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Original Article

Anatomic basis for an algorithmic approach for free fibula flap donor side selection in composite oro-mandibular defects

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ABSTRACT

Introduction: Head and neck oncological resections may result in composite oro-mandibular defects involving the oral mucosa (lining), mandibular bone and the skin (cover). Reconstructive options for such defects have evolved over a period. Free fibula flap reconstruction is currently accepted the world over as the gold standard for oro-mandibular defect reconstruction. Existing literature provides conflicting views about the use of a particular side and orientation of the fibula flap for achieving the optimal outcome. The purpose of this study is to confirm anatomically the effect of bone, soft tissue and vessel orientation on the ease of doing reconstruction. **Materials and Methods:** This is a cadaveric study. A mandibular model with a defect was used. This was pre plated to maintain continuity. Composite fibula flaps of the same dimension were harvested from both legs of a fresh cadaver. The harvested flaps were used to reconstruct the mandibular defect in different orientations and the best configuration for each reconstructive requirement was assessed. **Results:** Keeping the peroneal surface for plating, that is, facing outwards, four different configurations of the fibula flap are possible for a given mandibular defect. With a posterior vascular pedicle ipsilateral fibula is suitable for skin cover and contralateral for mucosal lining and the reverse for an anteriorly placed pedicle. **Conclusion:** The algorithm based selection of appropriate sided fibula flap facilitates complex mandibular reconstruction by placing the right kind of tissue at the right place and helps in reducing the donor site morbidity by allowing the surgeon to harvest only the required amount of skin.

KEY WORDS

Free fibula flap; ideal side of fibula; mandibular reconstruction

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INTRODUCTION

Head and neck oncological resections may result in composite oro-mandibular defects involving the oral mucosa (lining), mandibular bone and the skin (cover). Reconstructive options for such defects have evolved over a period of time. Free fibula flap reconstruction is currently accepted the world over as the gold standard.[1]

Anatomically, the fibula bone has a triangular cross section, it has a lateral surface where peroneal muscles are attached, this is a broad flat surface and is ideal for fixing the reconstruction plate during mandibular reconstruction, At the lower end of this peroneal surface is the posterior crural septum through which the peroneal artery perforators supplying the skin paddle run, this septum has variable length and mobility, which determines the movement of the skin paddle.

On the posterior and medial facet of this triangle, originates the flexor hallucis longus (FHL) muscle and on the supero-medial aspect is the origin of the tibialis posterior muscle and between these two run the vascular pedicle.

Due to this unique three-dimensional anatomy there is always a possibility of using the bone flap in a more efficient fashion for the reconstructive need. Existing literature, however, provides conflicting views about the use of a particular side and orientation of the fibula flap for achieving the optimal outcome.[1-4]

The purpose of this study is to confirm anatomically the effect of bone, soft tissue and vessel orientation on the ease of doing reconstruction.

We also propose an algorithm for choosing the correct side of the fibula for a particular reconstructive need and at the same time minimising the donor side morbidity.

MATERIALS AND METHODS

This is a cadaveric study. A mandibular model with a defect was used. This was pre plated to maintain continuity. Composite fibula flaps of the same dimension were harvested from both legs of a fresh cadaver. The harvested flaps were used to reconstruct the mandibular defect in different orientations, and the best configuration for each reconstructive requirement was assessed.

Following variables were considered:

1. Placement of the vascular pedicle – The pedicle needs to be placed anteriorly if the microvascular anastomosis is to be done on the opposite side due to vessel paucity in the ipsilateral neck.
2. Type of associated soft tissue defect – The defect could be a mucosal defect (lining), the skin defect (cover) or a combined mucosa and skin defect.

The usefulness of the algorithm proposed is demonstrated in different clinical situations.

RESULTS

Keeping the peroneal surface for plating, that is, facing outwards, four different configurations of the fibula flap are possible for a given mandibular defect. Implications of each one for reconstruction are discussed below.

Ipsilateral fibula flap placing the vascular pedicle posterior

The skin paddle comes out from the lower and outer border of the reconstructed mandible because of the anatomical position of the posterior crural septum [Figure 1]. If this skin paddle has to be taken inside the oral cavity, it has to travel over the plated surface of the fibula, which wastes about 3-4 cm of skin paddle width. The length of the posterior crural septum being variable also restricts the inside movement of the skin paddle.

The FHL muscle lies at the submandibular region with the vascular pedicle lying on its superior aspect and therefore pulling the muscle inside for intraoral reconstruction kinks the vascular pedicle.

Ipsilateral fibula flap placing the vascular pedicle anterior

In this situation, the septum location becomes superior and medial in relation to the bone. Hence, the skin paddle does not have to go around the bone to come inside and thus we do not lose skin paddle width when we turn it inside. It can thus be used for providing mucosal lining more easily. For moving the skin paddle outside to provide skin cover, it has to travel over the plated surface

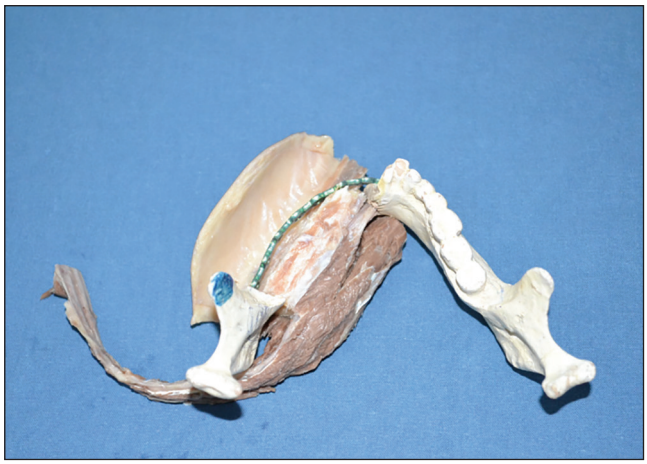


Figure 1: Ipsilateral fibula with pedicle posterior

of the fibula although the wastage of skin paddle width is not much [Figure 2].

The FHL muscle is supero-medial to the bone and lies within the oral cavity thus it can be easily utilized for intraoral lining.

Contralateral fibula flap placing the vascular pedicle posterior

This configuration leads to a tissue orientation similar to that discussed in point 2 (Ipsilateral fibula flap placing the vascular pedicle anterior and thus is suited for intra oral reconstruction [Figure 3].

Contralateral fibula flap placing the vascular pedicle anterior

This configuration leads to a tissue orientation similar to that discussed in point 1 (Ipsilateral fibula flap placing vascular pedicle posterior and thus is not particularly suited for intra oral reconstruction and skin paddle is best utilised outside [Figure 4].

DISCUSSION

Of all the reconstructive options available for the complex mandibular defect, the free fibula osteo-cutaneous flap is the most widely used one. However, there is conflicting literature regarding the ideal donor side of the fibula. Hidalgo advocated selection of the donor area based on the quality of the recipient vessels in the neck, that is, ipsilateral fibula for anastomosis with the same sided neck vessels and contralateral otherwise. In all the cases, he prefers the skin paddle orientation of situation 1 and 4 (the skin paddle should cover the fibula from outside). The advantage cited is that the posterior crural septum covers the plate and acts as a second line of defence, preventing the plate exposure in the event of skin breakdown. However in this configuration if one attempts to reconstruct intraoral defects, one has to add at least 3 cm of extra width to the skin paddle because it has to go around the fibula before it could enter the oral cavity. This configuration also has the potential to kink the delicate peroneal perforators as they go around the bone, which could lead to a loss of the skin paddle. As the FHL muscle lies in the submandibular region, it will not be utilised as an intraoral seal.[5]

Yagi *et al*. suggested considering the location of the pedicle in the neo-mandible, requirement of a skin paddle and orientation of the fibula to the remnant mandible in determining the ideal choice of side for the mandibular reconstruction, but he has also not emphasised the additional width of the skin paddle required if one does not choose the correct side and orientation of the fibula.[2]

Wei *et al.* and Yadav *et al.* put forth that there is no donor side specificity of fibula free flap for complex oro-

Figure 2: Ipsilateral fibula with pedicle anterior

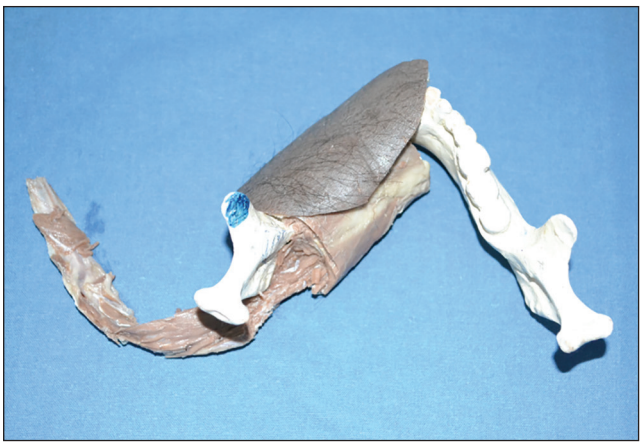


Figure 3: Contralateral fibula with pedicle posterior

Figure 4: Contralateral fibula with pedicle anterior

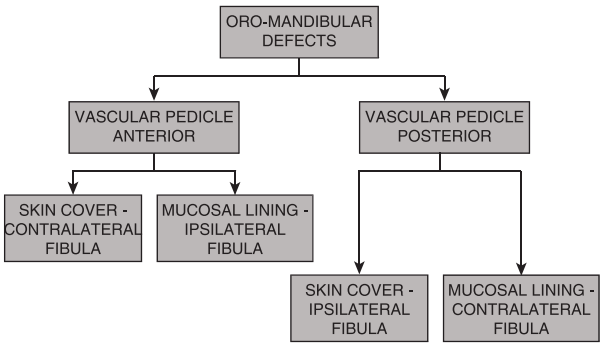
mandibular reconstruction. However, it has been noted by author that if one takes a very large skin paddle for composite tissue defects, mere need to add 3 cm of width does not make much difference and one could use any side and orientation of fibula for any defect reconstruction.

The question of choosing the side and orientation arises only if one considers minimising the donor site deformity by harvesting only the exact amount of skin required.

This would be possible only if one plans precisely, and the algorithm, which authors propose [Algorithm 1], helps one to achieve better management of the donor, as well as the recipient site.[1,3]

The skin paddle of the fibula flap is usually harvested from its lower portion to ensure adequate pedicle length. Being the lower end of the leg, only small sized skin defects can be primarily closed. Moderate sized defects up to 8 cm in width in the lower leg may be closed using a soleal musculocutaneous perforator based propeller flap.[6] A large skin defect arising from harvesting a big skin paddle needs to be covered with a split skin graft with its potential donor site morbidity.

The basis for selection of the side of the donor fibula are the placement of the pedicle (i.e., anterior or posterior) and the reconstructive requirements (i.e., bone only, bone and lining, bone and skin cover or bone, lining and cover). An anteriorly placed pedicle may be considered in case of a vessel depleted neck or for a ramus reconstruction, when one needs to reconstruct ramus of the mandible and plans to keep the vascular pedicle posteriorly, there is a possibility of acute kink of the vessels if we choose to anastomose the vessels in the neck and if we choose to anastomose the vessels with superficial temporal vessels, one has to grapple with the problem of size mismatch between the donor and recipient vessels with



Algorithm 1: Algorithm for ideal donor side selection

an increased potential of failure. In other situations, the vascular pedicle may be placed posteriorly.

Based on our results, we can give our recommendations for the different composite defects as under:

Bone with small mucosal defect (A small mucosal defect is one, which could be easily resurfaced by the FHL muscle alone)

If the pedicle is positioned anteriorly, such a defect would be adequately reconstructed with an ipsilateral fibula with the FHL muscle (as described in point 2). The donor area skin can be closed primarily because no skin is harvested. In a posteriorly placed pedicle, the contralateral fibula may be used (point 3).

Bone with a large mucosal defect (A large mucosal defect is one, which could not be closed by FHL muscle alone)

When the pedicle is positioned anteriorly, such a defect would need an ipsilateral fibula with optimal sized skin paddle (as described in point 2). The donor area skin may be closed primarily, with a soleal propeller flap or skin graft.

In a posteriorly placed pedicle, the contralateral fibula may be used (point 3).

Buccal mucosal defect extending to the upper alveolus and secondary reconstructions of the mandible would necessitate a contralateral neck anastomosis.

Bone with a skin defect

These defects are most optimally reconstructed with the ipsilateral fibula if the pedicle has to be brought posteriorly (point 1) or with the contralateral fibula if the pedicle has to be brought out anteriorly (point 4).

Bone with skin and mucosal defect

Such defects can be reconstructed with a configuration described in points 2 and 3. The skin paddle may be used to cover the skin defect and the FHL muscle for reconstructing the mucosal defect.

However, if the size of the defect is beyond the dimension which could be covered by fibula, such defects are reconstructed with double flaps using the fibula skin paddle for one defect and a second free/regional flap for the other defect.

This concept enables us to reduce the donor site defect by choosing the side of fibula flap, which has the skin

Figure 5: Primary closure of donor site

paddle that will fall into an anatomically correct position to reconstruct the soft tissue defect. Closure of smaller defects primarily or with propeller flaps result in superior aesthetic outcome [Figures 5 and 6].

CONCLUSION

The algorithm based selection of appropriate sided fibula flap facilitates complex mandibular reconstruction by placing the right kind of tissue at the right place and helps in reducing the donor site morbidity by allowing the surgeon to harvest only the required amount of skin.

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Figure 6: Propeller flap closure of donor site

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