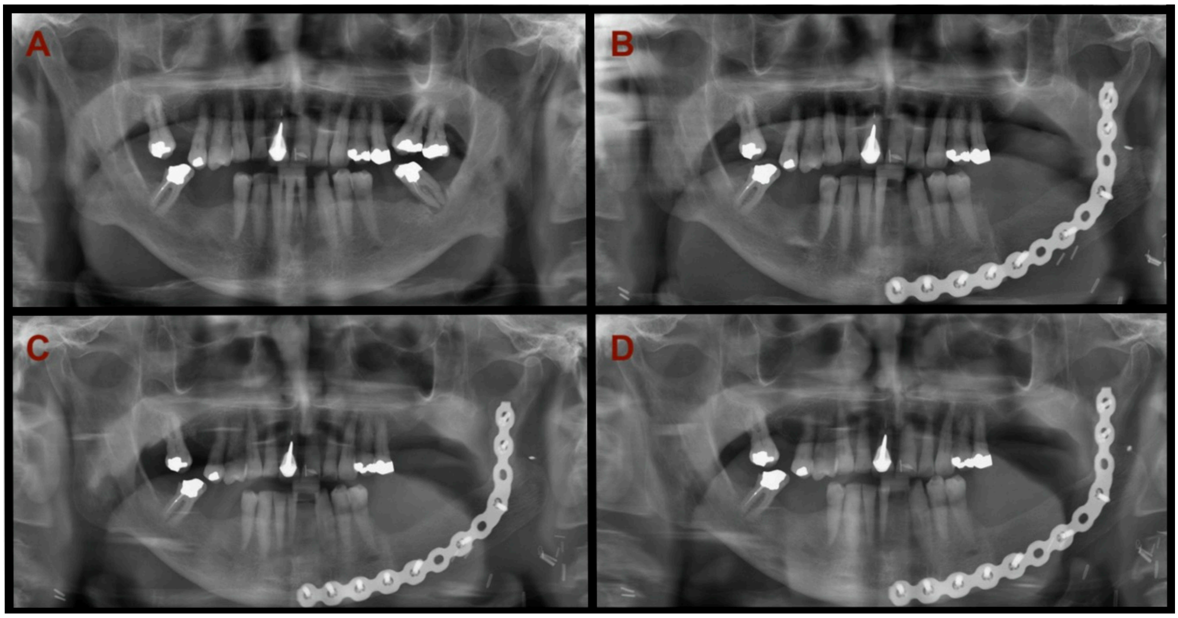

Figure 11: DPRs of a seventy-four-year-old patient; (A) preoperative DPR with a squamous cell carcinoma (left mandible); (B) two months postoperative DPR with reconstruction plate in situ; (C) five months postoperative DPR with complete ossification of the transplant and the mandible, reconstruction plate in situ; (D) DPR 8 months after reconstruction with the TDAP-Scap-aa free flap

1.6 Life Quality and Donor Site Morbidity in Microvascular Reconstructive Surgery

Over the last decades, clinically introduced advanced reconstruction techniques and free flap transfers allow for sufficient functionality with satisfying survival rates (Husso *et al*., 2016). However, modern treatment focuses not only on survival but also on preserving quality of life (Gupta *et al*., 2016).

Standardized questionnaires focussing on daily life activities and functions are considered one of the best methods to investigate quality of life (Ferri *et al*., 2019). In head and neck surgery, the SF-36 questionnaire is well-established to quantify the life quality after free flap reconstruction. (Hikosaka *et al*., 2011, Segna *et al*., 2018, Ferri *et al*., 2019, Schardt *et al*., 2017, Catala-Lehnen *et al*., 2012, Zhu *et al*., 2013, Zhang *et al*., 2013).

The SF-36 is a general health questionnaire consisting of 36 questions that assesses the patient's health status using eight different dimensions. Those are vitality, physical functioning, bodily pain, general health perceptions, physical role functioning, emotional role functioning, social role functioning, and mental health. Furthermore, the health changes are evaluated but not used to compute scales scores. The possible score ranges from 0 to 100 points. The greatest possible limitation is represented by 0 points, while the total absence of health restrictions is represented by 100 points. This scale has been utilised worldwide in many medical fields since it was first published in the 1990s in Italy (Ferri *et al*., 2019).

One efficient way to maintain life quality after reconstructive surgery is to reduce donor site morbidity. Regarding the scapular region as a harvesting site, the morbidity is mostly caused by sacrificing the thoracodorsal nerve, the bulk of the skin paddle, and the latissimus muscle. A general approach for assessing donor site morbidity is the use of orthopaedic scores (Schardt *et al*., 2017). The DASH score is one of the most established standardized questionnaires for upper-limb dysfunction (Clark *et al*., 2008, Angst *et al*., 2011, Beaton *et al*., 2001, Bot *et al*., 2004). The questionnaire asks about the patients' ability to perform certain activities as well as their symptoms. Thus, the DASH score is not a joint-specific index but evaluates the overall function of the upper limb. The possible score ranges from 0 to 100 points. Higher scores indicate a greater level of severity and disability. 0 points represent the total unrestricted function of the upper limb, while 100 points represent the greatest functional restriction (Wylie *et al.*, 2014, Kennedy *et al.*, 2011). Modern harvesting techniques are performed as little invasive as possible to decrease postoperative morbidity (Pau *et al*., 2019).

Both, the SF-36 and the DASH score are widely known standard methods to assess quality of life and donor site morbidity in reconstructive surgery (Ferri *et al*., 2019, Segna *et al*., 2018, Hikosaka *et al*., 2011, Schardt *et al*., 2017, Clark *et al*., 2008, Beaton *et al*., 2001).

1.7 Aim of This Study

This questionnaire study aimed to evaluate donor site morbidity and quality of life in patients that received extensive oromandibular reconstruction with the thoracodorsal, perforator-scapular free flap based on the angular artery (TDAP-Scap-aa free flap). Additionally, demographic data and case characteristics were collected by an electronic clinical chart review over five years (2016–2020). This is the first study investigating these clinical parameters in advanced head and neck defect cases undergoing reconstruction with the TDAP-Scap-aa free flap. Moreover, this is the largest objective assessment of postoperative donor site morbidity and quality of life after harvesting a chimeric scapular free flap.

1.7.1 Hypothesis

1.7.1.1 Null Hypothesis (H0)

Quality of life and donor site morbidity (disabilities of arm, shoulder, and hand) after reconstruction with the TDAP-Scap-aa free flap in advanced head and neck defect cases do not significantly differ from the healthy norm population.

1.7.1.2 Alternative Hypothesis (H1)

Quality of life and donor site morbidity (disabilities of arm, shoulder, and hand) after reconstruction with the TDAP-Scap-aa free flap in advanced head and neck defect cases differ from the healthy norm population.

2 Material and Methods

This study was carried out following the local legal requirements and the Declaration of Helsinki (1975) at the tertiary clinical centre of our university (Medical University of Graz, Austria) and included the approval of the Ethics Committee of the University (EK No.:31-355 ex 18/19). Informed consent was obtained from all subjects before treatment.

2.1 Study Population and Data Collection

In this thesis, patients who underwent extensive defect reconstructions in the head and neck area using a TDAP-Scap-aa free flap were postoperatively evaluated regarding quality of life and donor site morbidity.

The study cohort was selected according to specific inclusion and exclusion criteria to form a homogenous patient collective. All patients involved in this study were treated between 2016 and 2020 in the Oral- and Maxillofacial Surgery department at the Medical University of Graz, Austria.

All surgical procedures, pre- and postoperative treatments and the complete follow-up was done at the department mentioned above.

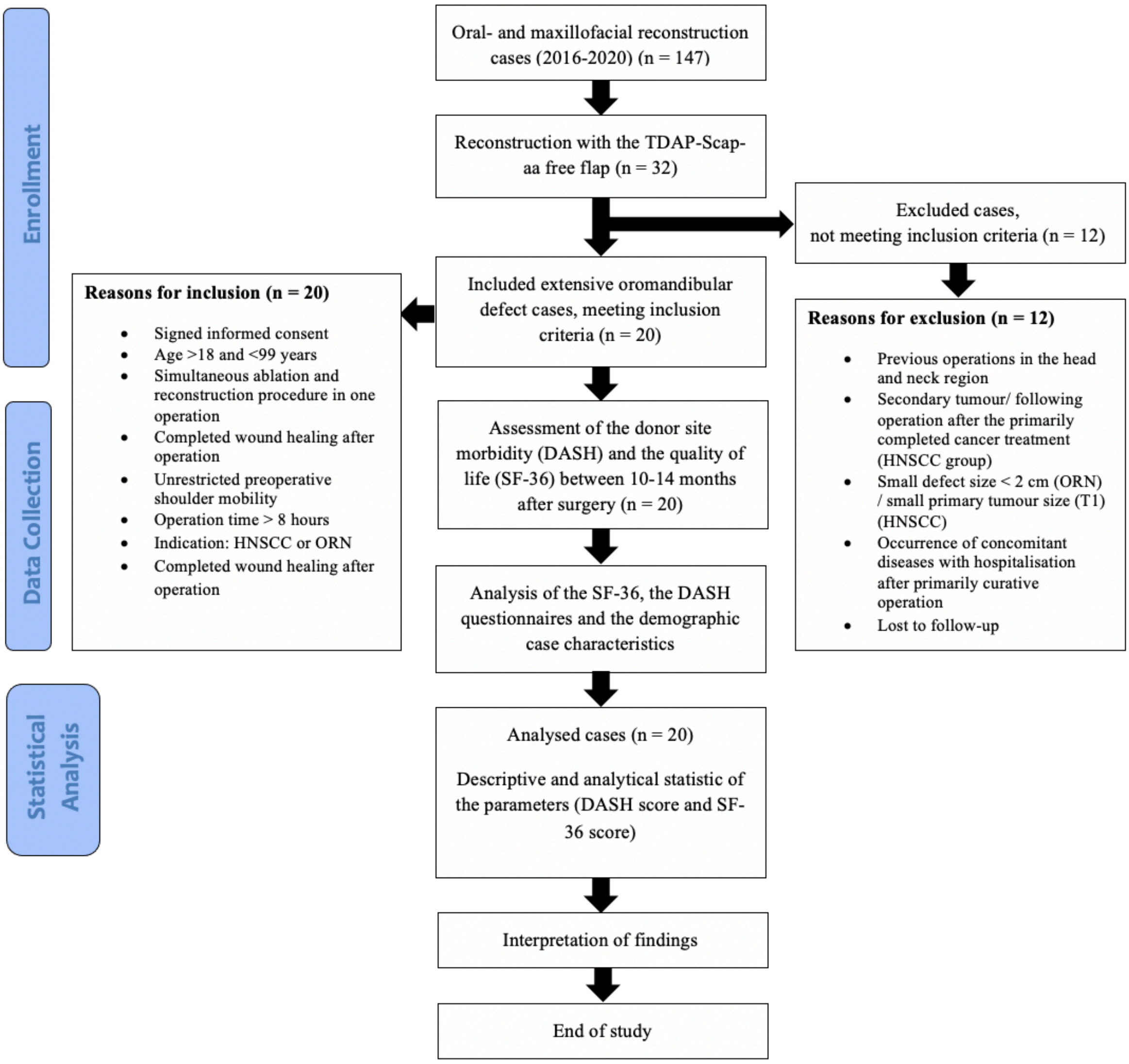

Figure 12: Flow chart shows the overall steps and design of this study DASH = Disabilities of Arm, Shoulder and Hand, SF-36 = Short Form Health, HNSCC = Head and Neck Squamous Cell Carcinoma, ORN = Osteoradionecrosis

2.1.1 Inclusion Criteria

- age over 18 years
- age under 99 years
- complete diagnosis and treatment process performed at the Department of Oral- and Maxillofacial Surgery, Medical University of Graz, Austria
- signed informed consent
- unrestricted preoperative shoulder mobility
- completed wound healing after operation
- simultaneous ablation and reconstruction procedure in one operation
- duration of the surgery over 8 hours
- completed microvascular defect reconstruction with the TDAP-Scap-aa free flap in the head and neck region

2.1.2 Exclusion Criteria

- previous operations in head and neck region
- second/following operation after primarily curative operation (HNSCC)
- tumour recurrence/secondary tumour after primarily completed tumour ablation (HNSCC)
- occurrence of concomitant diseases with hospitalisation after primarily curative operation
- missing informed consent
- patients age under 18 years
- lost to follow up
- small defect size < 2 cm (ORN)/primary tumour size (T1) (HNSCC)

2.2 Analysed Parameters

The study's analysed primary outcome parameters were quality of life and donor site morbidity after extensive defect reconstruction within the head and neck area using a TDAP-Scap-aa free flap.

The SF-36 and DASH questionnaires were used to evaluate patients' quality of life and donor site morbidity after extensive reconstruction in the head and neck region with the TDAP-Scap-aa free flap. The SF-36 considers eight fields of global health, focusing on physical and emotional aspects, with scores ranging from 0 (poorest health) to 100 (optimal health) (Ferri *et al*., 2019). The DASH questionnaire considers the overall function of the upper limb. The possible score ranges from 0 (no disability) to 100 (most severe disability) (Wylie *et al*., 2014, Kennedy *et al*., 2011). Both questionnaires were chosen with consideration of the availability of the questionnaire in the native language of patients and its worldwide validation. The total time needed to complete the questionnaires was approximately twenty minutes.

The raised SF-36 parameters of the included patients who underwent reconstructions with TDAP-Scap-aa free flaps were compared with already published quality of life data of the German norm population due to lack of data for the Austrian population. Furthermore, donor site morbidity of the harvesting site was assessed through the DASH index and compared with the corresponding values of the United States general population available in the literature due to lack of data from the Austrian population.

Additionally, demographic data were collected by an electronic clinical chart review using the clinical documentation system MEDOCS over a retrospective period of 5 years (2016–2020) concerning the following parameters: gender, age, pTNM-staging (tumour, lymph node metastasis, distant metastasis, status of resection), diagnosis/indication for free flap harvesting, extension and type of defect, defect classification, extension, size and type of flap components and the type of the recipient vessel for microvascular anastomosis. In every case, the size of the bone graft and the skin component were measured intraoperatively.

2.3 Statistical Analysis

All data were deidentified before usage and stored in a protected Microsoft Excel^{TM} database.
Scores for the SF-36 were automatically calculated using an online open-source tool (SF-36 OrthoToolKit, https://orthotoolkit.com). The DASH questionnaire was evaluated according to its standard protocol. Descriptive and analytical statistics were used to analyse the parameters of this study. Analytical statistics included T-tests and were used when appropriate. For all calculations, a p-value of <0,05 was considered statistically significant. All statistical analyses were performed using the statistical software package SPSS software (IBM SPSS Statistics for Windows, Version 24.0, IBM, New York, USA).
In this study, SF-36 scores of the patients who underwent reconstruction with the TDAP-Scap-aa free flap, were compared with the already preexisting data of the healthy German norm population (SF-36 control group) (Ellert and Kurth, 2013). The DASH scores of the examined patients were compared with already existing values of the United States norm population (DASH control group) (Hunsaker *et al.*, 2002). With the aim of determining possible significant differences, the significance (p) was calculated with a T-test. To additionally show the statistical distribution, the study's data were visualized using tables and figures.

3 Results

During the study period, a total of 147 patients (n = 147) required microsurgical reconstruction in the head and neck area. Of these, 20 patients (n = 20) underwent a simultaneous defect reconstruction using the TDAP-Scap-aa free flap with a mean age of 60,0 (± 11,4) years and ranging from 36 to 77 years old. There were 14 patients (70 %) diagnosed with a head and neck squamous cell carcinoma (HNSCC) and six patients (30 %) with an osteoradionecrosis (ORN). A total of 64,3 % of the HNSCC patients (n = 9) were diagnosed with a tumour infiltrating nearby anatomical structures such as bone (T4), 21,4 % (n = 3) had a tumour size larger than 4 cm (T3), and 14,3 % (n = 2) had a tumour extent between 2 to 4 cm (T2). All patients had tracheostomy performed before surgery was started and underwent successful tracheostomy decannulation after convalescence. The demographic case characteristics are given in Table 1.

Table 1: Demographic Case Characteristics

Case Characteristics				Tumour Classification*				Tumour Resection Status
Case No.	Age (years)	Sex (m/f)	Diagnosis	T	N	M	G	R
1	64	M	HNSCC	4	2	0	2	0
2	43	M	HNSCC	4	2	0	3	0
3	61	M	HNSCC	3	1	0	2	0
4	68	M	HNSCC	3	0	0	2	0
5	68	F	HNSCC	4	0	0	1	0
6	56	M	ORN	-	-	-	-	-
7	43	M	HNSCC	4	1	0	2	0
8	63	F	HNSCC	2	1	0	2	0
9	69	M	ORN	-	-	-	-	-
10	52	M	ORN	-	-	-	-	-
11	77	F	HNSCC	4	1	0	2	
12	47	M	HNSCC	4	2	0	3	0
13	53	M	ORN	-	-	-	-	0
14	62	M	ORN	-	-	-	-	-
15	67	M	HNSCC	4	2	0		0
16	75	F	HNSCC	3	2	0	2	0
17	36	F	ORN	-	-	-	-	-
18	64	M	HNSCC	2	1	0	2	0
19	74	M	HNSCC	4	0	0	2	0
20	58	M	HNSCC	4	2	0	2	0

*Table 1: Demographic case characteristics of the patient collective after tumour resection and reconstruction with the TDAP-Scap-aa free flap including the age, gender, and the diagnosis in the main left column. The main middle column illustrates the classification of the primary tumour according to the TNM system, whereas the right column refers to the status of the tumour resection. *Pathological TNM; HNSCC = Head and Neck Squamous Cell Carcinoma, ORN = Osteoradionecrosis, No. = number, m = male, f = female, T = size of the primary tumour, N = degree of spread to regional lymph nodes, M = presence of distant metastasis, G = grade of the cancer cells, R = resection status/completeness of the operation*

The average size for the harvested soft tissue component was 86 cm^2 (± 49,8; range 16–200 cm^2) of skin paddle and the bone graft ranged from 4 to 12 cm (mean 7,8 cm ± 2,1) in length and 2,4 to 3 cm (mean 2,7 cm ± 0,2) in width. 55 % of defects (n = 11) were located at the left side, 30 % on the right side (n = 6), while the ablation included both sides in the remaining 15 % (n = 3). In 18 cases (90 %) the mandible was part of the bony ablation (mandibular defect group), in the remaining two cases (10 %) the maxillary bone was part of the resection (maxillary defect group). There was one type IIB and one type IIIB bony defect of the maxilla after tumour resection (Brown's classification of maxillectomy and midface defects) (Brown and Shaw, 2010). Regarding the mandibular defect group, a hemimandibulectomy was carried out in half of the cases (50 %), a lateral resection of the mandible was performed in five cases (33 %) and an anterior resection which included the symphysis was done in three cases (17 %). In the mandibular group 67 % of the soft tissue defects (n = 12) were located intraorally, followed by 17 % skin defects (n = 3) and 17 % combined defects involving the intraoral mucosa and the skin (n = 3). Regarding the clinically challenging reconstruction of subitem IIB, there were five out of six cases (83 %) in which the soft tissue defect included at least three soft tissue zones (IIB2) and one case (17 %) in which less than three zones were affected (IIB1) (Cordeiro's mandibular defect classification). Direct wound closure of the harvesting site could be accomplished in all cases. Detailed defect and flap characteristics for each patient are shown in Table 2.

Table 2: Defect and Flap Characteristics

Case No.	Localization of Defect	Extension of Defect	Defect Classification*	Side of Defect (left/right)	Size of Bone Defect**			Size of Skin Defect***	
					length (cm)	width (cm)	(cm^2)	(cm x cm)	(cm^2)
1	Tonsil	Tonsil, Mandible, Soft Palate, Base of Tongue	IIB2	right	8,5	2,9	24,7	10x8	80
2	Floor of Mouth	Mandible, 2/3 of Anterior Tongue	IIB	right	9	2,5	22,5	12x6	72
3	Tonsil	Tonsil, Mandible, Soft Palate, Base of Tongue	IIB2	left	4,5	2,8	12,6	10x10	100
4	Floor of Mouth, Hard Palate	Floor of Oral Cavity, Mucosa of Cheek, Hard Palate	*IIB*	left	4	2,5	10	13x5	65
5	Maxilla	Upper Jaw, Hard Palate, Maxillary Sinus	*IIIB*	left	7,5	2,5	18,8	8x8	64
6	Tonsil	Mandible, Skin at Neck	IIC	left	10	3	30	14x8	112
7	Floor of Mouth	Mandible, Floor of Mouth	IB	right/left	12	2,9	34,8	20x10	200
8	Floor of Mouth	Mandible, Floor of Mouth	IIIB	left	8	2,4	19,2	8x6	48
9	Floor of Mouth, Mandible	Mandible, Floor of Mouth, 1/2 of Tongue	IIIB	right	7	2,6	18,2	19x10	190
10	Submental Region	Submental Skin, Chin, Mandible	IC	right/left	5	2,7	13,5	4x4	16
11	Mandible	Mandible, 1/2 of Tongue (left)	IIIB	left	8,5	2,9	24,7	4x4	16
12	Mandible/Soft Palate	Soft Palate, Lateral Pharyngeal Wall, Mandible	IIB1	left	8	2,4	19,2	8x7	56
13	Mandible	Mandible/Floor of Mouth/Submental Skin	ID	right/left	5	2,9	14,5	8x6	48
14	Neck, Floor of Mouth	Skin of the Neck, Floor of Mouth, Mandible	IIID	right	7	2,8	19,6	10x15	150
15	Retromolar Triangle	Mandible, Floor of Mouth, Soft Palate	IIB2	left	8	2,5	20	10x8	80
16	Tongue	½ of Tongue (right), Floor of Mouth, Mandible	IIIB	right	6	2,6	15,6	10x8	80
17	Mandible, Skin	Mandible, Skin of Cheek	IIC	left	10	2,8	28	7x8	56
18	Floor of Mouth	Mandible, Skin of Cheek, Floor of Mouth	IID	left	9	2,4	21,6	10x8	80
19	Retromolar Triangle	Mandible, Floor of Mouth, Lateral Pharyngeal Wall	IIB2	left	9	2,5	22,5	8x9	72
20	Floor of Mouth	Mandible, Floor of Mouth, 2/3 of Tongue	IIB2	right	10	2,9	29	15x9	135
				mean	7,8	2,68	20,9		86
				SD	2,1	0,2	6,3		49,8

*Table 2: Individual defect and flap characteristics of the study's patient population. *The mandibular defects were classified after Cordeiro's mandibular defect classification (Cordeiro et al., 2018), whereas maxillary defects (indicated by italic script) were classified according to Brown's classification of maxillectomy and midface defect (Brown and Shaw, 2010), ** Lateral border of the scapula bone (measurement beginning from the scapula tip), *** Size of the skin paddle; No. = number, SD = standard deviation,*

In 13 cases (65 %), the TDAP-Scap-aa free flap was harvested from the right side, in the remaining seven cases (35 %) it was harvested from the left side. In all cases, the microvascular anastomosis was performed extraorally in the neck region. The majority of the recipient arteries were facial arteries in eight patients (40 %), followed by superior thyroid arteries in seven (35 %), lingual arteries in three (15 %), and external carotid arteries in two cases (10 %). In one case (5 %), the ipsilateral recipient site vessels were not available. Therefore, the contralateral neck was utilised as a source for the recipient site vessel. While harvesting, the thoracodorsal nerve could be preserved in all cases. Details of flap harvesting are presented in Table 3.

Table 3: TDAP-Scap-aa Flap Harvesting

Case No.	Hard tissue	Soft tissue	Side of Flap Harvesting (left/right)	Anastomosis (Artery)	Preservation of Nerve** (yes/no)
1	x	x	right	Facial Artery	yes
2	x	x	right	Lingual Artery	yes
3	x	x	left	Superior Thyroid Artery	yes
4	x	x	right	Superior Thyroid Artery	yes
5	x	x	right	External Carotid Artery	yes
6	x	x	right	Superior Thyroid Artery	yes
7	x	x	right	Facial Artery	yes
8	x	x	left	Superior Thyroid Artery	yes
9	x	x	left	Lingual Artery	yes
10	x	x	left	Superior Thyroid Artery	yes
11	x	x	left	Superior Thyroid Artery	yes
12	x	x	right	Superior Thyroid Artery	yes
13	x	x	right	External Carotid Artery	yes
14	x	x	right	Facial Artery (contralateral)	yes
15	x	x	left	Facial Artery	yes
16	x	x	right	Facial Artery	yes
17	x	x	left	Facial Artery	yes
18	x	x	right	Facial Artery	yes
19	x	x	right	Lingual Artery	yes
20	x	x	right	Facial Artery	yes

*Table 4: Harvesting and flap characteristics of the TDAP-Scap-aa free flap including the type of the flap components, the side of the flap harvesting, the recipient vessel for the extraoral microvascular anastomosis and the preservation of the thoraco-dorsal nerve. * TDAP-Scap-aa flap = chimeric, thoracodorsal, perforator scapular free flap based on the angular artery, Hard-tissue: scapula bone, Soft-tissue: skin, Anastomosis: extraoral, **Nerve: thoraco-dorsal nerve; No. = number*

All 20 patients completed the DASH questionnaire to evaluate postoperative donor site morbidity between 10 to 14 months after surgery. In the study collective the DASH score attained a mean score of 21,74 points (± 7,30, range 9,2–35,8) and showed a statistically significant difference in comparison to the mean U.S. population (10,1 ± 14,68 points) (healthy control group). The individual patient DASH scores are presented in Table 4.

Table 4: Patients' Individual and Summary DASH Scores

Evaluation of Donor Site Morbidity	
Case No.	DASH (postoperative)
1	23,3
2	28,3
3	20,8
4	35,8
5	20,0
6	32,5
7	20,8
8	22,5
9	25,8
10	35,0
11	9,2
12	10,8
13	16,7
14	24,2
15	14,2
16	23,3
17	19,2
18	21,7
19	15,8
20	15,0

	Min	Max	Mean	SD
DASH Score	9,2	35,8	21,74	7,30

Table 4: Patients' individual DASH values and summary scores including the maximum, the minimum, the mean and the standard deviation; No. = number, Min = minimum, Max = maximum, SD = standard deviation

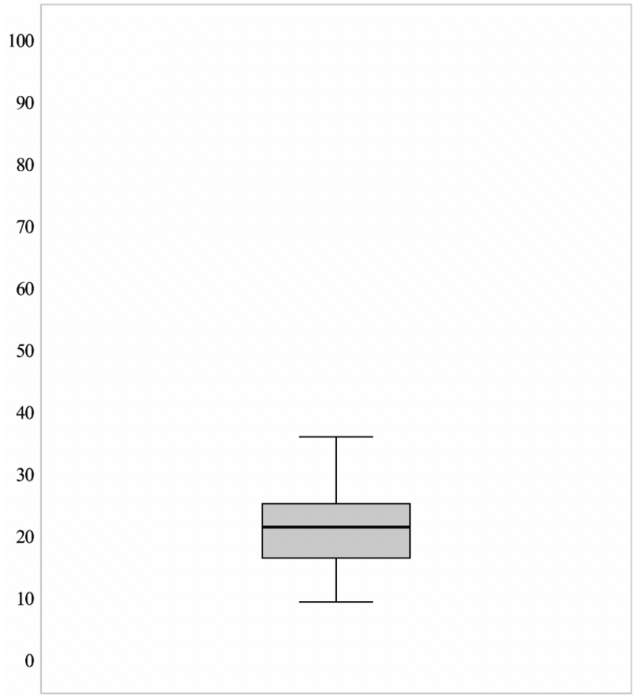

Figure 13:DASH Score after reconstruction with the TDAP-Scap-aa free flap

A separate analysis was conducted to illustrate the most frequent severe disabilities in everyday life after flap harvesting (Fig. 14). Restrictions on the ability to carry heavy objects and feeling less capable because of the arm/shoulder/hand problem were the most frequently stated restrictions with 22,2 % (n = 6) each. A total of 18,5 % (n = 5) people reported major problems when gardening or doing yard work, 11,1 % (n = 4) had difficulty with heavy household chores. 7,4 % each claimed to be less capable using the hand (n = 2), to have great problems in performing recreational activities (n = 2) or in pushing open a heavy door (n = 2). One patient reported severe limitations when playing golf (recreational activities with force/impact through arm, n = 1; 3,7 %).

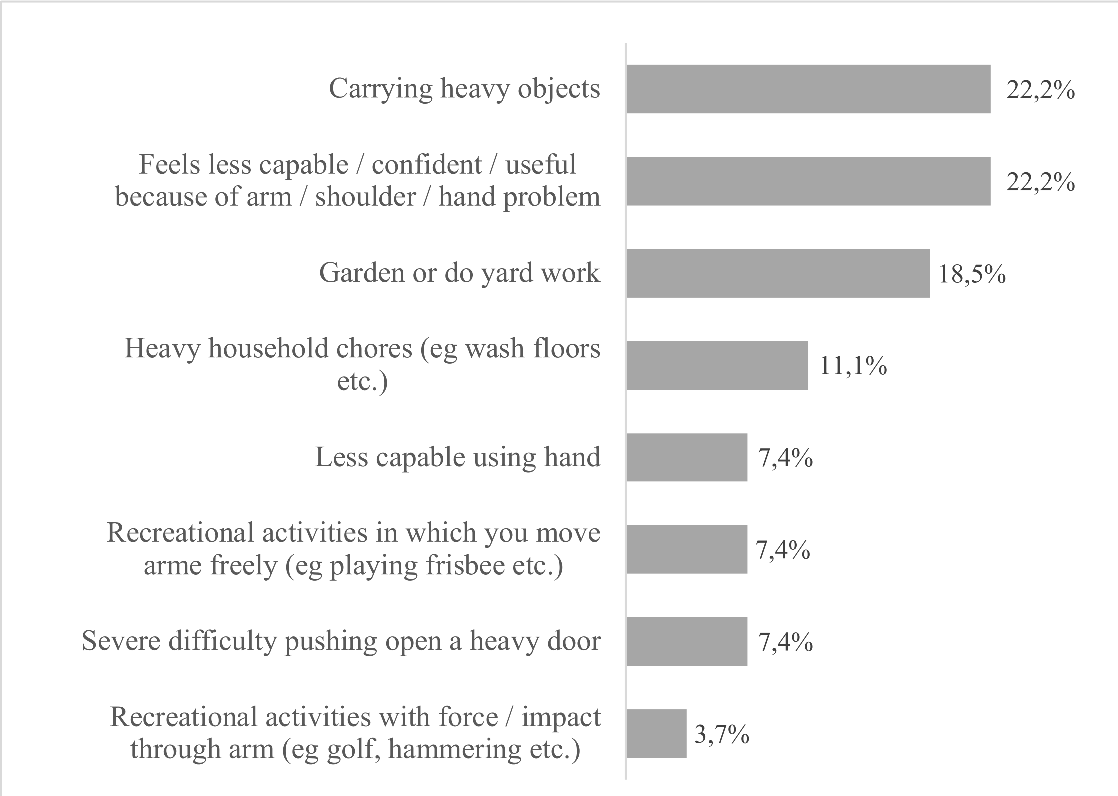

Figure 14: Illustration of the most common severe disabilities, which occurred after the harvesting of the TDAP-Scap-aa free flap.

The quality of life results, evaluated using the SF-36 questionnaire, showed statistically significant differences between the study cohort and the general German population (healthy control group) regarding the subscales vitality, physical functioning, general health perceptions, physical role functioning, social role functioning and mental health. Concerning emotional role functioning and bodily pain, one-sample T-test analysis demonstrated that these factors did not differ significantly between the cohort and the German norm population. The summary data for each subscale and the values of the German norm population are shown in Table 5 and Figure 15.

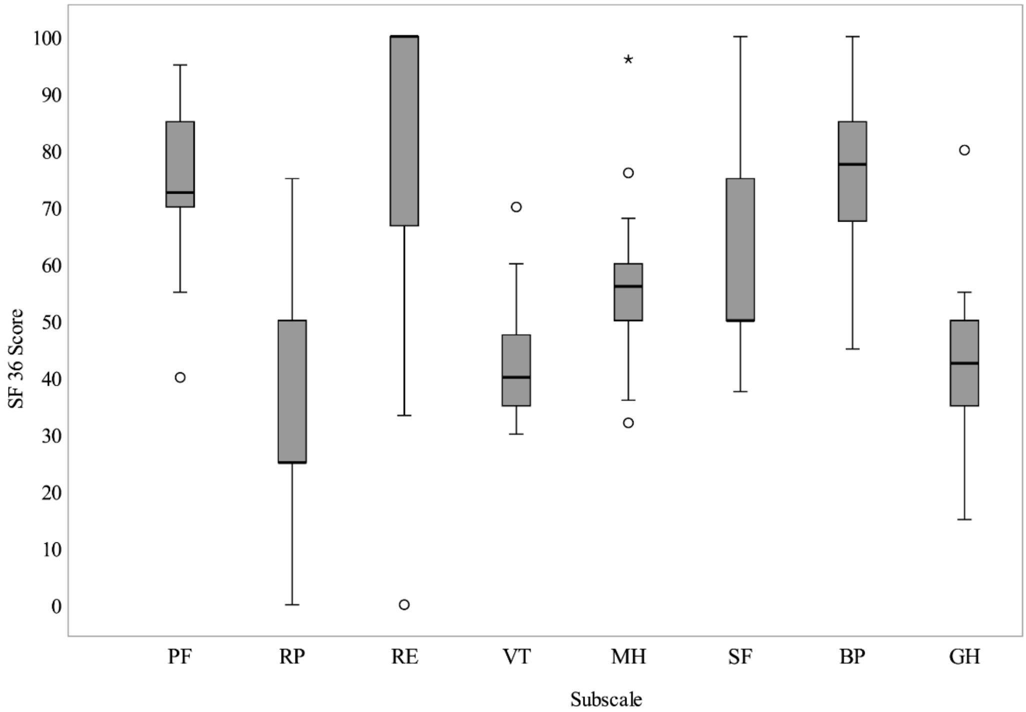

Figure 15: SF-36 results showing the quality of life outcome approximately one year (10-14 months) after reconstruction with the TDAP-Scap-aa free flap. Subscales are Physical Functioning (PF), Role Physical (RP), Role Emotional (RE), Vitality (VT), Mental Health (MH), Social Functioning (SF), Bodily Pain (BP) and General Health (GH).

Table 5: Summary Data of the SF-36 Quality of Life Results

	Min	Max	Mean	SD	German POP	Sign.
Physical Functioning (PF)	40	95	73,25	16,08	85,71	p = 0,003
Role Physical (RP)	0	75	33,75	23,33	83,7	p < 0,001
Role Emotional (RE)	0	100	78,34	31,12	90,35	p = 0,102
Vitality (VT)	30	70	43,25	10,04	63,27	p < 0,001
Mental Health (MH)	32	96	56,60	14,47	73,88	p < 0,001
Social Functioning (SF)	38	100	60,62	17,34	88,76	p < 0,001
Bodily Pain (BP)	45	100	74,25	15,90	79,08	p = 0,188
General Health (GH)	15	80	42,75	12,92	68,05	p < 0,001
Health Change (HC)	25	100	70,00	19,19		

Table 5: Summary scores of the quality-of-life results assessed by the SF-36 questionnaire compared with the German norm population as control group. Min = minimum, Max = maximum, SD = standard deviation, German POP = SF 36 mean values of the German norm population, Sign./p = significance

4 Discussion

In head and neck surgery, the reconstruction of complex three-dimensional defects after extended osteoradionecrosis, tumour removal or trauma offers several technical challenges because both soft and hard tissue components are frequently part of the defect. The morbidity associated with these operations ranges from postoperative oral incompetence to airway obstruction. However, today microvascular free flaps are a well-established standard treatment option that should provide a profit in both functional and aesthetic enhancement for the patient. Therefore, the donor site choice is substantial for the postoperative outcome and depends not only on defect size and its anatomical localisation but also on individual patient factors. The principal goal in the modern state of the art treatment is focused on the long-term preservation of the patients' quality of life. Thus, the morbidity caused by the donor site surgery must be taken into consideration to achieve the best possible result (Bak *et al*., 2010, Futran and Mendez, 2006).

The purpose of this study was to present a series of extensive oromandibular defects including soft and hard tissue which were reconstructed by the TDAP-Scap-aa microvascular free flap technique (Pau *et al*., 2019). Regarding this novel microvascular reconstruction method this study placed particular emphasis on the patients' postoperative quality of life and donor site morbidity.

4.1 The TDAP-Scap-aa Free Flap: Clinical Findings and Literature Comparison

The results of the present study indicate that the reconstruction with the TDAP-Scap-aa free flap, which is chimeric microvascular free flap consisting of a hard tissue bone and a soft tissue skin component, provides several advantages in head and neck reconstruction.

Regarding the bony part of the flap, the length of harvested bone was 4 to 12 cm (mean 7,8 ± 2,1cm). This hard tissue component allows for the reconstruction of Class III and incomplete Class IV mandibular defects (Brown's classification of mandibular defects) and extensive three-dimensional defects of the maxilla (Brown *et al*., 2016). Subsequently, this demonstrates the capability of the angular artery to supply a bony transplant from the lateral border of the scapular up to 12 cm in length. Although Dolderer *et al.* and Ferri *et* *al.* reported that only a bony segment up to 8 cm could be harvested from the lateral border of the scapula, the present results of this study confirms the findings of Clark *et al.* and Zrnc *et al.* that the possible size of the harvested lateral scapular bone can safely be extended up to 12 cm in length (Dolderer *et al*., 2010, Ferri *et al*., 2021, Zrnc *et al*., 2020, Clark *et al*., 2008).

While the fibula provides the longest possible bony transplant that can be harvested in the human body and the iliac crest provides a suitable shape for mandibular reconstruction, the scapula with its distinctive shape and thickness offers unique options for extensive defect reconstruction (Wolff and Hölzle, 2011). This is especially true for the reconstruction of the mandibular angle. The bone component of the TDAP-Scap-aa free flap is perfectly suitable because of the morphological similarity to the natural mandibular bone (Fig. 16, 17).

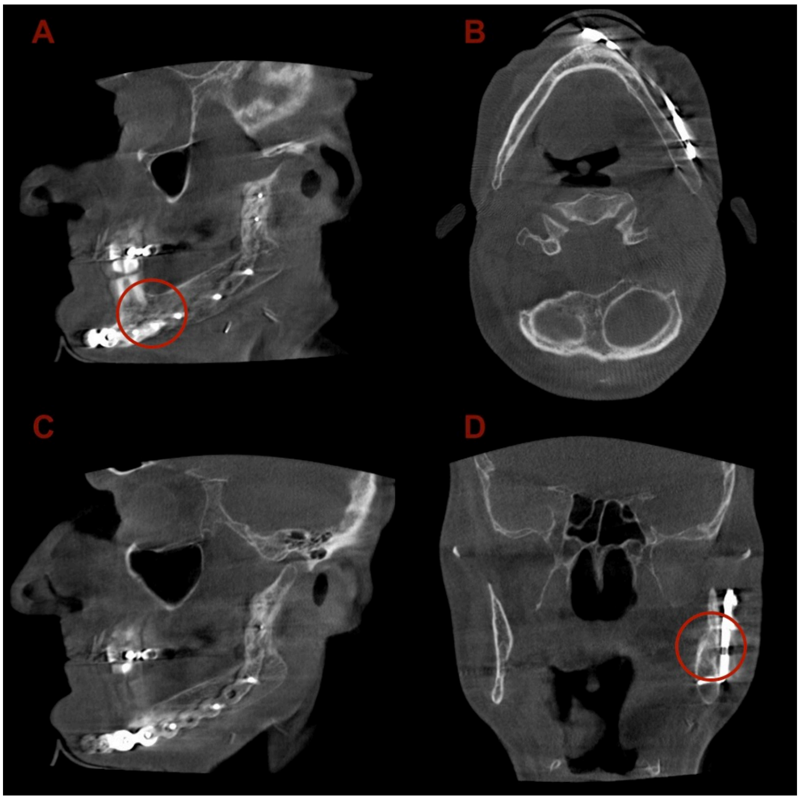

Figure 16: Seventy-four-year-old male patient after the resection of a large T4 squamous cell carcinoma of the oral cavity and reconstruction with the TDAP-Scap-aa free flap. A CBCT-image was performed for radiological assessment;(A) Sagittal view of the reconstruction site (left side) – closed proximal ossification gap (red circle) between the mandible and the bone graft 6 months postoperatively; (B) Symmetrical projection of the mandible in the transversal plane; (C) Sagittal view displaying the anatomical projection of the reconstructed mandibular angle with the reconstruction plate in situ; (D) Frontal view shows the complete ossification of the distal gap between the bone transplant and the mandible

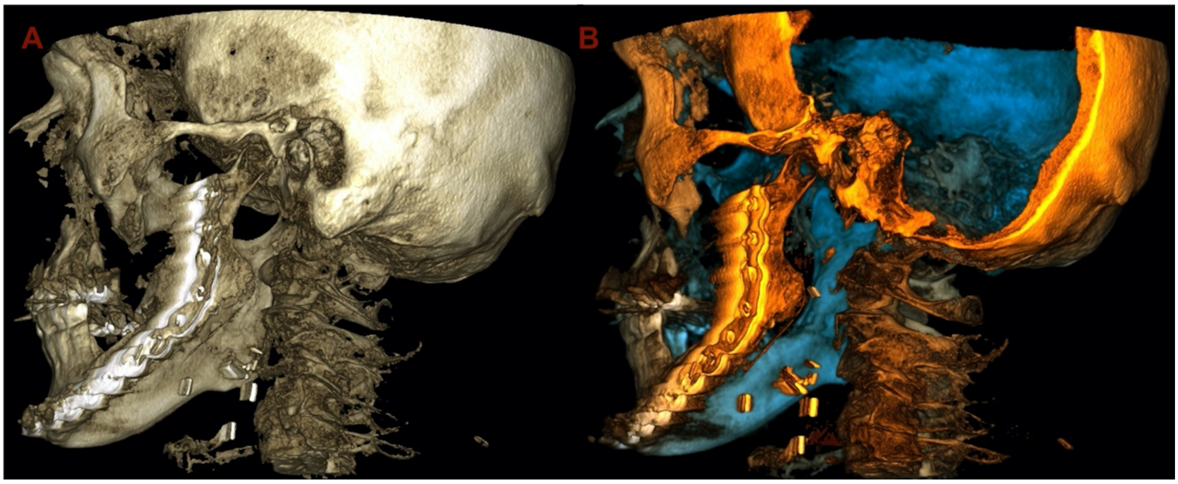

Figure 17: Three-dimensional reconstruction of a seventy-four-year-old male patient after reconstruction with a TDAP-Scap-aa free flap;(A) Anatomical projection of the reconstructed mandibular angle; (B) Coloured three-dimensional image displaying the contrast between the superimposed bone structures.

In our series, the size of the harvested skin graft averaged 86 ± 49,8 cm^2, with the largest skin area measuring up to 200 cm^2 which allows a sufficient soft tissue lining of all defects. Since the skin is harvested without the underlying muscle, it has the advantage that it can be used for a comfortable structure lining due to the resulting reduced thickness and volume. This is particularly important if the tongue, the pharynx and/or the palate are part of the soft tissue reconstruction. Consistent with our findings, several research groups reported similar quantities of harvested flap components and described this as one of the eminent benefits of free flaps raised from the subscapular region (Choi *et al*., 2015, Zrnc *et al*., 2020, Pau *et al*., 2019).

Compared to the DCIA and the fibular free flap, the TDAP-Scap-aa flap offers several advantages in reconstructing extended oral defects. In contrast to the osteomyocutaneous DCIA flap, the skin graft of the TDAP-Scap-aa flap is less bulky and more flexible due to the independent pedicle (Urken *et al*., 1990). Furthermore, the length of the pedicle (angular artery and the thoracodorsal artery together), which Seitz *et al*. have described as approximately 15 cm on average, even enables anastomosis on the contralateral side of the neck (Seitz *et al*., 1999). In this study, this procedure was only necessary in one case, but can be of central importance in pre-irradiated or pre-operated patients where the identification of alternative vessels from the contralateral neck is necessary due to the absence or damage of the arteries and veins on the ipsilateral neck side.

According to several reports, the pedicle of the fibular free flap ranges from 4 to 8 cm, and the size of the skin flap that can additionally be harvested is limited in its extension (Flemming *et al*., 1990, Hidalgo, 1989). The fibular free flap and the TDAP-Scap-aa free flap differ not only in terms of a higher feasible soft tissue size and pedicle length but also in the difficulty of the primary wound closure which can lead to postoperative complications after fibular flap and extended skin paddle harvesting such as postoperative wound healing and sensibility disorders. More precisely, the fibular donor site can only be self-closed to an expansion of 6 to 7 cm. Otherwise, an additional split-thickness skin graft is required to ensure good wound healing, which may exacerbate donor site morbidity and lead to unsatisfactory scarring (Munoz Guerra *et al*., 2001, Santamaria *et al*., 1998). To overcome the drawback of the short pedicle length, a well-established way to avoid a vein graft is to raise the fibular transplant from the distal third of the lower leg to extend the harvested vessel span (Wolff and Hölzle, 2005). Additionally, this reduces the possibility of primary wound closure.

Regarding the TDAP-Scap-aa flap, this study showed - consistent with the reports from Ferri *et al.* and Choi *et al.* (Ferri *et al*., 2021, Choi *et al*., 2015) - that primary wound closure of the donor site could be performed in all cases and up to a harvested skin area of 200 cm^2, which is by far more than the skin that comes with a fibular or a DCIA flap. One major drawback of the TDAP-Scap-aa flap may be the extended overall operation time compared to the fibular or the DCIA free flap. This is caused by the fact that a two-team approach is hardly realisable. Nevertheless, in patients with extensive composite defects, the truly chimeric TDAP-Scap-aa flap allows for the hard and soft tissue reconstruction with only one free flap. Only one donor site, one primarily wound closure and one microvascular anastomosis are needed. In contrast to the alternative methods existing of the reconstruction of such expanded composite defects – double or multiple free flap methods - the overall operation time using the TDAP-Scap-aa free flap is not really prolonged and therefore not a medical issue (Pau *et al*., 2019, Wilkman *et al*., 2019, Ferri *et al*., 2021). Moreover, the gauge of the nourishing vessel can be adapted to the diameter of the source vessel and the total flap size by either shortening the pedicle or dissecting it further. Additionally, the subscapular artery system is little affected by atherosclerosis, which is often a concomitant disease of older patients and more often manifests in the lower extremities (Wilkman *et al*., 2019, Brown *et al*., 2010).

Comparing the present results with other studies regarding scapular free flaps there are three major distinctions. Firstly, one of the main differences between the TDAP-Scap-aa flap and other chimeric scapular free flaps is the amount of harvested bone solely nourished by the angular artery. The present study results demonstrate that not only the scapular tip but also the lateral border of the scapula up to a length of 12 cm can be safely used as bone graft when the angular artery is used as blood supply. Moreover, utilising the angular artery as the source vessel reinforces the independence of bony and soft tissue components, so that both the bone and the skin component can completely be feely moved against other without interfering the blood supply. Secondly, the soft tissue component of this free flap only consists of skin nourished by one or more perforator vessels from the latissimus dorsi muscle. The day before surgery or at least preoperatively these perforators are identified by using a Doppler ultrasound. Thirdly, the TDAP-Scap-aa flap is primarily used for reconstructing extensive chimeric defects or lateral through-and-through defects in head and neck surgery. (Choi *et al*., 2015, Ferri *et al*., 2021, Gibber *et al*., 2015, Bianchi *et al*., 2010, Dolderer *et al*., 2010, Clark *et al*., 2008, Pau *et al*., 2019, Zrnc *et al*., 2020). As shown from the data of this study, there were mainly patients with extensive soft and hard tissue defects such as after T3 or T4 tumour removals included in the study cohort. To objectively characterise these defects Cordeiro's classification for mandibular defects was used. According to this classification, multiple large, very complex, laterally located bony defects in combination with several affected soft tissue zones and types were identified in this present study. Therefore, the medical indication of this single free flap reconstruction technique primarily focuses on expanded composite defects that may occur after head and neck tumour resections, after oncologic radiation procedures, after expanded trauma including the loss of hard and soft tissues or after previous insufficient reconstruction techniques.

4.2 Donor Site Morbidity

Although several studies describe the donor site morbidity after harvesting a scapula free flap to be less severe in comparison to other free flaps, only a few reports assessed the upper limb morbidity with an objective tool (Piazza *et al*., 2013, Dowthwaite *et al*., 2013, Wilkman *et al*., 2019, Valentini *et al*., 2009, Zrnc *et al*., 2020, Roll *et al*., 2007, Coleman *et al*., 2000). Wilkman *et al.* reported in their study only four late donor site complications (impaired range of motion of the scapula) and two early complications (one seroma and one severe postoperative pain) after investigating 40 patients (Wilkman *et al*., 2019). In 2010, Chepeha *et al.* presented a case series and evaluated the postoperative shoulder function using the Constant-Murley shoulder function test in 9 patients and described minimal donor site morbidity (Chepeha *et al*., 2010). This correlates with data of Clark *et* *al.*, who depicted similar results using the DASH questionnaire after scapular tip free flap harvesting in 12 patients (DASH score 10,6; ranging from 0–32) (Clark *et al.*, 2008). Due to this limited amount of data, several research groups stated that further investigations regarding an objective evaluation of postoperative donor site morbidity after microvascular free flaps should be conducted (Tracy *et al.*, 2019, Zrnc *et al.*, 2020, Dowthwaite *et al.*, 2013). In 2021, Ferri *et al.* underpinned the previous assumptions of low donor site morbidity by presenting a series of 19 patients. In their study the authors presented a mean Constant-Murley score of 92,2 and a mean DASH score of 48,6 (Ferri *et al.*, 2021). Although an increased postoperative DASH score was observed in the study of Ferri *et al.*, that would indicate a quite high disability of the donor site, the authors still concluded – due to the high values of the observed Constant-Murley score – that the donor site morbidity was generally only minimal.

So far, this study presents the largest investigation of long-term donor-site morbidity after harvesting a chimeric scapular free flap (TDAP-Scap-aa free flap). The present study found a mean DASH score of 21,74 (± 7,3) after investigating 20 patients between 10 to 14 months postoperatively. However, similar to other disability measurement instruments, one cannot directly interpret this as a 21,7-percent-disability. The scores closer to 0 indicate a low level of disability whereas scores up to 100 suggest very high levels of upper-limb impairment (Wylie et al., 2014, Angst et al., 2011, Kennedy et al., 2011). Up until now, there are no benchmark DASH scores available which would allow to directly transfer the collected scores into the corresponding level of disability of a patient. However, Kennedy *et al.* suggested the following three points after conducting their survey at the Institute of Work and Health, Toronto, Canada. Firstly, people with DASH scores above 40 are predominantly unable to work because of their upper-limb pain. Secondly, the patients with a DASH score ranging from 15 to 40 refer to a group which potentially have upper-limb problems but are still able to do their routine work. Thirdly, DASH scores under 15 demonstrate no or only minimal upper-limb pain (Kennedy et al., 2011). Although these results are just a preliminary proof, a mean DASH score of 21,74 (± 7,3) as it was found in this study would indicate that patients will not be prevented from doing their routine work as a result of the harvesting procedure approximately one year after the reconstruction with the TDAP-Scap-aa free flap. Nevertheless, as shown in figure 13, some disabilities are reported that can lead to a lack of ability to perform hard chores in some patients, whether at home or at work.

Another analysis of the Institute of Work and Health in Toronto, Canada showed that the

DASH score can also be used for the severity discrimination of a patient's upper limb disability which divides the grade of disability into five categories (very mild, mild, moderate, severe and very severe). In this context, the patient-based and the clinician-based severity can be described as two subcategories (Kennedy et al., 2011). According to this investigation, the mean clinician-based upper-limb disability of the study population in this work can be described as very mild to mild. The average patient-rated severity of the upper limb disability can be specified as mild.

Although the mean DASH score of 21,74 (± 7,3) obtained in this study is above the U.S. general population mean value of 10,1 (± 14,68), this finding should not be considered as a negative result because a healthy collective is used as the control group. In contrast, this reinforces the clinically acquired assertion of the minimal donor site morbidity regarding this harvesting site (Bot et al., 2004). This is due to the fact that various variables must be included in the evaluation. The average age of the study patients (mean 60 ± 11,4 years) would solely lead to a deterioration of the U.S. population's mean DASH score of approximately 1,5 points (Hunsaker et al., 2002). Furthermore, when comparing postoperative morbidity at the donor site with a healthy control group such as the U.S. population, the impact of a severe diseases on the upper extremity function must be considered, especially in cases where HNSCC or ORN and the resulting extensive surgical procedure have been present. In addition to that, 75 % of the study collective underwent neck dissection, which could also negatively influence the DASH score (Goldstein et al., 2015).

To improve the postoperative shoulder mobility after scapular free flap harvesting, various suggestions can be found in the literature. In this regard, some reports emphasise the importance of muscle refixation to the scapula bone with the help of drill holes and resorbable sutures, aggressive postoperative rehabilitation, late removal of suction drainages to prevent seroma, whilst others describe the re-approximation of the rotator cuff muscles in a special arm position (Clark *et al*., 2008, Chepeha *et al*., 2010, Gibber *et al*., 2015, Ferri *et al*., 2021). Unfortunately, none of these methods have been objectively verified so far in clinical trial. However, the generally accepted expert opinion is that a wound closure in layers and early postoperative physiotherapy are highly important factors which may help to achieve a satisfactory postoperative outcome (Gibber et al., 2015, Ferri et al., 2021, Pau et al., 2019). These procedures are also performed routinely at the department of Oral- and Maxillofacial Surgery at Medical University of Graz, Austria.

Comparing the DASH scores of this study with the corresponding reports mentioned above is challenging and from a strict objective point of view in detail not possible because both the amounts and types of tissues and the different harvesting techniques vary from one study to another. Nevertheless, the data of these studies conclude that the donor site morbidity after scapular free flap harvesting is low (Clark *et al*., 2008, Ferri *et al.*, 2021, Chepeha *et al.*, 2010). This is in accordance with the findings of this investigation that even after extended soft and hard tissue harvesting with the TDAP-Scap-aa free flap technique, the donor site morbidity can be described as mild. Furthermore, although high amounts of both soft and hard tissue were harvested in all cases, patients were able to restart their routine work without restrictions.

4.3 Quality of Life

Especially in the last years, patient-based quality of life rating scales have been established as a standard evaluation tool for clinical procedures in modern medicine. In this study, the SF-36 questionnaire was utilised to assess the patients' health status after reconstruction with the TDAP-Scap-aa free flap. The evaluation of the postoperative quality of life was conducted between 10 and 14 months after surgery. This time point was chosen because already existing studies identified the patients' quality of life at the time one year after treatment as an important predictor for the further upcoming long-term survival rate (Babin *et al*., 2008, Schliephake and Jamil, 2002, Rogers *et al*., 1999).
Low values of the SF-36 subscales physical functioning, role physical and bodily pain are strongly associated with high physical morbidity, whereas low values of the SF-36 scales mental health, role emotional and social functioning indicate impaired mental/psychological health. A change of the subscales vitality and general health can both be related to a change in mental and/or physical health (Ware *et al.*, 1993).

In this study, the statistical calculation showed a significant deviation between the study results and the German norm population in all subscales except in the subscales bodily pain and emotional role. This implicates that these two subscales do not really vary between patients undergoing TDAP-Scap-aa free flap reconstruction and healthy people aged from 18 to 79 years (German norm population) (Ellert and Kurth, 2013). Regarding the subscales physical functioning, vitality and mental health, these scores showed an average deterioration of up to 20 points compared to the German norm population. The largest difference between the results of the study and the healthy control group could be found in the physical role (average decline approximately 50 points), the social functioning and the general health subscales (average decline of between 25 and 28 points). A low physical role score may indicate problems with work or other daily activities as result of physical health.

Similar observations about the impact of malignancy on health-related quality of life have been well described in the literature, illustrating that both the primary tumour and the reconstructive surgery negatively influence postoperative quality of life. More precisely, if the primary tumour size increases, the patients' quality of life deteriorates (Pierre *et al*., 2014, de Melo *et al*., 2018, Rathod *et al*., 2015, Tahani *et al*., 2017). This could be related to the fact that the more the tumour stage increases, the more increases the invasiveness of the therapy. Most of the study's patients presented themselves with an advanced tumour stage (T3 and T4 tumours) and therefore required extensive ablative and reconstructive surgery. Furthermore, not only the different types of therapy depending on the tumour stages but also the individual psychological aspects, the proper wound care and the oral hygiene influence additionally the postoperative quality of life (Nelke, 2014). Approximately three-quarters of all HNSCC diagnoses are associated with tobacco and alcohol use, which has a far higher prevalence among people with a disadvantaged socioeconomic status (Jethwa and Khariwala, 2017, Hiscock *et al.*, 2012). A low socioeconomic status alone would deteriorate each quality of life subscale of the German norm population by five to twelve points, which is about the same decline as in patients with a chronic disease (Ellert and Kurth, 2013). Therefore, it can be assumed, that chronic tobacco and alcohol consumption, which is also present in three out of four HNSCC patients, is highly associated with a disadvantaged or decreased socioeconomic status. Consequently, it can be expected that a large portion of HNSCC patients already has a lower average quality of life at baseline value in comparison to the healthy German norm population. This fact may be also true for the study cohort included in this work. Furthermore, the average age of this study cohort (mean 60 ± 11,4 years) which is above the mean age of the German norm population must be also considered as a factor that potentially further worsens each subscale of the SF-36 quality of life results. In that context, the impact of the increasing years of age on the quality of life was already demonstrated by the study of Ellen and Kurth, in which they presented age-stratified results of the SF-36 values regarding the German norm population (Ellert and Kurth, 2013).

Concerning the quality of life subscale physical role, which was found to be by far the study's lowest value scoring roughly 40 % when compared to the healthy German norm population (control group), this SF-36 subscale is only one out of three subscales that provide information about the overall physical health. In this study, the other two subscales were found to be approximately 86 % (subscale physical functioning) and 95 % (subscale bodily pain) of the values in the German norm population. Consequently, physical, and mental health values in all subscales except of two could be observed at least 66% of the corresponding values in the healthy German control group. Regarding the two quality of life subscales (physical role and general health) that were below the reference value of 66 %, the subscale general health was with 63 % quite close to the referenced 66 %. The reason for the low outcome of the subscale physical role may potentially be referred to the time point (12 to 14 months after surgery). A life quality assessment at a later time point would potentially have led to an increasing life quality outcome, since with increasing time after surgery clinical follow ups will decrease, daily life activities will adapt in their performance and the individual mind will better compensate any occurring mental trauma referred to a patient disease.

Comparing the study's results with Schardt's report, which assessed the postoperative quality of life after microvascular reconstruction in the head and neck region with varying harvesting sites (DCIA and fibular free flap), the values, except for the subscales general health and physical role, are quite similar (Schardt *et al*., 2017). The difference in these scores could be caused by the inclusion of benign tumours in the work of Schardt *et al.* (about one-quarter of tumour patients) most probably leading to a lower extent of the surgery. Additionally, the study of Schardt *et al*. did not offer any data concerning the primary tumour stage or the amount of harvested hard and soft tissue, which has been described as a factor influencing quality of life. Furthermore, approximately half of the patients in Schardt's report were treated in a two-stage approach, which strengthens the assumption that the reconstruction of smaller defect sizes was evaluated in their study (Schardt *et al.*, 2017).

Since the reconstructive procedure performed in this study involved two surgical steps simultaneously in one operation (donor site and the recipient site) it is impossible to separately determine the donor site's sole influence on the postoperative quality of life. Although postoperative quality of life scores after reconstruction with the TDAP-Scap-aa free flap are lower compared with the healthy control group, all mean subscales, except for the role physical and general health, are in the upper third (more than 66 %) of the mean scores of the German norm population.

4.4 Limitations

Although the patient cohort of this study followed specific inclusion and exclusion criteria and both the quality of life and the donor site morbidity assessment was performed using established standard methods, some limitations must be considered when interpreting the results of this study. Firstly, the study's sample size could potentially reduce the comparability of the used reconstruction technique with other methods and kind of prohibits generalising the found research results. However, in the literature many reports dealing with the assessment of quality of life and donor site morbidity of different microvascular reconstruction methods investigated a patient size that was similar to this study (Schardt *et al*., 2017, Clark *et al*., 2008, Choi *et al*., 2015, Dolderer *et al*., 2010). Secondly, in this study no further investigation was performed concerning the quality of life and donor site morbidity between radiated patients and patients who did not receive radiation therapy. Therefore, the influencing effect that results from a radiation therapy on the patient's quality of life could not have been evaluated in this study. Thirdly, no quality of life or upper limb disability assessment was conducted preoperatively for a direct comparison of pre- and postoperative values. This evaluation could have been valuable to compare the postoperative results with the initial scores to objectively eliminate preexisting impairments. However, in this study patients with existing impairments prior to operation were excluded from the patient cohort. Additionally, the postoperative raised values of this study were compared with the officially available average values of the healthy norm population. Further, similar to this study design, previous reports which evaluated donor site morbidity and quality of life after microvascular free flap reconstruction studies about donor site morbidity and quality of life after microvascular free flap reconstruction did also not include preoperative assessments (Clark *et al*., 2008, Ferri *et al*., 2021, Schardt *et al*., 2017).

5 Conclusion

The present study assessed the TDAP-Scap-aa free flap regarding the postoperative donor site morbidity, the quality of life, and the clinical data within a homogenous patient collective. All patients (n = 20) in this study underwent extensive oromandibular ablation procedures followed by microvascular reconstructions with the TDAP-Scap-aa free flap. The quality of life and donor site morbidity was evaluated between 10 and 14 months after surgery. Regarding the null hypothesis (H0) that the quality of life and the donor site morbidity after TDAP-Scap-aa free flap reconstruction in advanced defect cases do not statistically significant differ from the norm population, statistically significant differences were found in both the DASH and the SF-36 scores compared to the healthy norm population. Consequently, the alternative hypothesis can be confirmed (H1).

The reason that the null hypothesis has to be rejected is primarily referred to the fact that postoperative life quality and donor site morbidity values were compared with standards of a healthy norm population Although these standards could postoperatively not be reached in full when investigating the patient collective of this study, this work still shows that the donor site morbidity after extensive soft and hard tissue harvesting using the TDAP-Scap-aa free flap technique can be described as mild. This defines the second lowest tier in the five-tier category rating of the donor site morbidity.

Although high amounts of soft and hard tissue were harvested within the reconstruction procedures, the mean DASH score indicates that the patients were able to perform their routine work without limitations approximately one year after surgery.

The postoperative quality of life is determined not only by the primary defect size and the therapy performed, but also by psychological aspects and the individual socioeconomic background that additionally influence the quality of life. Therefore, it is not really possible to objectively assess the impact of the donor site choice on the general health status. Although postoperative quality of life scores (mean subscales) that were evaluated after the reconstruction with the TDAP-Scap-aa free flap were found to be lower when compared with the healthy German population (control group), nearly all of these mean subscales, were found to reach at least 66 % or more of the corresponding mean scores of the German norm population. When assessing the quality of life with the SF-36 questionnaire, this study shows that the overall physical and mental quality of life approximately one year after the reconstruction of extensive soft and hard tissue defects

with the TDAP-Scap-aa free flap in the head and neck region is located in the upper third of the German norm population's overall quality of life.
As a future work project further studies on a prospective and/or a multicentred basis with a larger patient collective are required to analyse the TDAP-Scap-aa free flap reconstruction technique in more detail. Additionally, a preoperatively performed objective baseline assessment would be needed to even better evaluate the reconstruction technique's influence on the quality of life and on the donor site morbidity.

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Appendices

Individual SF-36 scores

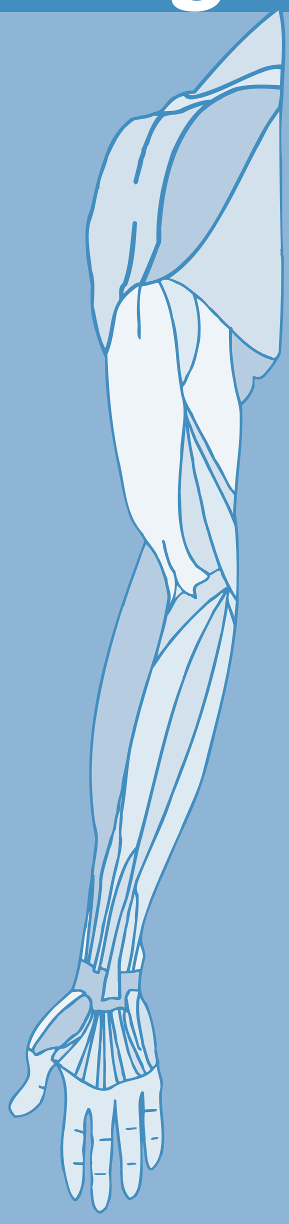
Evaluation of Postoperative Quality of Life *								
Case No.	PF	RP	BP	MH	GH	SF	RE	VT
1	80,0	50,0	100,0	35,0	52,0	100,0	90,0	40,0
2	40,0	0,0	0,0	45,0	56,0	37,5	77,5	15,0
3	80,0	75,0	100,0	40,0	52,0	62,5	80,0	35,0
4	55,0	25,0	66,7	30,0	32,0	50,0	45,0	35,0
5	70,0	25,0	100,0	40,0	60,0	50,0	55,0	50,0
6	70,0	25,0	100,0	45,0	60,0	50,0	77,5	45,0
7	75,0	75,0	66,7	40,0	60,0	50,0	67,5	35,0
8	40,0	0,0	66,7	35,0	44,0	37,5	45,0	50,0
9	70,0	25,0	33,3	30,0	36,0	50,0	67,5	30,0
10	55,0	0,0	33,3	35,0	36,0	50,0	90,0	35,0
11	90,0	25,0	100,0	60,0	60,0	75,0	100,0	45,0
12	90,0	25,0	100,0	45,0	76,0	75,0	77,5	55,0
13	70,0	25,0	33,3	35,0	56,0	50,0	67,5	50,0
14	70,0	25,0	100,0	40,0	60,0	50,0	77,5	35,0
15	80,0	50,0	100,0	55,0	68,0	62,5	77,5	40,0
16	80,0	25,0	100,0	40,0	48,0	62,5	55,0	45,0
17	70,0	25,0	100,0	50,0	56,0	87,5	100,0	45,0
18	90,0	50,0	100,0	45,0	56,0	50,0	77,5	35,0
19	95,0	50,0	100,0	50,0	68,0	75,0	67,5	55,0
20	95,0	75,0	66,7	70,0	96,0	87,5	90,0	80,0

*postoperative SF-36 questionnaire; Subscales are Physical Functioning (PF), Role Physical (RP), Role Emotional (RE), Vitality (VT), Mental Health (MH), Social Functioning (SF), Bodily Pain (BP) and General Health (GH); No. = number

DISABILITIES OF THE ARM, SHOULDER AND HAND

DER

DASH-Fragebogen



ANLEITUNG

Dieser Fragebogen beschäftigt sich sowohl mit Ihren Beschwerden als auch mit Ihren Fähigkeiten, bestimmte Tätigkeiten auszuführen.

Bitte beantworten Sie *alle Fragen* gemäß Ihrem Zustand in der vergangenen Woche, indem Sie einfach die entsprechende Zahl ankreuzen.

Wenn Sie in der vergangenen Woche keine Gelegenheit gehabt haben, eine der unten aufgeführten Tätigkeiten durchzuführen, so wählen Sie die Antwort aus, die Ihrer Meinung nach *am ehesten* zutreffen würde.

Es ist nicht entscheidend, mit welchem Arm oder welcher Hand Sie diese Tätigkeiten ausüben. Antworten Sie Ihrer Fähigkeit entsprechend, ungeachtet, wie Sie die Aufgaben durchführen konnten.

DISABILITIES OF THE ARM, SHOULDER AND HAND

Bitte schätzen Sie Ihre Fähigkeit ein, wie Sie folgende Tätigkeiten in der vergangenen Woche durchgeführt haben, indem Sie die entsprechende Zahl ankreuzen.

	Keine Schwierig-keiten	Geringe Schwierig-keiten	Mäßige Schwierig-keiten	Erhebliche Schwierig-keiten	Nicht möglich
1. Ein neues oder festverschlossenes Glas öffnen	1	2	3	4	5
2. Schreiben	1	2	3	4	5
3. Einen Schlüssel umdrehen	1	2	3	4	5
4. Eine Mahlzeit zubereiten	1	2	3	4	5
5. Eine schwere Tür aufstoßen	1	2	3	4	5
6. Einen Gegenstand über Kopfhöhe auf ein Regal stellen	1	2	3	4	5
7. Schwere Hausarbeit (z. B Wände abwaschen, Boden putzen)	1	2	3	4	5
8. Garten- oder Hofarbeit	1	2	3	4	5
9. Betten machen	1	2	3	4	5
10. Eine Einkaufstasche oder einen Aktenkoffer tragen	1	2	3	4	5
11. Einen schweren Gegenstand tragen (über 5kg)	1	2	3	4	5
12. Eine Glühbirne über Ihrem Kopf auswechseln	1	2	3	4	5
13. Ihre Haare waschen oder fönen	1	2	3	4	5
14. Ihren Rücken waschen	1	2	3	4	5
15. Einen Pullover anziehen	1	2	3	4	5
16. Ein Messer benutzen, um Lebensmittel zu schneiden	1	2	3	4	5
17. Freizeitaktivitäten, die wenig körperliche Anstrengung verlangen (z. B. Karten spielen, Stricken, usw.)	1	2	3	4	5
18. Freizeitaktivitäten, bei denen auf Ihren Arm, Schulter oder Hand Druck oder Stoß ausgeübt wird (z.B. Golf, Hämmern, Tennis, usw.)	1	2	3	4	5
19. Freizeitaktivitäten, bei denen Sie Ihren Arm frei bewegen (z. B. Badminton, Frisbee)	1	2	3	4	5
20. Mit Fortbewegungsmitteln zurecht zukommen (um von einem Platz zum anderen zu gelangen)	1	2	3	4	5
21. Sexuelle Aktivität	1	2	3	4	5

22. In welchem Ausmaß haben Ihre Schulter-, Arm- oder Handprobleme Ihre normalen sozialen Aktivitäten mit Familie, Freunden, Nachbarn oder anderen Gruppen während der vergangenen Woche beeinträchtigt? *(Bitte kreuzen Sie die entsprechende Zahl an)*

Überhaupt nicht	Ein wenig	Mäßig	Ziemlich	Sehr
1	2	3	4	5

23. Waren Sie in der vergangenen Woche durch Ihre Schulter-, Arm- oder Handprobleme in Ihrer Arbeit oder anderen alltäglichen Aktivitäten eingeschränkt? *(Bitte kreuzen Sie die entsprechende Zahl an)*

Überhaupt nicht eingeschränkt	Ein wenig eingeschränkt	Mäßig eingeschränkt	Sehr eingeschränkt	Nicht möglich
1	2	3	4	5

Bitte schätzen Sie die Schwere der folgenden Symptome während der letzten Woche ein. *(Bitte kreuzen Sie in jeder Zeile die entsprechende Zahl an)*

	Keine	Leichte	Mäßige	Starke	Sehr starke
24. Schmerzen in Schulter, Arm oder Hand	1	2	3	4	5
25. Schmerzen in Schulter, Arm oder Hand während der Ausführung einer bestimmten Tätigkeit	1	2	3	4	5
26. Kribbeln (Nadelstiche) in Schulter, Arm oder Hand	1	2	3	4	5
27. Schwächegefühl in Schulter, Arm oder Hand	1	2	3	4	5
28. Steifheit in Schulter, Arm oder Hand	1	2	3	4	5

29. Wie groß waren Ihre Schlafstörungen in der letzten Woche aufgrund von Schmerzen im Schulter-, Arm- oder Handbereich? *(Bitte kreuzen Sie die entsprechende Zahl an)*

Keine Schwierig-keiten	Geringe Schwierig-keiten	Mäßige Schwierig-keiten	Erhebliche Schwierig-keiten	Nicht möglich
1	2	3	4	5

30. Aufgrund meiner Probleme im Schulter-, Arm- oder Handbereich empfinde ich meine Fähigkeiten als eingeschränkt, ich habe weniger Selbstvertrauen oder ich fühle, dass ich mich weniger nützlich machen kann. *(Bitte kreuzen Sie die entsprechende Zahl an)*

Stimme überhaupt nicht zu	Stimme nicht zu	Weder Zustimmung noch Ablehnung	Stimme zu	Stimme sehr zu
1	2	3	4	5

DASH Wert für Behinderung/Symptome = $\left[\frac{\text{Summe der n Antwortpunkte}}{n} - 1\right] \times 25$,
wobei n der Anzahl der beantworteten Fragen entspricht

Wurden mehr als 3 Fragen nicht beantwortet, so darf ein DASH Wert nicht berechnet werden.

SPORT- UND MUSIK-MODUL (OPTIONAL)

Die folgenden Fragen beziehen sich auf den Einfluss Ihres Schulter-, Arm- oder Handproblems auf das Spielen Ihres Musikinstrumentes oder auf das Ausüben Ihres Sports oder auf beides.
Wenn Sie mehr als ein Instrument spielen oder mehr als eine Sportart ausüben (oder beides), so beantworten Sie bitte die Fragen in bezug auf das Instrument oder die Sportart, die für Sie am wichtigsten ist.
Bitte geben Sie dieses Instrument bzw. diese Sportart hier an:

☐ Ich treibe keinen Sport oder spiele kein Instrument (Sie können diesen Bereich auslassen).

Bitte kreuzen Sie die Zahl an, die Ihre körperlichen Fähigkeiten in der vergangenen Woche am besten beschreibt. Hatten Sie irgendwelche Schwierigkeiten:

	Keine Schwierig-keiten	Geringe Schwierig-keiten	Mäßige Schwierig-keiten	Erhebliche Schwierig-keiten	Nicht möglich
1. In der üblichen Art und Weise Ihr Musikinstrument zu spielen oder Sport zu treiben?	1	2	3	4	5
2. Aufgrund der Schmerzen in Schulter, Arm oder Hand Ihr Musikinstrument zu spielen oder Sport zu treiben?	1	2	3	4	5
3. So gut Ihr Musikinstrument zu spielen oder Sport zu treiben wie Sie es möchten?	1	2	3	4	5
4. Die bisher gewohnte Zeit mit dem Spielen Ihres Musikinstrumentes oder mit Sporttreiben zu verbringen?	1	2	3	4	5

ARBEITS- UND BERUFS-MODUL (OPTIONAL)

Die folgenden Fragen beziehen sich auf den Einfluss Ihres Schulter-, Arm- oder Handproblems auf Ihre Arbeit (einschließlich Haushaltsführung, falls dies Ihre Hauptbeschäftigung ist).
Bitte geben Sie Ihre/n Arbeit/Beruf hier an:

☐ Ich bin nicht berufstätig (Sie können diesen Bereich auslassen).

Bitte kreuzen Sie die Zahl an, die Ihre körperlichen Fähigkeiten in der vergangenen Woche am besten beschreibt. Hatten Sie irgendwelche Schwierigkeiten:

	Keine Schwierig-keiten	Geringe Schwierig-keiten	Mäßige Schwierig-keiten	Erhebliche Schwierig-keiten	Nicht möglich
1. In der üblichen Art und Weise zu arbeiten?	1	2	3	4	5
2. Aufgrund der Schmerzen in Schulter, Arm oder Hand Ihre übliche Arbeit zu erledigen?	1	2	3	4	5
3. So gut zu arbeiten wie Sie es möchten?	1	2	3	4	5
4. Die bisher gewohnte Zeit mit Ihrer Arbeit zu verbringen?	1	2	3	4	5

Auswertung der optionalen Module: Die Antwortpunkte der Fragen werden summiert; durch 4 (Anzahl der Fragen) dividiert; 1 wird subtrahiert und danach mit 25 multipliziert.
Für die Auswertung eines optionalen Moduls dürfen keine Antworten fehlen.

Institute for Work & Health | Research Excellence Advancing Employee Health

SF-36 questionnaire

Fragebogen zum Gesundheitszustand (SF-36)

In diesem Fragebogen geht es um Ihre Beurteilung Ihres Gesundheitszustandes. Der Bogen ermöglicht es, im Zeitverlauf nachzuvollziehen, wie Sie sich fühlen und wie Sie im Alltag zurechtkommen.

Bitte beantworten Sie jede der folgenden Fragen, indem Sie bei den Antwortmöglichkeiten die Zahl ankreuzen, die am besten auf Sie zutrifft.

1. Wie würden Sie Ihren Gesundheitszustand im Allgemeinen beschreiben?

(Bitte kreuzen Sie nur eine Zahl an)

Ausgezeichnet...................................... 1

Sehr gut.. 2

Gut.. 3

Weniger gut.. 4

Schlecht... 5

2. Im Vergleich zum vergangenen Jahr, wie würden Sie Ihren derzeitigen Gesundheitszustand beschreiben?

(Bitte kreuzen Sie nur eine Zahl an)

Derzeit viel besser als vor einem Jahr............................ 1

Derzeit etwas besser als vor einem Jahr......................... 2

Etwa so wie vor einem Jahr.. 3

Derzeit etwas schlechter als vor einem Jahr.................. 4

Derzeit viel schlechter als vor einem Jahr...................... 5

3. Im Folgenden sind einige Tätigkeiten beschrieben, die Sie vielleicht an einem normalen Tag ausüben. Sind Sie durch Ihren derzeitigen Gesundheitszustand bei diesen Tätigkeiten eingeschränkt? Wenn ja, wie stark?

(Bitte kreuzen Sie in jeder Zeile nur eine Zahl an)

TÄTIGKEITEN	Ja, stark eingeschränkt	Ja, etwas eingeschränkt	Nein, überhaupt nicht eingeschränkt
a. anstrengende Tätigkeiten, z.B. schnell laufen, schwere Gegenstände heben, anstrengenden Sport treiben	1	2	3
b. mittelschwere Tätigkeiten, z.B. einen Tisch verschieben, staubsaugen, kegeln, Golf spielen	1	2	3
c. Einkaufstaschen heben oder tragen	1	2	3
d. mehrere Treppenabsätze steigen	1	2	3
e. einen Treppenabsatz steigen	1	2	3
f. sich beugen, knien, bücken	1	2	3
g. mehr als 1 Kilometer zu Fuß gehen	1	2	3
h. mehrere Straßenkreuzungen weit zu Fuß gehen	1	2	3
i. eine Straßenkreuzung weit zu Fuß gehen	1	2	3
j. sich baden oder anziehen	1	2	3

4. Hatten Sie in den vergangenen 4 Wochen aufgrund Ihrer körperlichen Gesundheit irgendwelche Schwierigkeiten bei der Arbeit oder anderen alltäglichen Tätigkeiten im Beruf bzw. zu Hause?

(Bitte kreuzen Sie in jeder Zeile nur eine Zahl an)

SCHWIERIGKEITEN	JA	NEIN
a. Ich konnte nicht so lange wie üblich tätig sein	1	2
b. Ich habe weniger geschafft als ich wollte	1	2
c. Ich konnte nur bestimmte Dinge tun	1	2
d. Ich hatte Schwierigkeiten bei der Ausführung (z.B. ich mußte mich besonders anstrengen)	1	2

5. Hatten Sie in den vergangenen 4 Wochen aufgrund seelischer Probleme irgendwelche Schwierigkeiten bei der Arbeit oder anderen alltäglichen Tätigkeiten im Beruf bzw. zu Hause (z.B. weil Sie sich niedergeschlagen oder ängstlich fühlten) ?

(Bitte kreuzen Sie in jeder Zeile nur eine Zahl an)

SCHWIERIGKEITEN	JA	NEIN
a. Ich konnte nicht so lange wie üblich tätig sein	1	2
b. Ich habe weniger geschafft als ich wollte	1	2
c. Ich konnte nicht so sorgfältig wie üblich arbeiten	1	2

6. Wie sehr haben Ihre körperliche Gesundheit oder seelischen Probleme in den vergangenen 4 Wochen Ihre normalen Kontakte zu Familienangehörigen, Freunden, Nachbarn oder zum Bekanntenkreis beeinträchtigt?

(Bitte kreuzen Sie nur eine Zahl an)

Überhaupt nicht.. 1

Etwas... 2

Mäßig.. 3

Ziemlich.. 4

Sehr... 5

7. Wie stark waren Ihre Schmerzen in den vergangenen 4 Wochen?

(Bitte kreuzen Sie nur eine Zahl an)

Ich hatte keine Schmerzen... 1

Sehr leicht 2

Leicht.. 3

Mäßig.. 4

Stark.. 5

Sehr stark.. 6

8. Inwieweit haben die Schmerzen Sie in den vergangenen 4 Wochen bei der Ausübung Ihrer Alltagstätigkeiten zu Hause und im Beruf behindert?

(Bitte kreuzen Sie nur eine Zahl an)

Überhaupt nicht.. 1

Ein bisschen.. 2

Mäßig.. 3

Ziemlich.. 4

Sehr... 5

9. In diesen Fragen geht es darum, wie Sie sich fühlen und wie es Ihnen in den vergangenen 4 Wochen gegangen ist. (Bitte kreuzen Sie in jeder Zeile die Zahl an, die Ihrem Befinden am ehesten entspricht). Wie oft waren Sie in den vergangenen 4 Wochen...

(Bitte kreuzen Sie in jeder Zeile nur eine Zahl an)

BEFINDEN	Immer	Meistens	Ziemlich oft	Manch-Mal	Selten	Nie
a. ...voller Schwung	1	2	3	4	5	6
b. ...sehr nervös	1	2	3	4	5	6
c....so niedergeschlagen, daß Sie nichts aufheitern konnte?	1	2	3	4	5	6
d. ...ruhig und gelassen	1	2	3	4	5	6
e. ...voller Energie?	1	2	3	4	5	6
f. ...entmutigt und traurig	1	2	3	4	5	6
g. ...erschöpft	1	2	3	4	5	6
h. ... glücklich	1	2	3	4	5	6
i. ...müde	1	2	3	4	5	6

9. Wie häufig haben Ihre körperliche Gesundheit oder seelischen Probleme in den vergangenen 4 Wochen Ihre Kontakte zu anderen Menschen (Besuche bei Freunden, Verwandten usw.) beeinträchtigt?

(Bitte kreuzen Sie nur eine Zahl an)

Immer.. 1

Meistens.. 2

Manchmal.. 3

Selten.. 4

Nie.. 5

10. Inwieweit trifft jede der folgenden Aussagen auf Sie zu?

(Bitte kreuzen Sie in jeder Zeile nur eine Zahl an)

AUSSAGEN	Trifft ganz zu	Trifft weit-gehend zu	Weiß nicht	Trifft weitgehend nicht zu	Trifft überhaupt nicht zu
a. Ich scheine etwas leichter als andere krank zu werden	1	2	3	4	5
b. Ich bin genauso gesund wie alle anderen, die ich kenne	1	2	3	4	5
c. Ich erwarte, dass meine Gesundheit nachlässt	1	2	3	4	5
d. Ich erfreue mich ausgezeichneter Gesundheit	1	2	3	4	5