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A Systematic Review of Microvascular Reconstruction Techniques in Head and Neck Surgery: Accessing Advancements in Surgical Methods and Functional Outcomes

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ABSTRACT

In recent years, microvascular reconstruction in head and neck surgery has gained significant advancements. With advent of latest technological innovations in microvascular reconstruction techniques, now surgeons have better and more safe option of critical surgeries such as neck and head. Scientists now have a deeper understanding of anatomical complexities because of the latest knowledge and tools. In this systematic review, we aim to discuss the latest technological advancements in head and neck surgery and what kind of microvascular reconstruction techniques are performed with novel surgical methods. Innovations like Augmented Reality (AR) integration, patient-specific implants, and 3D-printed surgical guides have improved surgical outcomes. This review discusses dynamic microvascular reconstruction techniques for facial paralysis. We have emphasised the success of immediate functional gracilis transfer and chimeric flaps. We will discuss novel strategies such as microvascular alternative donor site technology and the adoption of immediate dental implants, which have also contributed to improved aesthetic and functional outcomes.

KEYWORDS: Advanced Head and Neck Reconstruction Techniques, Alternative Donor Site Options in Surgery, Digital Surgical Mapping for Precision Planning, Rapid Dental Implantation Solutions.

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INTRODUCTION

The inception of reconstructive microsurgery can be traced back to the pioneering principles established by Alexis Carrel and Guthrie in the early 1900s when vascular surgery first time became the real option of surgery, which not only laid the groundwork for vascular surgery but also paved the way for the development of transplant surgery[0]. These foundational insights have, over time, catalysed the emergence of microvascular surgery, transforming the landscape of reconstructive medicine by enabling the correction of complex defects that were once deemed irreparable, often resulting in significant disfigurement and compromised outcomes. Mahieu et al. (2016) stated that the advent of free flap techniques has revolutionised this field because it has provided us with new benchmarks of reconstructive excellence across a myriad of defect types and surpassed the capabilities of traditional pedicled flaps in terms of versatility and effectiveness[II].

For head and neck reconstruction, the microvascular reconstruction field has evolved from mere closure of wounds to a sophisticated endeavour aimed at enhancing patient satisfaction through restoring aestheticness and functionality, Yadav (2013) elaborated. Innovation in microvascular reconstruction of the head and neck highlights the need for careful planning and selecting appropriate flap options so that surgeons may achieve optimal aesthetic results and improve patients' quality of life [III]. Højvig et al. and Chang et al., 2015 have highlighted great success rates for microvascular reconstruction in the head and neck region, and these techniques are shifting the focus towards refining surgical techniques further and exploring novel strategies to elevate overall patient outcomes[IV, V]. This involves physically restoring the defect site while ensuring that the chosen donor site aligns with the patient's aesthetic and functional expectations. Agrawal et al., 2018 suggested advancements in intravascular or microvascular reconstruction, such as using alternative flap donor sites or medial sural artery perforator (MSAP), providing superior colour matching and reducing donor site morbidity, enhancing outcomes in complex cases. Other advancements include virtual surgical planning (VSP) and medical modelling for precise mandible and midface reconstruction [VI]. Innovations in facial paralysis management, such as functional gracilis muscle transfer solves facial nerve challenges. Integrating artificial intelligence (AI) promises to enhance patient safety by predicting complications and stratifying risks in this complex field [VII].

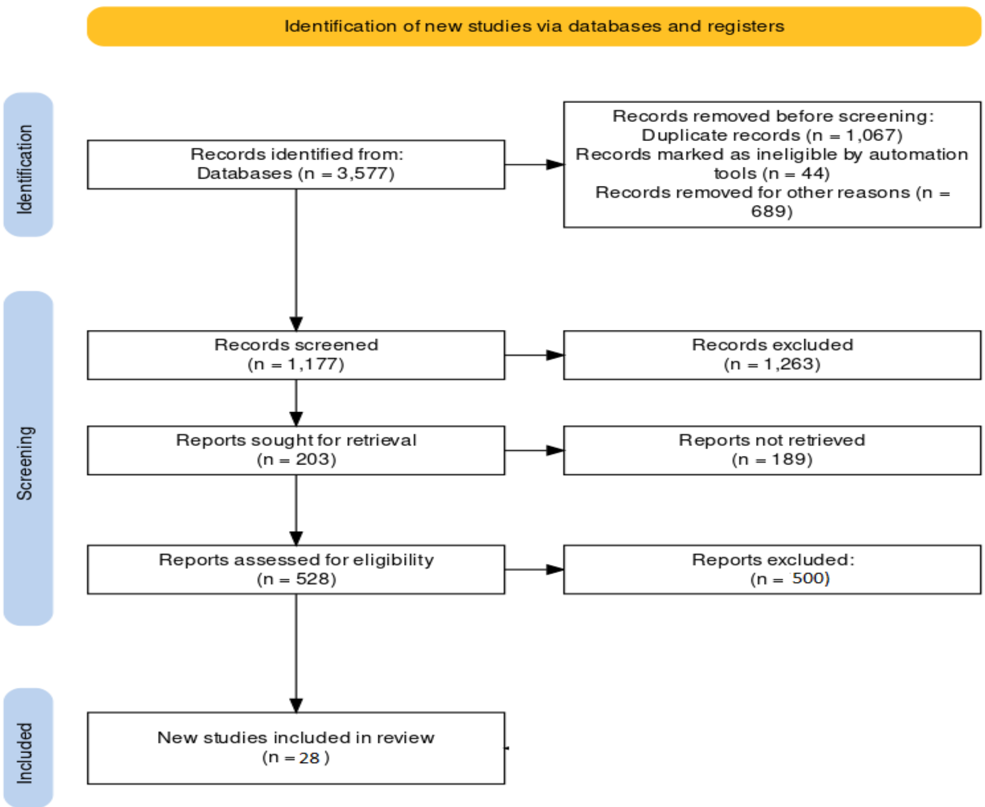
METHODOLOGY

We selected PubMed, MEDLINE, Scopus, and Web of Science to conduct our search, where we limited these studies published in English from January 2000 to December 2023. Our MeSH terms and Boolean operators were used: *("microvascular reconstruction" OR "free flap" OR "head and neck surgery") AND ("technological advancements" OR "virtual surgical planning" OR "CAD-CAM" OR "functional outcomes" OR "aesthetic outcomes") AND ("facial paralysis" OR "dental implants" OR "nerve reconstruction" OR "bone flaps").*

INCLUSION CRITERIA

We focused those papers on the latest advancements in microvascular reconstruction techniques in head and neck surgery, and research articles that report on technological advancements, functional outcomes, or aesthetic outcomes were selected only. We intend to include papers on virtual surgical planning, CAD-CAM, nerve reconstruction, dental implants, or alternative bone flaps. While selecting, we keep in mind that papers are peer-reviewed.

While excluding studies, we discarded titles that did not mentioned head and neck surgery and microvascular reconstruction. Case reports, editorials, letters, and conference abstracts are not included, and those studies published before 2000 or in languages other than English. After selecting data of interest, we made a Prisma chart which is below.



RESULTS

We yielded a total of 3,577 records as a result on PubMed, MEDLINE, Scopus, and Web of Science. We removed 1,067 duplicates using Convidence Software and excluded 733 records based on automation tools and other reasons. We got 1,777 records were screened. From these, 1,263 records were excluded, leaving 203 reports for retrieval. However, 189 reports could not be retrieved, resulting in 528 reports being assessed for eligibility. Ultimately, 28 studies met the inclusion criteria and were included in the review. Selected studies provided valuable insights into the advancements in microvascular reconstruction techniques in head and neck surgery, highlighting significant progress in surgical methods and functional outcomes.

Microvascular Reconstruction Techniques in Head and Neck Surgery and Their Advancements

Microvascular Technique	**Description**	**Novel Advances and Innovations**
Soft Tissue Reconstruction	Involves using free flaps like anterolateral thigh (ALT), radial forearm, and latissimus dorsi myocutaneous flaps for reconstructing defects.	- Introduction of alternate flap donor sites like the profunda artery perforator (PAP) and medial sural artery perforator (MSAP) flaps. Enhanced understanding of perforator anatomy and microsurgery techniques. Use of intraoperative perfusion imaging with indocyanine green to improve flap viability.
Virtual Surgical Planning (VSP) and CAD-CAM	Utilizes high-resolution CT scans for detailed planning of resections and reconstructions, particularly for bony defects.	- Adoption of 3D printing for creating precise surgical guides and patient-specific titanium plates. Development of in-house systems for designing and modeling, reducing costs. Integration of CT angiograms of donor sites with 3D models for comprehensive planning.
Dental Rehabilitation	Focuses on the reconstruction of dental structures, often using free fibula flaps, to restore oral function and aesthetics.	- Immediate dental implant placement using CAD-CAM technology for pre-determined screw holes. Strategies to place dental implants before radiation to improve success rates and patient quality of life.
Nerve Reconstruction and Reinnervation	Addresses sensory and motor deficits resulting from resections, through nerve grafting and coaptation.	- Advances in nerve repair techniques and the use of allo- or autografts for sensory restoration. Exploration of coaptation methods for improving sensory outcomes in areas like the lower lip.
Alternate Bone Flaps	Explores the use of different vascularized bone flaps for reconstructing bony defects in the head and neck, traditionally utilizing fibula and scapula flaps.	- Introduction of the medial femoral condyle (MFC) flap for midface reconstruction. Development of chimeric flaps combining vascularized bone and soft tissue flaps for comprehensive reconstruction.
Facial Reanimation	Aims to restore facial movement in cases of facial paralysis using techniques like nerve grafting and functional muscle transfers.	- Incorporation of dynamic muscle transfers using the gracilis muscle and profunda artery perforator (PAP) flaps for both aesthetic and functional restoration. Paradigm shift towards immediate functional muscle transfer even in elderly patients or those undergoing radiation.
Prefabricated and Pre-expanded Flaps	Flaps that are stretched or expanded prior to transfer to the surgical site, often used for significant defects.	- Improved techniques for flap expansion and transfer, leading to better cosmetic and functional outcomes. Application in various areas of the head and neck, including scalp, forehead, and facial reconstruction.
Supermicrosurgery	Involves the dissection and anastomosis of tiny vessels (0.3 to 0.8 mm), used in lymphedema treatment and soft tissue reconstruction.	- Advances in surgical instruments and techniques for precise anastomosis. Application in perforator-to-perforator freestyle flaps and lymphovenous anastomoses.
Perforator Flaps	Flaps based on perforating vessels that supply the skin and subcutaneous tissues, used for various defects.	- Enhanced preoperative imaging and planning for accurate flap design. Development of new perforator flap options for specific head and neck reconstructions.

Chimeric Flaps	Composite flaps consisting of multiple tissues with independent vascular supplies, used for complex reconstructions.	- Advancements in surgical techniques for creating and transplanting chimeric flaps. Application in combined soft tissue and bony reconstructions.
Angiosome Revascularization	Based on the concept of angiosomes (vascular territories), used for designing flaps with reliable blood supply.	- Improved understanding and mapping of angiosomes for precise flap design. Application in compromised circulation areas and pre-irradiated tissues.
Intraoperative Imaging Techniques	Includes methods like ICG fluorescence angiography and ultrasound Doppler for assessing flap perfusion during surgery.	- Enhanced real-time assessment of vascular status and perfusion. Early detection of perfusion issues, leading to immediate intervention and reduced flap failure.
Robot-Assisted Microvascular Surgery and AI	Utilizes robotic systems and artificial intelligence for precise and minimally invasive microvascular procedures.	- Increased precision and control in difficult-to-reach areas. Integration of AI for real-time data analysis and surgical planning.
Endoscopic-Assisted Microvascular Techniques	Incorporates endoscopic tools for minimally invasive microvascular surgery, particularly in hard-to-reach areas.	- Improved visibility and access to the surgical field. Reduced morbidity and faster recovery for patients.
Bioengineered Tissue and Vascular Grafts	Involves the use of 3D-printed tissue-engineered products and vascular grafts for reconstruction.	- Development of bioengineered grafts that mimic natural tissue structure and function. Application in tracheal reconstruction and damaged blood vessel repair.

DISCUSSION: Latest advancements in microvascular reconstruction techniques

1. Prefabricated and Pre-expanded Flaps

The prefabricated and pre-expanded flaps technique is suitable for significant defects with large surface sores, cancer operations tissue removal, and broad radiation therapy. Pre-expanded means that these flaps are stretched or expanded prior to their transfer to the surgical site. This expansion can increase the amount of tissue available for reconstruction, making it particularly useful for repairing significant defects, such as those caused by cancer operations or radiation therapy. Prefabricated means that the flaps (pieces of tissue) used in the surgery are created in advance, often in a different location on the patient's body, before they are transferred to the area that needs reconstruction. Multi-compartment flaps prefabricated or pre-expanded form innovative methods in microvascular surgery that are utilised to reconstruct defects significant in size in the head and neck region. Such methods call for skin expansion by inserting a tissue expander under the skin and soft tissues and moving it forward. The flap can be transferred, and an adequate amount of skin for coverage can be provided without any increase in the donor site morbidity. They excel in the elements that deal with equal colouring, texture similarity, and relevant contours, e.g., forehead, cheeks, lips, and chin. Contrasting to conventional techniques, prefinished and pre-expanded flaps have many benefits, overall including appearance, injury on the donor site, or the ability to cover deep wounds without additional surgeries. The surgical technique commences with the 2-D or 3-D planning of the expander size and shape that can be fixed under the scalp or near the area with the defect. Subsequently, the gradual inflation of the expander is started which takes weeks or months; the expanded flap that is then transferred to the defect site is finally closed with the primary closure of the donor area. Prefabricated and pre-expanded flaps are used in scalp surgery, followed by laser hair removal for a smooth, hairless appearance on the scalp flaps. Nevertheless, the technique has certain imperfections, like multiple operations, a chance of different complications: hematoma, infection and necrosis, and an extended stay at the hospital. In recent case studies, enough evidence indicates that these facial reconstructions are highly accurate and that the obtained CD textures are excellent matches. Research continues to try to find a way to refine the expansion process more and lessen complications and possible areas in which this device can be used elsewhere in the head and neck region[VIII].

Super micro surgery

In the case of super microsurgery, a method that entails the dissection and anastomosis of tiny vessels from 0.3 to 0.8 mm, microsurgery has transformed the treatment of lymphedema and soft tissue reconstruction[IX]. It is particularly effective in reconstructing small and very delicate parts, such as the facial nerve or eyelid, where anastomosis must be completely precise. This technique enables the surgeon to operate even over tiny vessels and minimises the donor-site morbidity by dissecting short pedicles at the suprafascial level[IX]. Applied initially to digit tip saving, super microsurgery is now employed in numerous microsurgical procedures, which include lymphovenous anastomoses, vascularised lymph node transfers, and perforator-to-perforator anastomoses. Developments in technology and surgical skills have augmented microsurgical results so that microsurgeons can focus on decreasing donor-site morbidity and increasing reconstruction function and cosmetic appearance. Supermicrosurgery, also known as microneurovascular anastomosis for vessels and single nerve fascicles measuring 0.3 to 0.8 mm, utilises the most delicate instruments for very small anastomosis. Firstly, Koshima et al. introduced this technique, and later, it was expanded by others to do perforator-to-perforator freestyle flaps and lymphovenous anastomosis for obstructive lymphedema. Perforator-to-perforator freestyle flaps tissue flaps are harvested from donor areas of the body, typically containing perforating blood vessels, and transferred to the recipient site, where they are connected to recipient perforators (small blood vessels) to ensure adequate blood supply and tissue viability. Supermicrosurgery is now an integral part of the microsurgery practice, which includes testing and standardisation, as well as wholesome results studies supporting it. Supermicrosurgery has dramatically improved the management of ageing lymphedema through procedures such as lymphovenous anastomosis (LVA) and vascularised lymph node transfer (VLNT) [IX]. LVA involves anastomosis of subcutaneous lymphatic vessels to deep venules, which requires super microsurgical skills due to the minimal calibre of the vessels. VLNT is a technique that involves transplanting a free tissue flap that possesses vascularised lymph nodes to reestablish lymphatic flow. The clinical studies on these methodologies have proved positive outcomes in lymphedema treatment, suggesting subjective improvement and volume changes in patients. The question for many is whether LVA and VLNT are efficient and influential in lymphedema treatment, mainly due to complex techniques, varying results and the limitations of well-designed studies.

Regarding soft tissue reconstruction, super microsurgery makes it possible to use accurate perforator flaps and carry out perforator-to-perforator anastomoses, which lower the risk of morbidity after surgery and the duration of the operation, respectively. The method offers the surgeon more discretion in selecting the donor area and recipient's vessel to enhance the whole process and aesthetic and functional outcomes. In addition, a microscope diverting light (microscope) is still being applied in hand surgery for fingertip replantation, toe-tip transfer and free nail transfer, offering accurate and precise anatomic structure reconstruction and sensory functioning to be restored[IX]. Supermicrosurgery is also applicable in fields like craniofacial, upper eyelid, and urethral reconstructions, demonstrating its versatility and precision for various purposes. Teaching super microsurgery techniques demands adequate skills, including synthetic models, biological cadaveric models, and living animal models. Through magnetically controlled mechanical arms, RAS technology may make super microsurgery more accurate by precisely controlling instruments and damping hand tremors. The following areas in super microsurgery will receive more emphasis: transplantation of organs, customised reconstruction and salvage procedures in very complicated cases with severe existing diseases. Besides, as microsurgical research changes in the coming days, program development and research on outcomes will be essential for implementing and refining super microsurgical procedures [IX].

Perforator Flaps

Perforator flaps may be applied to solve different types of defects of the oral cavity, pharynx, or scalp with one of the advantages of minimal donor site morbidity. The perfusion flaps serve as a revolutionary injection of energy into microvascular surgery, with head and neck defects being the apparent recipients. Their identification is through the vascular supply, which derives from perforating vessels that go through the deep fascia to nourish the skin and subcutaneous regions. In the head and neck region, perforator flaps are selected for reconstructing defects associated with oncologic resections, trauma, or inherited anomalies[XI.] Perforator flap development offers several advantages over traditional options – less morbidity at the donor site, better aesthetic outputs and more variability. The procedure will involve locating the perforator vessels, which will be done via dissection. Subsequently, meticulous and advanced microsurgical skills will be utilised to operate the vessel. Nevertheless, perforator flaps have challenges, such as reliance on postulate imaging, steep learning curve and potential for vascular compromise. Continual research in this field aims to perfect flap construction, enhance patient outcomes, and widen the area of application of the perforator flap in reconstructive surgery[X].

Chimeric Flaps

Chimeric flaps, the latest and so far the most complex technique in reconstructive surgery, are quite superior and versatile for reconstruction[XII]. They are a composite of their constituent tissues, which may include skin, muscle, bone and other adipocytes with an independent specific vascular supply, and are also harvested as whole units[XIII].

Therefore, 3-D printing's exclusive ability to substitute targets that are not present in nature is of great importance in repairing complex conditions, especially when volume deficits or dynamic movement need to be restored, as commonly encountered in facial reconstruction [XIV].

The utility of chimeric flaps is best illustrated in microvascular surgery, particularly face and neck surgery, where instead of just filling in the defect, a reconstruction must focus on tailoring the flap to provide adequate coverage and functional restoration. For example, in a situation where there is a significant soft tissue defect that involves the facial skin due to extensive facial trauma or tumour resection, a chimeric flap could be used to give the coverage, the support for the structure, and a muscle for the moving action [XVXVIXVII]. Engaging the principle of chimeric flaps has granted better cosmetic and functional outcomes than the old practices that required the creation of protective structures, resulting in a worse adolescence. Even though procedures for creating and transplanting chimeric flaps are complex and require detailed preparation and implementation, it is successful. It allows surgeons of any level to perform the surgery, as it has been done many times by many surgeons successfully. Surgeons ought to meticulously outline the vascular anatomy of the flap region to attain either the former blood vessels' connection or the creation of new ones. As advantageous as they are, chimeric flaps may have weaknesses like longer operation times and a lack of mastery of speciality surgical skills. The development of chimeric flaps is an exponentially growing and rapidly advancing research area currently devoted to modifying chimeric flap procedures and patient recovery. It can replicate complicated reconstructions for situations involving two types of tissue, usually the case for combining skin with the muscle for this purpose- facial reconstruction[XVIII].

Angiosome Revascularization

The angioma notion, promoted by Taylor and Palmer, is a fundamental development in reconstructions received by patients, especially in making up perforator flaps for microvascular operations of the head and neck. Vascular territories are being mapped to design flaps with a reliable blood supply that ensures success in the compromised circulation areas (such as in pre-irradiated tissues). The angioma idea is more stable and specific than the older methods, which sometimes were imprecise and prevented complete flap perfusion, leading to necrosis. This process starts with a thorough preoperative evaluation and imaging of the vascular territories, which is essential in designing the flap. Limitations that come with it include the need for anatomical knowledge and access to advanced imaging techniques. Researchers continue concentrating on angleosomal study, with further sophistication of anglesoma vision and its clinical use being the ultimate goal.

Computer-Aided Design and Manufacturing (CAD/CAM)

The field of reconstructive surgery (either for jaws – mandible or maxilla, mainly after tumour resection or trauma) necessitated CAD/CAM tools in the accurate and precise planning and execution processes, focusing on bony reconstructions. CAD/CAM systems provide the opportunity for tailored surgical jigs and implants, which are almost exactly like the patient's anatomical structure, thus leading to the most satisfactory outcomes in both directions, function and aesthetics. Such a breakthrough brings considerable advantages that were never seen before in routine practice because other methods used to be less precise and made it critical to correct the outcome more often as it proceeded. The microsurgical head and neck procedures are also being done with the aid of CAD/CAM, which requires imaging the surgical site to generate a digital model, one of which is used for designing and manufacturing custom implants and guides. While this technology has dramatically improved the precision and efficiency of reconstructive surgery, it has limitations, including the need for specialised equipment and training and the potential for increased costs. Research in this area continues to focus on improving the accuracy and accessibility of CAD/CAM technology for reconstructive surgery[II].

Intraoperative Imaging Techniques

During the surgery, imaging methods have reached a new height of importance. Besides that, they have become synonymous with the surgical practice of both head and neck reconstructions. Such approaches, including indocyanine green (ICG) fluorescence angiography, ultrasound Doppler, and intraoperative computed tomography (CT), are essential for assessing donor flaps during surgery[XIX]. Moreover, the sensors allow the direct, real-time assessment of the vascular situation inside the tissue and, thus, enable immediate intervention in cases of blood flow problems or perfusion. The use of perioperative imaging is critically essential in cases in which vascular compromise can be expected, for instance, patients with previous radiotherapy, a significant scar or complex anatomical problems. These detection methods are helpful in the early phase of problems, which can further minimise the risk of flap failure, postoperative complications, and corrective surgeries [XX].

In contrast to the older technique, which mostly did the job based on the surgeons' experience and checking for perforation until postoperative observation, intraoperative imaging presents a much more accurate and objective assessment of flap perfusion. In such a way, introducing new technologies has augmented surgery results, patient safety, and the empowerment of surgical restorations. However, these benefits of intraoperative imaging methods come with certain limitations that rely on the cost of the equipment used, the chance of delay in the work of either surgical team members or the whole surgical team, and the need for additional training. Developing these technologies further through ongoing research among these considerations is the ultimate goal in bringing them into the surgical room and treating non-life-threatening injuries in the future.

Robot-Assisted Microvascular Surgery and AI

Robot-assisted microvascular surgery, besides AI, is probably the most significant revolution to date in the snowstorm, "Head and neck reconstructive surgery." This technology has one of its greatest strengths: medical devices precisely to these hard-to-reach places like the pharynx or base of the tongue, where accuracy and deftness are the most important [XXII]. A robotic system, including the da Vinci Surgical System, even provides surgeons with better precision, dexterity and control than those techniques can achieve. The incorporation of AI into robot-assisted surgery, in addition to generating real-time data analysis, helps with surgical planning and intraoperative guidance. Ultimately, these mixes of technologies can bring about better surgical outcomes, shorter operative time, and low rates of complications.

Together with this, the larger and three-dimensional view that the robotic system gives provides greater visibility of the surgical field to the surgeon who will need this in the delicate anatomy of the head and neck systems. Besides helping perform microvascular surgeries or AI, robot-operated surgeries become very costly, surgeons require specialised training, and possible problems encountered during surgeries may appear. Of course, even research and development advances closely explore the limits achievable in reconstructive surgery, all to help with clinical treatments in head and neck cases with complexities [XXIII].

Endoscopic-Assisted Microvascular Techniques

After the endoscopic technique was introduced to microvascular reconstruction surgery in the head and neck area, the procedure witnessed a paradigm shift[XXIVXXIII].

This enables surgeons to manage a disease process that has invaded the nasopharynx or paranasal sinuses, which are generally hard to reach using traditional surgery. Through the use of endoscopes, surgeons are availed of the opportunity for minimally invasive surgery, resulting in a lowered need for large incisions but better definiteness in microvascular procedures due to enlarged visibility. Robotics: The robotic-assisted technique reduces morbidity, shortens recovery time, and improves patient cosmetic outcomes [XXV]. Integrating endoscopic-assisted techniques in microvascular surgery represents a shift towards less invasive procedures, offering patients a more comfortable postoperative experience while maintaining high surgical standards [XXVI].

Bioengineered Tissue and Vascular Grafts

The 3D printing of tissue-engineered products and vascular grafts is an example that is gaining enormous interest in reconstructive surgery [XXVII]. These novel materials are becoming increasingly a topic for discussion as possible components for operations related to tracheal reconstruction and reconstruction of damaged blood vessels. The modified grafts are made to be similar to the natural structure and function of tissue; that means the rejection would be mainly reduced, and the replacement is more convenient. It is commonly, and importantly, used under challenging reconstructions where some traditional grafts might be of less value or lead to problematic complications[XXVII].

Bioengineered grafts are among the most recent and innovative research. They aim to create more durable and compatible body options for patients during reconstructive surgery. As this technology progresses, these mosaics can increase the outcomes of microvascular surgeries in the head and neck region [XXVIII].

CONCLUSION

Through the combination of new technology and innovative surgical techniques, microvascular reconstructions in head and neck surgery are taking new levels of precision, aesthetic, and functional outcomes to a higher level of perfection than the traditional approach ever did. Virtual Surgical Planning (VSP) and Computer-Aided Design and Manufacturing (CAD-CAM) have replaced traditional preoperative planning techniques. They are a giant leap forward in practice personalisation, ensuring exactness in tumour removals and comprehending other intricate surgeries. These approaches will increase surgical accuracy and outcomes while utilising the AR, the medical images of the patients, and the 3D creation of the implants and the surgical guides. Novel treatment means, like microvascular alternative donor sites and immediate dental implants right after surgery, have made more advanced techniques. As a result, it has enhanced aesthetic and functional outcomes. The stepwise methodology restores the intricate details and cuts down morbidity of donor sites, hence resulting in higher patient satisfaction and quality of life. Supermicrosurgery, which aspires to seat anastomoses in tiny vessels, has enabled complex reconstructions with excellent outcomes, especially in lymphedema treatment and soft tissue reconstruction. Based on the endocrine concept of angioma (to differentiate vascular anastomosis), chimeric and perforator flaps have gained paramount importance in composite reconstructions because of their safe microsurgical experience and the minimising of surgical invasion at the donor site. As surgical imaging techniques are appropriate, surgical precision is evolving with consideration of robotics and artificial intelligence integrated into surgery. At the same time, these updates bring additional upsides, such as the sheer learning curve for new treatments, the need for skilful training that involves some costs, and the possible rise of costs. Still exist. Incessant research and innovation are critical to overcoming the present drawbacks and improving the mastery of techniques in microvascular reconstruction in head and neck surgery.

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