Minireview Article

MICROVASCULAR RECONSTRUCTION OF MANDIBLE USING FREE FIBULA FLAPS:*A Systematic Review*

ABSTRACT

Segmental abnormalities of the mandible can be caused by infectious illnesses, trauma, malignant and benign tumours, and malignancies of all types. Problems with mastication, swallowing, and speech can result from the interruption of the mandible's continuity, disruption of muscle attachments, and loss of sensory and motor nerve innervations. Without a mandible reconstruction, significant functional, cosmetic, and social issues might develop, leading to a lower quality of life in terms of health. The best course of action is immediate reconstruction, both functionally and aesthetically.

Therefore, this systemic was planned aimed to predict the outcomes, assess risk factors and evaluate the immediate and late postoperative complications, involving mandibular reconstruction using microvascular free fibula grafts. Comparing it with other osseo-myo-cutaneous reconstructive options for mandibular defects.

Keywords: [Microvascular Reconstruction, Reconstruction of Mandible, Microvascular reconstruction of Mandible, Free Fibula Flaps, Segmental Defects of the Mandible]

1. INTRODUCTION

Segmental abnormalities of the mandible can be caused by infectious illnesses, trauma, malignant and benign tumours, and malignancies of all types. Problems with mastication, swallowing, and speech can result from the interruption of the mandible's continuity, disruption of muscle attachments, and loss of sensory and motor nerve innervations. Without a mandible reconstruction, significant functional,

cosmetic, and social issues might develop, leading to a lower quality of life in terms of health. The best course of action is immediate reconstruction, both functionally and aesthetically[1].

At the beginning of the 1980s, metal reconstruction plates were first developed. Non-vascularized bone grafts and reconstruction plates were used to try to rebuild the mandible, but the outcomes were inadequate functionally, and there was a failure rate of up to 30%[2].

Using a reconstructive plate, the mandibular defects can be bridged. If enough soft tissue is still there for a watertight primary closure, then this is feasible. Reconstruction plates are quick and simple to use, but one negative is that they are prone to complications including infection, plate fracture, loosening of screws , and the onset of problems with the screws that hold the plate in place[3].

Primary repair after ablative surgery or tissue loss due to trauma using autologous tissue has become the mainstay in maxillofacial and thoracico-cervical surgery during the past decade. The acceptable sites for donating graft tissue for tissue replacement in the head and neck area were osteomyocutaneous flaps such as, sternocleidomastoid with the clavicle, pectoralis major with an associated rib trapezius with the scapula, temporalis with the parietal bone,the pectoralis major with an associated rib, and the iliac crest[4].

The emergence of micro-vascular procedures, in particular, has broadened our scope of capability[5]. Pedicle flaps have given way to free flaps in the restoration of complicated oro-mandibular abnormalities throughout the years.

In 1975, Taylor et al. published the primary description of the free fibula flap as an exclusive osteal flap for tibial defect restoration. Although, the free fibular osteomyocutanous flap was first reported in 1983 by Chen et al.The ability of the flap to concurrently mend composite flaws was considerably improved by the addition of a paddled skin with the fibula. In 1989, Hidalgo described the free fibular flap in head and neck surgery for reconstruction of the mandible. These first reports paved the path for the free fibular osteomyocutaneous flap to establish itself as a gold standard for segmental defect repair of the mandible [6].

For numerous reasons, the fibular osteomyocutaneous free flap soon a acquired favour over these vascularized osseous flaps.

In comparison to the fibula, only the vascularized iliac crest flap has more bone girth. The considerable thickness of cortex and because the fibula is bicorticaled in nature, osseointegrated implants can be used for comprehensive and successful oromandibular repair.

It is by far the largest vascular bone flap known by length, with a harvest length of roughly 26 cm, enabling for restoration of the complete jaw[7]. The fibular can be cultivated as a exclusively osseous flap or in association with muscle andskin, allowing for significant versatility in the restoration of practically any soft tissue deformity of the mandible[8]. Flap harvesting is a simple procedure that allows ablative and reconstructive surgeons to operate together. Donor site morbidity is also modest, since maximum patients achieve their functionality as the were preoperatively , and the fibular flap may be harvested while the head operation is being performed, as changing the patient's posture is not necessary[9].

The fibula has a dual arterial supply, getting blood from both endosteal and periosteal sources. The substantial periosteal supply seems to be increasingly important for graft longivity than the endosteal supply, allowing for numerous osteotomies as close as 1 cm apart.The peroneal artery is the major blood supply to the microvascularfree fibular flap, and the flap is drained by the two venae comitantes**[10]**.

Thus the FFF has a highest success rate and a minimal peril of complications due to the development of surgical procedures.

Although , flap problems and loss can happen and can cause serious implications. Multiple risk factors for flap problems and flap loss have been discovered in the literature.These include the patient's medical history and habits, microvascular surgical technique, ischemicperiod, intraoperative hypotension, operative time period, recipient’s vascular selection, and anticoagulant therapy**[11].** Skeletal muscle mass (SMM), commonly known as sarcopenia, has been established as an increasingly significant risk factor of both survival and surgical prognosis in cancer patients in recent years. Another concern was the full loss of a flap due to unforeseen inadequacies in the donor veins;

partial flap loss due to infections, technical expertitize, operator skill set and experience still remain a key factor in graft success and survibility[12].

To improve surgical outcome, it is critical to prevent venous thrombosis, it ranks amnog the primary reasons leading to transplantation failure. There is ongoing debate over if dual venous anastomoses can help prevent postoperative venous thrombosis. Early researches did demonstrate that dual venous anastomoses decreased the incidence of venous thrombosis in free flap repair by increasing the quantity of anastomosed veins. Althought according toan hypothesis Hanasono et al who suggested, twin anastomoses may restrict the velocity of flow in these veins, and this stasis may play a role in the onset of venous thrombosis [13].

Therefore, this systemic was planned aimed to predict the outcomes, assess risk factors and evaluate the immediate and late postoperative complications, involving mandibular reconstruction using microvascular free fibula grafts.

2. MATERIAL AND METHODS

AIM OF THE STUDY:

TO EVALUATE THE SUCCESS RATES OF MANDIBULAR RECONSTRUCTION USING MICROVASCULAR FREE FIBULA GRAFTS.

OBJECTIVES OF THE STUDY:

1. To evaluate the short term and long term complications of using microvascular free fibula grafts for mandibular reconstruction.
2. To evaluate the short term complications affecting the survivability success rate of microvascular free fibula grafts.
    - Infection.
    - Flap Necrosis.
    - Hematoma.
3. To evaluate the factors long term complications affecting the survivability success rate of microvascular free fibula grafts.
    - Wound Dehiscence.
    - Ischaemia/Arterial Insufficiency.
    - Nonunion/Malunion.
    - Graft Rejection.
4. Evaluation of the role of these criterias in governing graft acceptance or rejection with respect to time.

METHODOLOGY

Search Strategy:

A systematic literature search of PubMed, Google Scholar, Medline,Ebsco Host, Embase and Cochrane Library databases was performed from 2000 to 2023was done to collect articles pertaining to 'Mandibular Reconstruction Using Free Fibula Grafts' using specific boolean words. The boolean terms used for the search were 'Microvascular Reconstruction Of Mandible', 'Free Fibula Grafts', 'Maxillo-Facial Reconstruction With Autologous Grafting', 'Reconstruction Of Mandibular Segmental Defects', 'Vascularised Mandibular Grafts', 'Microvascular Reconstruction of Jaw Defects', 'Osteocutaneous Free Fibula Flaps'.
("Microvascular Reconstruction Of Mandible" [Mesh] OR 'Reconstruction'[All Fields] OR 'Microvascular' [All Fields] OR 'Mandible'[All Fields] AND "Free Fibula Grafts"[Mesh] OR 'Free Fibula' [All Fields] OR 'Fibula Grafts'[All Fields] AND "Maxillo-Facial Reconstruction With Autologous Grafting" [Mesh] OR 'Maxillo-Facial'[All Fields] OR 'Reconstruction'[All Fields] OR'Autologous Grafting'[All Fields] AND "Reconstruction Of Mandibular Segmental Defects" [Mesh] OR 'Segmental'[All Fields]) OR 'Defect'[All Fields] AND "Vascularised Mandibular Grafts"[Mesh] OR 'Vascularised'[All Fields] OR 'Mandibular Grafts' [All Fields] "Microvascular Reconstruction of Jaw Defects"[Mesh] OR 'Jaw Defects'[All Fields] AND'Osteocutaneous Free Fibula Flaps' OR 'Osteocutaneous'[All Fields] OR "Fibula Flaps[All Fields]).

Technique:

The type of studies included were randomized control trials, discussions and original research.Duplicates were excluded and abstracts were screened based on predetermined selection criteria. Relevant full text articles were retrieved and reference lists manually screened for additional articles. Subsequently, the full texts of these articles were critically analysed.The review was done in accordance with Preferred Reporting items for systemic Reviews and Meta-Analysis (PRISMA) statement guidelines after detailed PICO analysis. 4408 records were obtained through database searches. After removing duplicates, 141 records were excluded. Out of the remaining 4267 records, titles were screened and 4213 articles were excluded after evaluating the title and abstract. Subsequently, 54 full-text articles were assessed for eligibility, out of which 52 did not meet the inclusion criteria and were excluded. Finally, 2 studies were selected for quantitative and qualitative assessment of the Mandibular Reconstruction Using 'Microvascular Free Fibula Grafts'.

Goal of Analysis:

A thorough review and analysis of the articles were made to identify the short and long term complications of using microvascular free fibula flaps, the factors affecting it and evaluation of its success rates.

CRITERIAS:

Inclusion Criteria:Includes systematic reviews, randomized control trials, discussions and original research involving the following,

1. Articles involving mandibular reconstruction.
2. Articles involving post traumatic reconstruction of mandible.
3. Articles involving post surgical reconstruction of mandible after pathologies like carcinoma and osteoradionecrosis.
4. Articles involving oromandibular reconstruction using microvascular free fibula flap.
5. Articles evaluating of success rates of osteocutaneous free fibula graft.

6. Articles analysing the early and delayed complications osteomyocutaneous free fibula flaps.

Exclusion Criteria:Excludes systematic reviews, randomized control trials, discussions and original research involving the following,

1. Articles involving maxillofacial reconstruction other than the mandible.
2. Articles assessing mandibular reconstruction outcomes in patient age group <18 yrs.
3. Articles involving reconstruction using autografts other than free fibula flap.
4. Articles assessing post surgical reconstruction outcomes with study duration < 5yrs.

Table 1 :**PICO ANALYSIS**

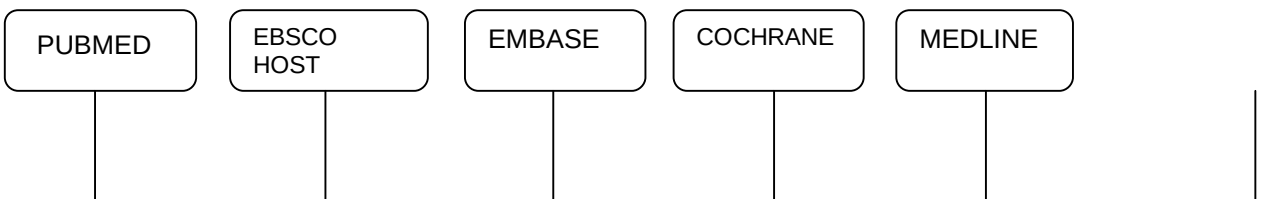
P	**Population**	Patients undergoing Mandibular Reconstruction post surgery due to trauma or pathology.
I	**Intervention**	Mandibular Reconstruction with Microvascular Free Fibula flaps.
C	**Comparison**	To compare the factors effecting complications of using Microvascular Free Fibula Flaps for Mandibular Reconstruction.
O	**Outcome**	To Evaluate the long term Survivility and Success Rate of Microvascular Free Fibula Flaps. Flap Necrosis, Wound Dehisence, Infection, Ischaemia/Arterial Insufficiency, Nonunion/Malunion, Hematoma/Venous thrombosis.

Table 2 : Follow up review

Name of Article	Early and late complications in the reconstructed mandible with free fibula flaps.	Survival analysis of segmental mandibulectomy with immediate vascularized fibula flap reconstruction in stage IV oral squamous cell carcinoma patients.	Low skeletal muscle mass is a strong predictive factor for surgical complications and a prognostic factor in oral cancer patients undergoing mandibular reconstruction with a free fibula flap	Fibula Free Flap in Head and Neck Reconstruction: Identifying Risk Factors for Flap Failure and Analysis of Postoperative Complications in a Low Volume Setting
Author	Johannes T.M. van Gemert.	Hongyang Ma et AL.	Roberto SACCO et AL.	Pieter-Jan Verhelst.
Inclusion of PICO	YES	YES	YES	YES
Review Method & Significant Deviation.	YES	YES	YES	YES
Reason for selection of study design.	YES	YES	YES	YES
Comprehensive Literature Search.	YES	YES	YES	YES
Study selection in duplicate.	YES	YES	YES	YES
Data extraction on duplicate.	YES	YES	YES	YES
Exclusion Criteria & it's justification.	NO	NO	NO	NO
Detailed description of PICO in study.	NO	NO	NO	NO
Exclusion of risks of bias.	YES	YES	YES	YES
Source of funding.	NO	NO	NO	NO
Stat Analysis done if meta analysisincluded.	YES	YES	YES	YES

Impact of ROB if meta analysis is performed.	NO	NO	NO	NO
Effect of ROB in data interpretation.	NO	NO	NO	NO
Explanation of heterogencity.	NO	NO	NO	NO
Investigation on publication bias on quantitative synthesis (if performed) and it's impact on result	YES	YES	YES	YES
Report on conflict of interest including funding.	NO	NO	NO	NO

Chart 1- **SEARCH DESIGN**



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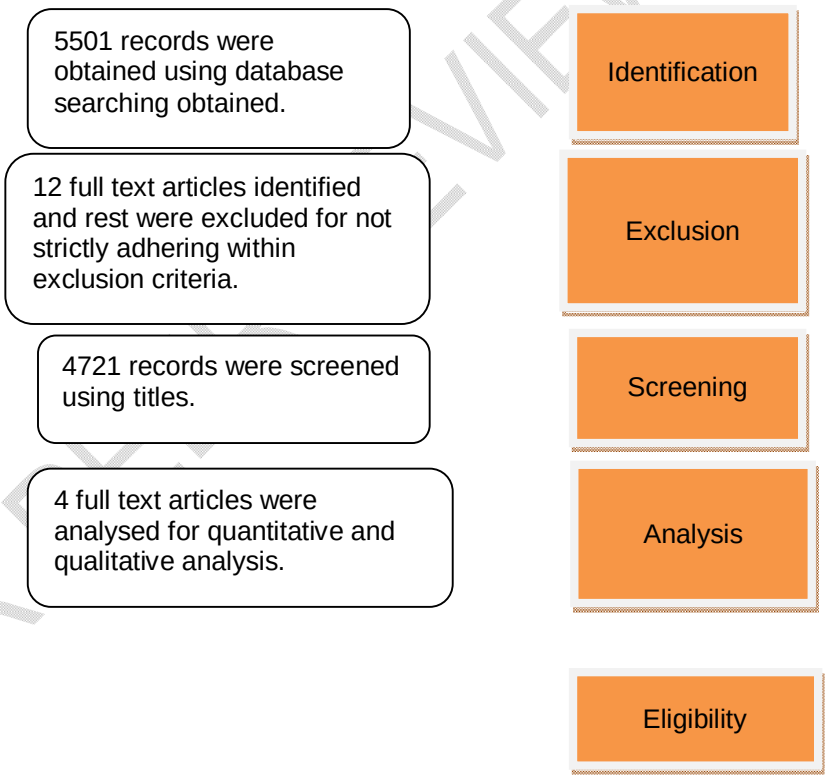


2.1 Review of Literature:

1. **Joseph j. Disa and Geter g. Cordeiro (2000)[2]:**For mandible reconstruction, microvascular surgery has become the favoured procedure. When feasible, rapid

rebuilding during segmental mandible excision provides the greatest cosmetic and functional outcome. Four donor sites have emerged as the principal sources of vascularized bone and soft tissue for restoration (fibula, iliac crest, radial forearm, and scapula). The fibula provides a number of benefits, including bone length and thickness, a donor site position that allows flap harvest to occur concurrently with tumour excision, and little donor site morbidity. Most abnormalities, particularly those with anterior or extensive bone defects needing repeated osteotomies, should be treated using the fibula donor site first.The use of an alternate donor site is best reserved for situations requiring a considerable amount of soft tissue but little bone. Dental rehabilitation with the help ofto optimise aesthetics and function, the use of prostheses and osseointegrated dental implants is an important aspect of the reconstructive process. The authors offer an approach for mandible rebuilding using microvascular osseous flaps.

2. **P. Sieg, J. O. Zieron, S.Bierwolf, S. G. Hakim (2002)[5]:** Despite the popularity of the 'laterodorsal calf' donor area with the fibula, flexor muscles, and overlaying skin for microsurgical bone and soft tissue transfer, various restrictions and potential problems must be noted. We provide data on 93 patients who had 96 reconstructions, 65 with soft tissue transplant and 31 without microvascular fibular grafts have been used for mandibular replacement and oromandibular repair for 8 years. Six patients died in the first four weeks, and eight flaps were lost. Skin paddle necrosis occurred in 7 (11%) of 61 patients with easy bone recovery.
3. **Stephen M. Warren, Loren J. Borud, Lawrence E. Brecht, Michael T. Longaker, John W. Siebert (2005)[4]:**Although free tissue transfer is a well-established method for adult mandibular repair, there have been few reports of paediatric microvascular lower jaw reconstruction.Microvascular restoration of the paediatric mandible is a safe, dependable surgery that offers the bone stock and soft tissue required to restore normal maxillomandibular development and dental rehabilitation in chosen patients.

4. **F. Ho¨lzle, M. R. Kesting, G. Ho¨lzle, A. Watola, D. J. Loeffelbein, J. Ervens, K. -D. Wolff (2007)[1]:** This study compared the perceptions of female and male patients on functional and cosmetic outcomes following mandibular reconstruction with free fibular flaps, the transplant of choice for lesions longer than half a mandible or the simultaneous covering of a soft-tissue defect. Based on clinical data, 54 patients with an average postoperative follow-up of 63 months were analysed retrospectively. Furthermore, each patient completed a 12-item scaled questionnaire to measure pain, speech, mastication, and deglutition on the recipient site, as well as pain, oedema, gait abnormalities, problems moving upstairs, and spraining on the donor site. Mastication functional ratings were poor for both sexes. The male group rated their deglutition and speaking impairments as more persistent or frequent. 62% of female patients and 34% of male patients thought the recipient region's aesthetic result was unsatisfactory. Both sexes rated donor site morbidity as modest, with outstanding aesthetic effects. Gender tends to influence how people perceive face changes. Female patients are less satisfied with the cosmetic results of mandibular reconstruction than males, but they are more satisfied with the functional benefits.
5. **Shu-Ying Chang, Jung-Ju Huang, M.D. Chung-Kan Tsao, Anh Nguyen, KrithiMittakanti, B.S. Chia-Yu Lin, Ming-Huei Cheng (2010)[10]:**In this study the restoration of segmental mandibular abnormalities, the fibula osteoseptocutaneous flap has been described as a superb choice. In order to determine the crucial ischemia time for this technique, this study was done to look into the association between ischemia time and the outcome of the fibula flap.
6. **Roberto SACCO, Gianluca SACCO, Alessandro ACOCELLA, Silvana SALE, Nicola SACCO, Edoardo BALDONI (2010)[11]:** The goal of this systematic analysis was to analyse the role of microsurgical reconstruction of the jaws in patients with bisphosphonate-related osteonecrosis, as well as biological consequences following at least a 12-month observation period. Methods and materials: An electronic MEDLINE search was conducted, supplemented by manual searching, to identify studies reporting data of at least 12 months

observation on the microsurgical reconstruction of the jaws in patients with bisphosphonate-related osteonecrosis, complications, and a success rate of 100%, as no recurrence of osteonecrosis was registered. Microsurgical jaw reconstruction is a viable therapy option in individuals with bisphosphonate-related osteonecrosis at the third stage.

7. **Johannes T. M. van Gemert, Robert J. J. van Es et al (2011):** Assessed the problems and effectiveness of free fibula flap mandibular repair. The study comprised 83 individuals with segmental mandibular abnormalities.Correlation studies were done to examine the link between recipient-site problems and success and reconstruction type and clinical factors. In effectively restored survivors, dental recovery was examined.The results of multivariate analysis revealed substantial associations between flap type and success (P.0001).51 (61%) of the patients were still alive two years following the reconstruction. When compared to reconstruction with free vascularized bone flaps, mandibular reconstruction using a free forearm flap and reconstruction plate was linked with greater complication rates and failure rates at the recipient location. 14 (44%) of the 32 successfully repaired survivors had complete dental rehabilitation, with 10 having dental implants and four not.Mandibular reconstruction with a free vascularized bone flap outperforms reconstruction with a free forearm flap and a reconstruction plate. Only around half of the survivors had complete dental rehabilitation.
8. **Prabha S. Yadav, Quazi G. Ahmad, Vinay K. Shankhdhar, G. I. Nambi (2012)[8]**: The free fibula flap is the preferred flap for mandibular repair after significant tumour removal. While significant defects are handled with a second flap [free or pedicle] in advanced centres, in resource-constrained locations, a free fibula flap with a wide skin paddle that can be de-epithelised to supply outer skin and inner lining is the best option.From January 2005 to December 2009, 386 free fibula flaps were employed in rebuilding difficult oral and mandibular deficits following tumour ablative procedures, 307 of which had de-epithelised double skin paddles.The results showed that 282/307 patients had complete flap

survival. In 9/307 individuals, complete flap loss was seen. In 16 cases, there was partial flap loss. Re-exploration was carried out.done in 30 patients, and the flap was saved in 21. The vascular supply of the free fibula osteomyocutaneous flap is dependable, and a flap with a wide skin paddle may be employed in resource-constrained sites to provide both inner lining and outside cover.

9. **Terry Sua, Rui Fernandes (2012)[6]:** Since Hidalgo's original report of its application for mandibular restoration, the fibula osteocutaneous free flap has been a workhorse. The purpose of this publication is to evaluate the use of the fibula flap in mandibular reconstruction and to dispel some of the prevalent misunderstandings about why some surgeons see it as a lesser reconstructive choice than the vascularized iliac crest flap.
10. **Zhengxue Han, Jinzhong Li, Hua Li, Ming Su, And Lizheng Qin (2013)[13]:** The purpose of this study was to assess the success rates of single and dual venous anastomosis of the free fibula osteocutaneous flap in mandibular repair. A retrospective assessment of all instances of mandibular reconstruction employing free fibula osteocutaneous flaps done in our department by a single surgeon from January 2005 to April 2012. All of the flaps were extracted and transplanted according to conventional procedures. A single or two veins were microvascularly anastomosed. A portable Doppler was used to assess the viability of the flap on the tenth day following surgery, in addition to usual clinical examination. During this time, two hundred and one free fibula osteocutaneous flaps were executed. In 112 flaps, single venous anastomosis was done.In 89 flaps, dual venous anastomoses were accomplished. The total incidence of vascular thrombosis was 3%, and the transplantation success rate was 98.5%. Six patients experienced surgical vascular thrombosis. One case involved arterial thrombosis 12 hours after the initial procedure in the dual venous anastomoses group. Three venous thrombosis occurred within 24 hours.Following the procedure in the single venous anastomosis group. Two venous thrombosis occurred 3-4 days after the initial operation in the dual venous anastomoses group, and both attempts to salvage failed. The Fisher's exact test

revealed no significant difference in success rates between single and dual anastomoses groups (P 5 0.59). There is no difference in success rates between single and dual venous anastomosis for mandibular reconstruction with free fibula osteocutaneous flap.

11. **Pieter-Jan Verhelst, Flore Dons, Pieter-Jan Van Bever, Joseph Schoenaers, Lloyd Nanhekhan,ConstantinusPolitis(2017**):In this study of maxillofacial reconstruction, the fibula free flap (FFF) has proven a workhorse. This approach has a high rate of success.

Identifying risk factors for flap failure and analysing consequences, on the other hand, might pave the road for better patient care. To identify risk variables and postoperative complications, a retrospective study of all FFFs performed at a low-volume single tertiary centre during a 20-year period was performed. There were 129 FFFs in all (122 mandibles and 7 maxillae). Complete flap failure occurred in 12.4% of patients, whereas partial flap failure occurred in 7.8%. Younger age was observed to be related with flap failure, and the majority of failures were connected with venous thrombosis. In-hospital surgical problems occurred in 60.5% of patients, in-hospital medical complications happened in 49.6%, and out-of-hospital complications occurred in 77.5%.In-hospital care.

12. **Johannes T.M. van Gemert, Jan H. Abbink, Robert J.J. van Es, Antoine J.W.P. Rosenberg, Ron Koole , Ellen M. Van Cann (2017)[3]:**Mandibular reconstructions with free fibula flaps evaluated. Identification of risk factors for significant recipient site problems, requiring surgical intervention under general anaesthesiaCrossing the midline fibula flaps have a greater risk of early significant recipient site problems than unilateral reconstructions. Tobacco use raises the chance of late problems.
13. **Meaghan L. Barr, Christos S. Haveles, Kameron S. Rezzadeh, Ian T. Nolan, Ruben Castro, Justine C. Lee, Derek Steinbacher and Miles J. Pfaff (2019)[9]:**For complex mandibular repair, the fibula free flap (FFF) remains the

gold standard. Surgeons have included virtual surgical planning (VSP) into the reconstructive algorithm, claiming that it improves operating efficiency and clinical results. There have been no large-scale investigations that have looked into these claims. This study evaluates the literature and tests the hypothesis that, when compared to standard procedures, VSP increases operation efficiency, clinical outcomes, and accuracy.

14. **E. Ansaria , N. Chargia , J.T.M. van Gemerta , R.J.J. van Esa,b , F.J. Dielemana , A.J.W.P. Rosenbergb , E.M. Van Canna, R. de Breea (2019)[12]:**Fibula free flaps (FFF) are efficient in successfully reconstructing mandibular segmental defects. Previous study has identified potential risk factors for FFF problems, including as age, comorbidities, and smoking. Low skeletal muscle mass (SMM) has emerged as a risk factor for complications and a prognostic factor for survival in patients with head and neck cancer. The purpose of this study is to determine the predictive and prognostic usefulness of low SMM for surgical FFF related issues, postoperative complications, and survival in patients who had mandibular reconstruction using FFF following oral cavity cancer excision.
15. **Hongyang Ma, Sohaib Shujaat, Michel Bila, Lloyd Nanhekhan, Jan Vranckx, ConstantinusPolitis, Reinhilde Jacobs (2020)[7]:**The purpose of this study is to determine the overall survival rate and postoperative outcomes of patients with oral squamous cell cancer (OSCC) after rapid mandibular reconstruction using vascularized fibula flap (VFF).

3. RESULTS

The initial search returned 5501 studies reported from January 1980 through July 2023. Abstracts and full text reports were acquired for 31 studies. After reviewing the full text reports on the basis of inclusion / exclusion criteria and Robis, only 4 studies were deemed eligible for the present preview. Primary data was extracted from 4 included studies. The total sample size was 795 patients with Mandibular Segmental Defects post surgery due to OSCC and other Pathologies, whose reconstruction was done usingMicrovascular Free Fibula Flap.

FROM THE RESULTS OF INCLUDED ARTICLES 4 ARTICLES WERE SELECTED AFTER APPLYING STRICT INCLUSION AND EXCLUSION CRITERIA:

Table 3: Inclusion and exclusion criteria

CRITERIA STUDY NAME	AUTHOR	INFECTION	FLAP NECROSIS	HEMATOMA/ HAEMORRHGE	WOUND DEHISENCE/ PARTIAL LOSS	ISCHAEMIA/ THROMBOSIS	NON UNION/ PlATE EXPOSURE	GRAFT REJECTION/ COMPLETE FAILURE
*9.Fibula Free Flap in Head and Neck Reconstruction: Identifying Risk Factors for Flap Failure and Analysis of Postoperative Complications in a Low Volume Setting 122	Pieter-Jan Verhelst, Flore Dons, Pieter-Jan Van Bever, Joseph Schoenaers, Lloyd Nanhekhan, ConstantinusPolitis	**26**	**10**	**7**	**10**	**6**	**9**	**16**

***10.Early and late complications in the reconstructed mandible with free fibula flaps 79**	**Johannes T.M. van Gemert, Jan H. Abbink, Robert J.J. van Es, Antoine J.W.P. Rosenberg, Ron Koole , Ellen M. Van Cann**	**14**	**5**	**3**	**4**	**9**	**5**	**10**
***11.Low skeletal muscle mass is a strong predictive factor for surgical complications and a prognostic factor in oral cancer patients undergoing mandibular reconstruction with a free fibula flap 78**	**E. Ansari , N. Chargia , J.T.M. van Gemerta , R.J.J. van Esa,b , F.J. Dielemana , A.J.W.P. Rosenbergb , E.M. Van Canna,b , R. de Breea,**	**0**	**6**	**5**	**4**	**2**	**0**	**1**
***12.Survival analysis of segmental mandibulectomy with immediate vascularized fibula flap reconstruction in stage IV oscc 516**	Hongyang Ma, Sohaib Shujaat, Michel Bila, Lloyd Nanhekhan, Jan Vranckx, ConstantinusPolitis , Reinhilde Jacobs	**46**	**26**	**21**	**72**	**21**	**0**	**41**

EVALUATION OF RESULTS OF INDIVIDUAL STUDIES:

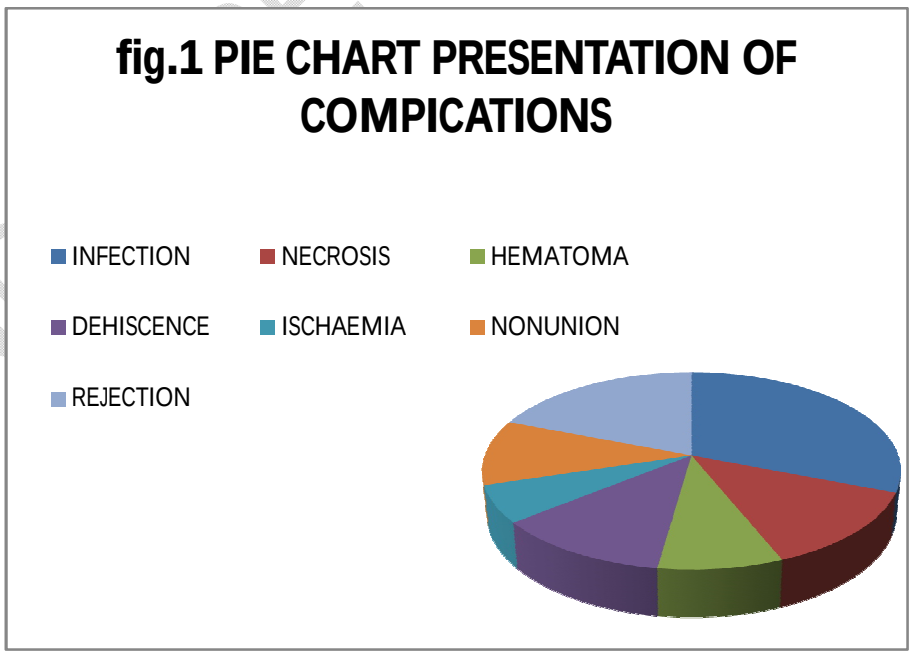
1. Fibula Free Flap in Head and Neck Reconstruction: Identifying Risk Factors for Flap Failure and Analysis of Postoperative Complications in a Low Volume Setting (N-122):

   EARLY COMPLICATIONS:

   - Percentage of occurrence of Infection: 21.30%
   - Percentage of occurrence of Flap Necrosis: 8.90%
   - Percentage of occurrence of Hematoma: 5.73%

   LATE COMPLICATIONS:

   - Percentage of occurrence of Wound Dehiscence: 8.19%
   - Percentage of occurrence of Ischaemia/Arterial Insufficiency: 4.91%
   - Percentage of occurrence ofNonunion/Malunion: 7.37%
   - Percentage of occurrence of Graft Rejection: 13.11%



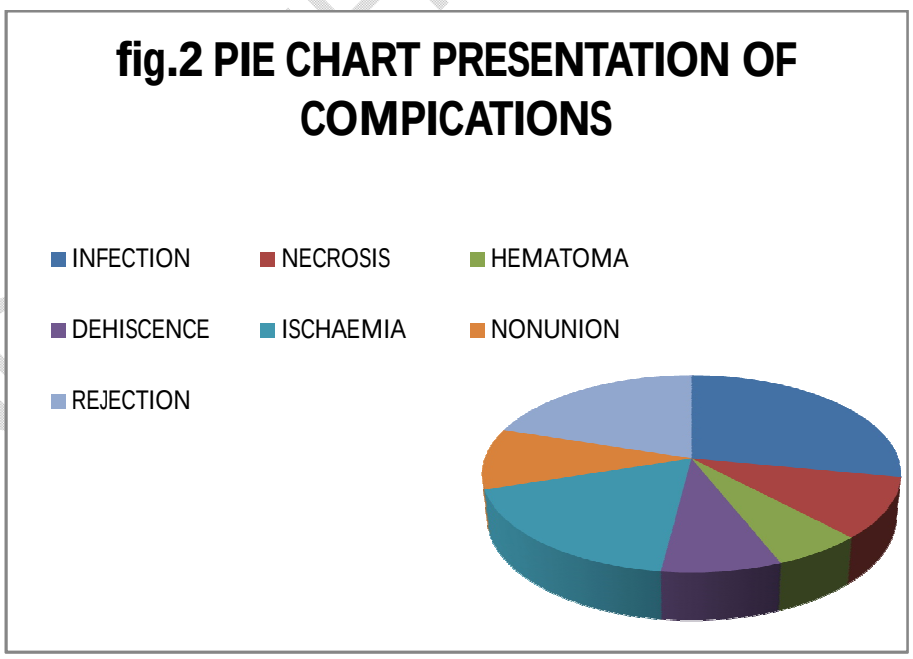
2. Early and late complications in the reconstructed mandible with free fibula flaps (N-79):

EARLY COMPLICATIONS:

- Percentage of occurrence of Infection: 17.72%
- Percentage of occurrence of Flap Necrosis: 6.32%
- Percentage of occurrence of Hematoma: 3.79%

LATE COMPLICATIONS:

- Percentage of occurrence of Wound Dehiscence: 5.06%
- Percentage of occurrence of Ischaemia/Arterial Insufficiency: 11.39%
- Percentage of occurrence ofNonunion/Malunion: 6.32%
- Percentage of occurrence of Graft Rejection: 12.65%



3. Low skeletal muscle mass is a strong predictive factor for surgical complications and a prognostic factor in oral cancer patients undergoing mandibular reconstruction with a free fibula flap (N-78):

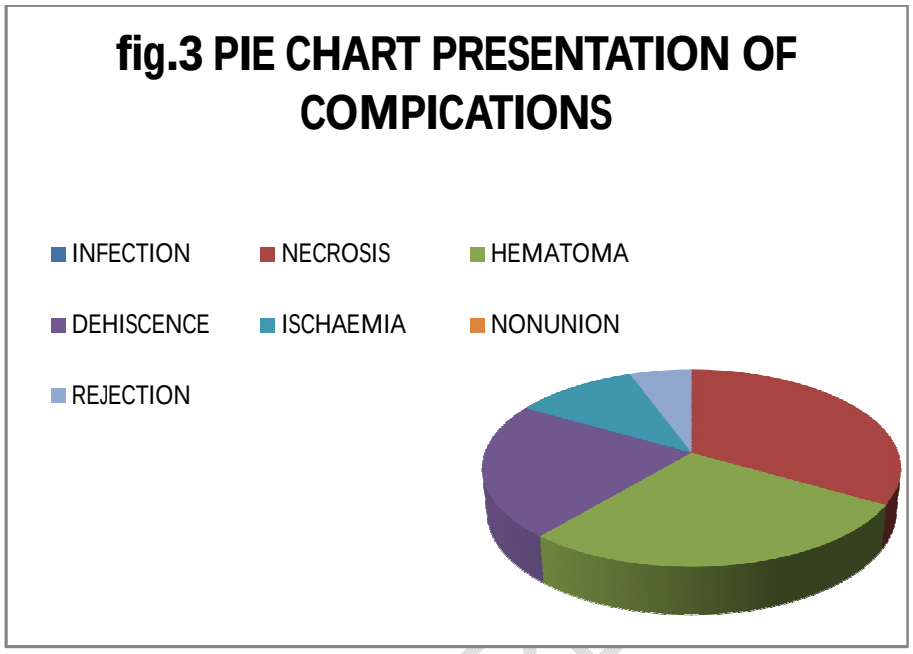
EARLY COMPLICATIONS:

- Percentage of occurrence of Infection: 0%
- Percentage of occurrence of Flap Necrosis: 7.69%
- Percentage of occurrence of Hematoma: 6.41%

LATE COMPLICATIONS:

- Percentage of occurrence of Wound Dehiscence: 5.12%
- Percentage of occurrence of Ischaemia/Arterial Insufficiency: 2.56%

- Percentage of occurrence ofNonunion/Malunion: 0%
- Percentage of occurrence of Graft Rejection: 1.28%



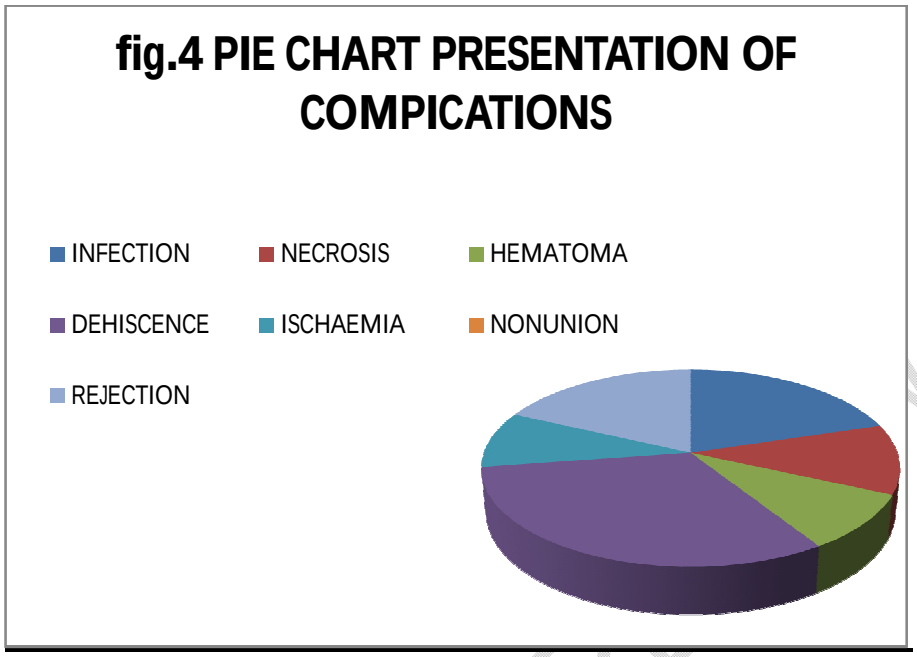
4. Survival analysis of segmental mandibulectomy with immediate vascularized fibula flap reconstruction in stage IV OSCC (N-516):

EARLY COMPLICATIONS:

- Percentage of occurrence of Infection:8.91 %
- Percentage of occurrence of Flap Necrosis: 5.03%
- Percentage of occurrence of Hematoma: 4.06%

LATE COMPLICATIONS:

- Percentage of occurrence of Wound Dehiscence:13.95 %
- Percentage of occurrence of Ischaemia/Arterial Insufficiency: 4.06%
- Percentage of occurrence ofNonunion/Malunion: 0 %
- Percentage of occurrence of Graft Rejection: 7.94%



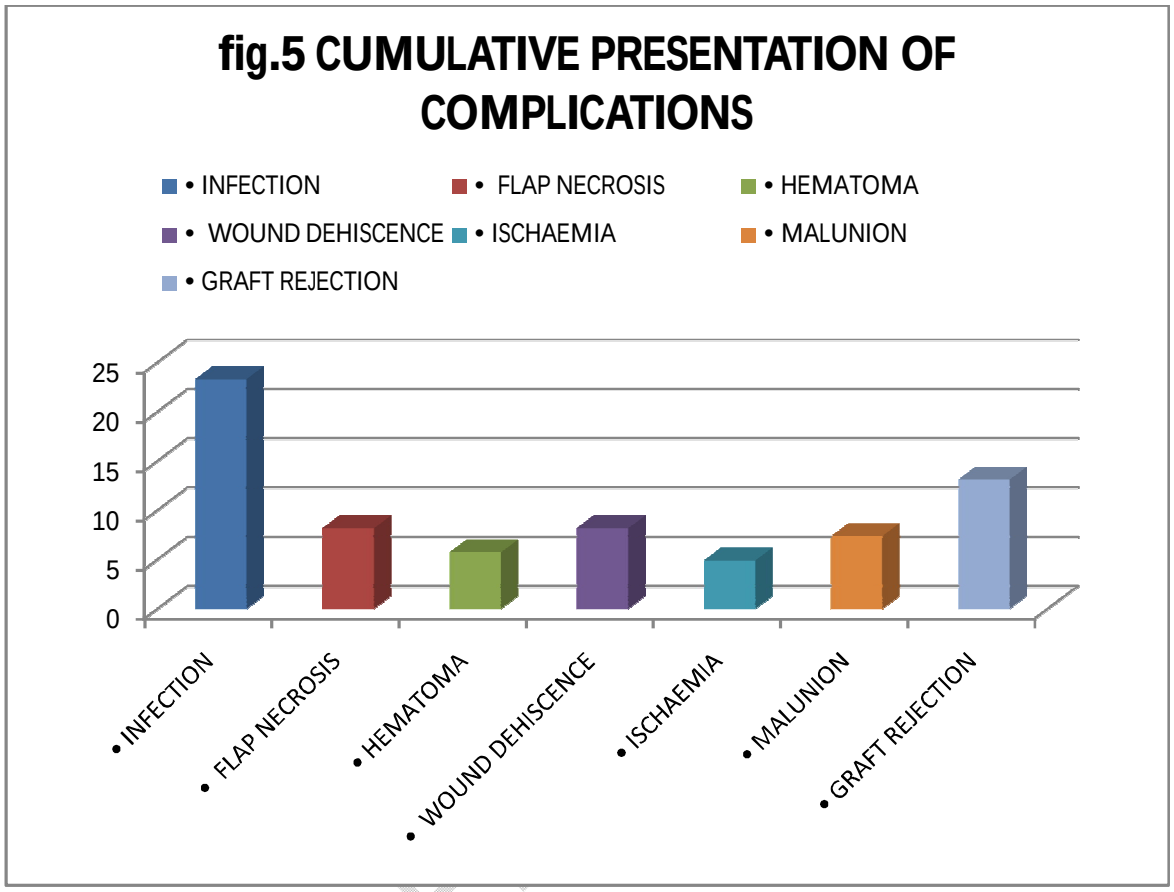
CUMULATIVE RESULTS OF STUDIES:

EARLY COMPLICATIONS:

- Percentage of occurrence of Infection: 21.30%
- Percentage of occurrence of Flap Necrosis: 8.90%
- Percentage of occurrence of Hematoma: 5.73%

LATE COMPLICATIONS:

- Percentage of occurrence of Wound Dehiscence: 8.19%
- Percentage of occurrence of Ischaemia/Arterial Insufficiency: 4.91%
- Percentage of occurrence ofNonunion/Malunion: 7.37%
- Percentage of occurrence of Graft Rejection: 13.11%



DISSCUSION:

Defects of the mandible occur mostly due to cancerous tumours and large cysts like OKC and benign neoplasms like Ameloblastoma. In such cases, respective procedures involves bone, soft tissue and tooth structure removal for oncosurgical procedures which is often associated with poor quality of life.

The novel concept of oncosurgery asserts thats reconstruction of defects after resective procedures remains the mainstay to preserve functionality with maintenance of quality of life and that control of disease is not the primary goal.

In the distant past, the usage of non-vascularized bone grafts resulted in insufficient restoration of function and graft failure, this limited their usage and since the past decade vascularised osseous grafts became increasingly desirable as a reconstructive option. Further to achieve better functional outcome, the criteria to maintain good

anatomic relationships which correlates to correct prosthetic rehabilitation through placement of osseointegrated dental implants, adjusting the residual mandible to correct occlusion and reconstruction of soft tissue deficits, which has now become the gold standard.

A number of options have been explored in the scope of vascularised osseous grafts for instance the iliac crest, scapular free graft, the rib, radial forearm and the metatarsal to mitigate the defects of the mandible.

In 1991, Urken et al in their study claimed that the metatarsal and radial forearm are too inconspicuous and have very feeble osseous tissue to adapt and restore a lengthy defect of the mandible.

Hidalgo and Rekow's report stated that use of radial forearm flap was associated with decreased functionality of the donor wrist and excessive chances of fracture, it was also claimed that although the vascularised rib graft has adequate length for reconstruction of mandible, reconstruction with it still remains an uncertainty due to its width being too less for insertion of transosseous dental implants for rehabilitation.

Where the vascularised iliac crest is capable of providing a good amount of cortico-cancellous osseous tissue portion which is excellent in terms of of thickness and contour, but its usage in reconstruction of mandible is questionable due to its innate bulk of soft tissue needed by it to support the vitality of the skin. Moreover the iliac crest has been linked to high chances of evolution of late hernia and delayed complications due to donor site morbidity and changes to the patients gait.

The microvascular free fibular flap ha shown to hold numerous advantages over the fore mentioned flaps. An extensive length of osseous tissue can be cultivated, it presents a uniform contour, an excellent vascular supply and an sub-anatomy that permits a number of osteotomies; it is positioned in a convenient location with accessibility to attached soft tissues.

A two team approach is near best for mandibular reconstruction using free fibula grafts with one team taking care of the respective and ablative surgical process and the other team conducting the consequent reconstructive and rehabilitation

procedures, which makes possible the two procedures to be conducted simultaneously in one single surgical window and thus secondary surgeries can be avoided.

The FFF is indicated for all anterior defects of the mandible and most of the lateral defects. The FFF allows adequate skin paddle in more than 90% of the patients with rare instances of donor site morbidity. Even though considering its numerous advantages and versatility, one of the primary shortcomings of the flap is the osseous height achieved which considerably lesser as compared to the iliac crest, this could be a genuine drawback in most dentulous patients, where non atrophic mandibular arches maybe encountered. In the mandibular arch, extensive bony defects may result in impaired functionality affecting speech or swallowing efficiency and also leading to poor aesthetics.

The emergence of microvascular surgical techniques for harvesting vascularised bone grafts, most surgical researchers consider the fibular free flap to be the workhorse for rehabilitation of extensive mandibular defects. Ghara et al compiled the possible advantages of the FFF which are the following:

- The FFF has a straight outline and uniform contour and higher stability against pressure and torsional forces.
- The abundance of perforators allow excellent vascular supply, swift integration and graft acceptance with high longevity.
- The FFP present a greater fraction osseous cortex than other free grafts.
- It is extensive in size allowing bridging of lengthy defects
- It allows osteotomy cuts at number of sites.

Hidalgo et al in their report stated a higher instance of graft loss when reconstruction was done with skin paddle. Extensive sub-anatomical studies have questioned the dependability on skin paddle flap when adapted at the interface of distal 3^{rd} to $2/3^{rd}$ of mandibular defects. When they compared the FFF to the scapular osteomyocutaneous flap or radial fore arm flap the main advantage presented b the

fibular free flap was the greater thickness of cortical bone which enable better osseointegration of dental prosthesis for rehabilitation.

Our study shows us that the FFF also is subject to few complications although minimal. Out of these early complications were mostly due to infections which was only about 21.3% and most of the late complications were due to graft rejection which was about 13.1%. The results of our systemic review echoes the claims of these previous studies in cumulative form supporting with evidence, the superiority FFF over the other free flaps which were subjected to greater complications and less desirability.

Even though the radial forearm presented many suitable qualities desired of a graft, it came along with the dilemma of high incidences of fracture of residual donor site.

The scapula osteocutaneous flap holds one significant advantage over the FFF which is the greater length of bone it provides; although the graft's perfusion, vascularity and adaptability at the interface of mandibular defects is unquestionably inferior when compared to the free fibular flap.

Henceforth in the present day scenario of microvascular reconstruction of the mandible; neither the radial forearm osteofasciocutaneous flap nor the scapular osteocutaneous free flap are considered viable options. The microvascular free fibula flap or FFF remains the gold standard for reconstruction of mandibular defects.

4. CONCLUSION

We would like to conclude this systematic review claiming that, the most adaptable and dependable method for microvascular reconstruction of extensive mandibular lesions is, in our opinion is the free fibularosteomyocutaneous flap. As supported by the results of our systemic review, it has minimal complications and maximum percentage of success in practice.

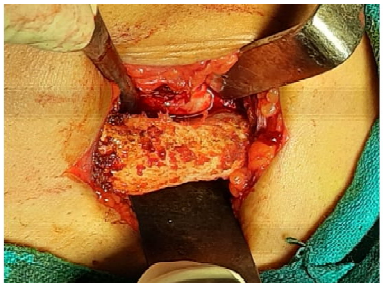
It offers a significant amount of bone that can becontoured for a passive fit to the residual mandible. Moreover the osseous height achieved through this graft is more than adequate for a prosthetic rehabilitation through dental dental implants place

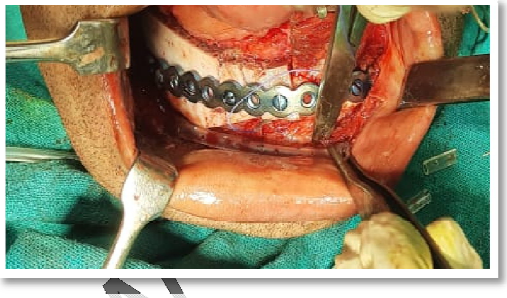
directly in to the grafted bone. There has been advent of techniques to improve the chances obtaining a viable vascularised graft, one such is mapping of the cutaneous perforators preoperatively, this technique is recommended as it promotes a versatile flap design and reduces the donor site morbidity. Other alternatives have although been explored which might be indicated in a few chosen case groups like the iliac crest or scapular free flap but their extensive use is limited as they are not as adaptable and do not provide the prosthetic options like the Free Fibular Osteomyocutaneous Flap.

PICTURES:

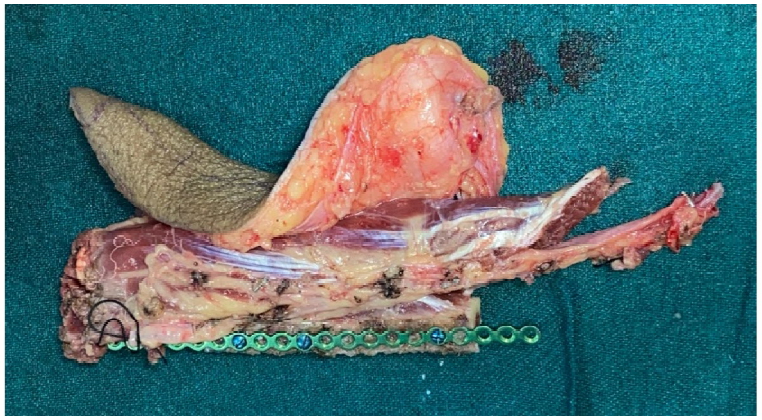
Pic 1- RADIAL FOREARM FREE FLAP

Pic -2 PECTORALIS MAJOR MYOCUTANEOUS FLAP (Non Vascularised)

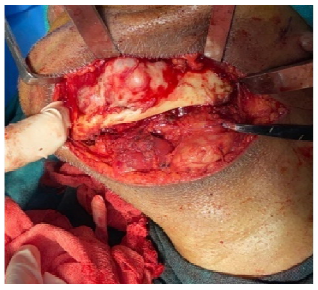


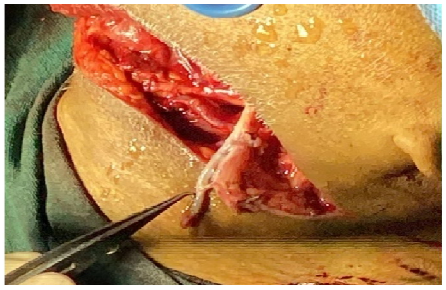


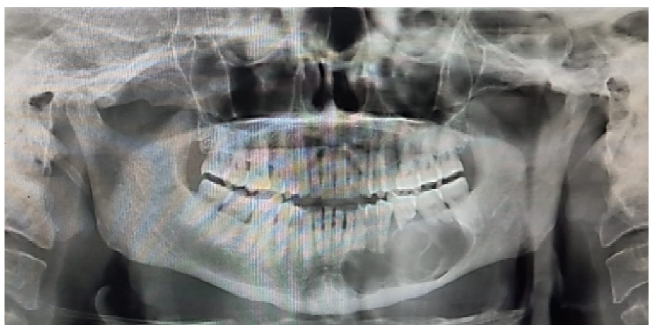
Pic -3 ILIAC CREST GRAFT (NonVascularised)



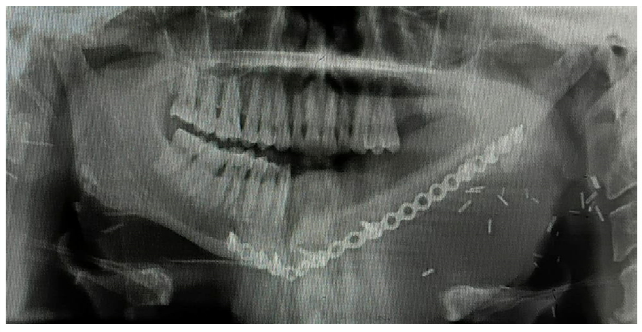
Pic -4 FREE FIBULA FLAP (Vascularized)







Pic -5 PRE OPERATIVE RADIOGRAPH



Pic -6POST OPERATIVE RADIOGRAPH

CONSENT (WHEREEVER APPLICABLE)

Not applicable

ETHICAL APPROVAL (WHEREEVER APPLICABLE)

Not applicable

REFERENCES

1. Joseph J. Disa, Md And Peter G. Cordeiro, Md: Mandible Reconstruction With Microvascular Surgery. Seminars in Surgical Oncology 2000; 19:226–234.
2. P. Sieg, J. O. Zieron, S. Bierwolf, S. G. Hakim : Defect-related variations in mandibular reconstruction using fibula grafts. A review of 96 cases. British Journal of Oral and Maxillofacial Surgery (2002) 40, 322–329.
3. Stephen M. Warren, M.D. Loren J. Borud, M.D. Lawrence E. Brecht, D.D.S. Michael T. Longaker, M.D. John W. Siebert, M.D: Microvascular Reconstruction of the Pediatric Mandible. (Plast. Reconstr. Surg. 119: 649, 2007.).
4. Shu-Ying Chang, M.D. Jung-Ju Huang, M.D. Chung-Kan Tsao, M.D. Anh Nguyen, M.D. KrithiMittakanti, B.S. Chia-Yu Lin, M.Sc. Ming-Huei Cheng, M.D., M.H.A: Does Ischemia Time Affect the Outcome of Free Fibula Flaps for Head and Neck Reconstruction? A Review of 116 Cases. (Plast. Reconstr. Surg. 126: 1988, 2010.).
5. Roberto Sacco , Gianluca Sacco , Alessandro Acocella , Silvana Sale , Nicola Sacco, Edoardo Baldoni: A systematic review of microsurgical reconstruction of the jaws using vascularized fibula flap technique in patients with bisphosphonate-related osteonecrosis. Journal Applied Oral Sciences; October 26, 2010.

6. Johannes T. M. van Gemert, DMD, MD, Robert J. J. van Es, Antoine J. W. P. Rosenberg, Andries van der Bilt ,Ron Koole, and Ellen M. Van Cann: Free Vascularized Flaps for Reconstruction of the Mandible: Complications, Success, and Dental Rehabilitation. 2012 American Association of Oral and Maxillofacial Surgeons J Oral MaxillofacSurg 70:1692-1698, 2012.
7. Prabha S. Yadav, Quazi G. Ahmad, Vinay K. Shankhdhar, G. I. Nambi: Reconstruction of oncological oro-mandibular defects with double skin paddled-free fi bulafl ap: A prudent alternative to double fl aps in resourceconstrained centres. Journal of Cancer Research and Therapeutics - January-March 2012 - Volume 8 - Issue 1.
8. Terry Sua, Rui Fernandes: Microvascular reconstruction of the mandible: An argument for the fibula osteocutaneous free flap; revespciroralmaxilofac. 2 0 1 4;36(2):1–8.
9. Zhengxue Han, Jinzhong Li, Hua Li, Ming Su, And Lizheng Qin: Single Versus Dual Venous Anastomoses Of The Free Fibula Osteocutaneous Flap In Mandibular Reconstruction: A Retrospective Study; 3 September 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/micr.22176.
10. Pieter-Jan Verhelst, Flore Dons, Pieter-Jan Van Bever, Joseph Schoenaers, Lloyd Nanhekhan, ConstantinusPolitis: Fibula Free Flap in Head and Neck Reconstruction: Identifying Risk Factors for Flap Failure and Analysis of Postoperative Complications in a Low Volume Setting; Craniomaxillofacial Trauma and Reconstruction received September 29, 2017 accepted after revision January 5, 2018.
11. Johannes T.M. van Gemert, Jan H. Abbink, Robert J.J. van Es, Antoine J.W.P. Rosenberg, Ron Koole, Ellen M. Van Cann: Early and late complications in the reconstructed mandible with free fibula flaps; WILEY Journal of Surgical Oncology 2017.
12. Meaghan L. Barr, Christos S. Haveles,Kameron S. Rezzadeh,Ian T. Nolan, Ruben Castro, Justine C. Lee, Derek Steinbacher and Miles J. Pfaff: Virtual

Surgical Planning for Mandibular Reconstruction With the Fibula Free Flap; (Ann PlastSurg 2019).

13. E. Ansaria , N. Chargia , J.T.M. van Gemerta , R.J.J. van Esa, F.J. Dielemana , A.J.W.P. Rosenbergb , E.M. Van Canna, R. de Breea: Low skeletal muscle mass is a strong predictive factor for surgical complications and a prognostic factor in oral cancer patients undergoing mandibular reconstruction with a free fibula flap; Oral Oncology 101 (2020).

14. Hongyang Ma, Sohaib Shujaat, Michel Bila, Lloyd Nanhekhan, Jan Vranckx, ConstantinusPolitis, Reinhilde Jacobs: Survival analysis of segmental mandibulectomy with immediate vascularized fibula flap reconstruction in stage IV oral squamous cell carcinoma patients; 8 December 2020.

15. David A Hindalgo; The osteocutaneous free fibula flap is the skin paddle reliable; Nov 27, 1991.

16. F. Ho¨lzle, M. R. Kesting, G. Ho¨lzle, A. Watola, D. J. Loeffelbein, J. Ervens, K. -D. Wolff: Clinical outcome and patient satisfaction after mandibular reconstruction with free fibula flaps. Int. J. Oral Maxillofac. Surg. 2007; 36: 802–806.

17. Arthur H. Salibian, Irving Rappaport, David W. Furnas,Bruce M. Achauer: Microvascular Reconstruction of the Mandible; The American Journal of Surgery 1980.

18. Matthew L. Iorio, Meera Cheerharan, B.S. Michael Olding: A Systematic Review and Pooled Analysis of Peroneal Artery Perforators for Fibula Osteocutaneous and Perforator Flaps; Plast. Reconstr. Surg. 130: 600, 2012.

19. Bhuvanesh Singh, Peter.G. Cordeiro, Jatin.P. Shah: Factors Associated With Complications of MicrovascularReconstruction Of Head And Neck Defects; Journal Of Plastic And Reconstructive Surgery, 1999.

20. David A. Hidalgo: Fibula free flap: a new method of mandible reconstruction; Plast. Reconstr. Surg. 1989:84:71-9.

21. Fu-Chan Wei et AL: Fibula Osseoseptocutaeous Flap For Reconstruction Of Composite Mandibular Defects; Journal Of Plastic And Recontructive Surgery, 1994.

22. Sarah Lonie, Pradyumna Herle, Alenka Paddle, Neelprada Pradhan, Theo Birch and Ramin Shayan: Mandibular reconstruction: meta-analysis of iliac- versus fibula-free flaps; ANZ J Surg 86 (2016) 337–342.

23. JenniferAn-Jou Lin, CharlesYuenYungLoh, Chia-HsuanTsai, Kai-PingChang ,JohnChung-HanWu& Huang-Kai Kao: Free Flap Outcomes of Microvascular Reconstruction after Repeated Segmental Mandibulectomy in Head and Neck Cancer Patients; Nature: Scientific Reports (2019) 9:7951.

24. Evan Matros, Graham S. Schwarz, Babak J. Mehrara, Qunying Y. Hu, Peter G. Cordeiro, Joseph J. Disa: Indications and Outcomes for Mandibular Reconstruction Using Sequential Bilateral Fibula Flap; Journal of Plastic and Reconstructive Surgery ,November 2010.

25. Qunying Y. Hu, Peter G. Cordeiro, Joseph J. Disa: Reconstruction Of Mandible With Osseous Free Flaps; Journal Of Plastic And Reconstructive Surgery,1999.

26. Mark L Urken et Al: Oromandibular Reconstruction Using Microvascular Composite Flaps: Arch Otalaryngol Head And Neck Surgery.

27. lan M. Zlotolow, Joseph M. Huryn, John D. Piro, Enrique Lenchewski, David A. Hidalgo: Osseointegrated Implants and Functional Prosthetic Rehabilitation in Microvascular Fibula Free Flap Reconstructed Mandibles; The American Journal Of Surgery Volume 165 December 1992.

28. Yang Ming Chang et AL: Immediate Osseointegrated Dental Implants, Journal Of Plastic and Reconstructive Surgery 1998.

29. Neil .F. Jones et Al: Reliability Of Fibular Osteocutaneous Flap For Mandibular Reconstruction; Journal Of Plastic and Reconstructive Surgery 1998.

30. Jose M. López-Arcas, Javier Arias , Jose L. Del Castillo, Miguel Burgueño, Ignacio Navarro, María J. Morán, Manuel Chamorro, and Vicente Martorell: The Fibula Osteomyocutaneous Flap for Mandible Reconstruction; J Oral MaxillofacSurg 68:2377-2384, 2010.

31. Raúl González-García, Luis Naval-Gías, Francisco J. Rodríguez-Campo, Mario F. Muñoz-Guerra, and Jesús Sastre-Pérez: Vascularized free fibular flap for the reconstruction of mandibular defects; . (Oral Surg Oral Med Oral Pathol Oral RadiolEndod2008;106:191-202).

DEFINITIONS, ACRONYMS, ABBREVIATIONS

ABBREVIATIONS:

OSCC	Oral Squamous Cell Carcinoma
SCC	SCC Squamous Cell Carcinoma
HNSCC	Head and Neck Squamous Cell Carcinoma
PNI	Perineural Invasion
FFF	Free Fibula Flap
SMM	Skeletal muscle mass
PMMC	Pectoralis Major Myocutaneous
VSP	Virtual surgical planning
VFF	Vascularized fibula flap
N	Total number of study subjects
OKC	Odontogenic Keratocyst
OMFS	Oral and Maxillofacial Surgery