Innovations

Postoperative assessment /monitoring of micro vascular free flaps comparing ceus and bone scan

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Abstract:

Reconstruction management of maxillofacial defects has progressed beyond the primary closure and skin grafts to a variety of pedicled flaps and more recently, the microvascular free tissue transfer using composite structures in order to match the missing tissues. Free scapula, iliac crest and fibular grafts are the most often used grafts and have been shown to be reliable. ***Methods****: 10 patients were classified under HCL classification as all of them had man dibular defects. In order to restore the form & functions of the defective mandible microvascular free fibular flap surgery was planned. Apart from the routine investigations, the patients were undertaken for preoperative CT angiography for the legs to study the vascular pattern, course etc.* ***Findings****: The patients were divided into two groups, in which the first group consists of 5 patients where bone scintigraphy alone was done and in the second group consisting of 5 patients CEUS was done to assess the flap vitality. In both the groups, all the ten patients had been operated for man dibular defects restored with microvascular free fibular flap.* ***Conclusion****: Bone scan serves as a useful prognostic tool in monitoring the vitality of free microvascular bone flap and also in early recognition of complications. Sensitivity of bone scan is superior to clinical monitoring, as it relies only on the skin paddle, In which the assessment of the flap vitality is not dependable.*

Introduction

Reconstruction management of maxillofacial defects has progressed beyond the primary closure and skin grafts to a variety of pedicled flaps and more recently, the microvascular free tissue transfer using composite structures in order to match the missing tissues. Free scapula, iliac crest and fibular grafts are the most often used grafts and have been shown to be reliable. With advanced microsurgical techniques and the development of more vascular reliability, free tissue transfer has become a routine procedure in the field of reconstructive surgery.

Flap vitality has significantly improved since the introduction of free microvascular reconstructions in the late 1960s and overall success rate is greater than 95%.However careful monitoring of microvascular free flaps is mandatory for identifying the complications earlier and resolving such problem becomes easier for better success rate. The majority of flaps are lost within the first 72 hours of surgery and most of these losses occurs within the first 48 hours of surgery. Close monitoring during the first 72 hours after surgery is therefore essential to recognize failing flaps early. To minimize the incidence of flap failure early detection of postoperative flap is chaemia is necessary for timely re-exploration. Conventional clinical monitoring is the most commonly used technique to monitor free flaps by evaluating the flap temperature, capillary refill, colour and bleeding following pricking the flap. The ideal monitoring method would be non invasive or at least minimally invasive method which is reliable, continuous, accurate and easy to use even for the inexperienced personnel, inexpensive and provide real time information. Besides bone scinti graphy and positron emission to mography, there has been no way to conclude directly about the bone perfusion of osseous or osseocutaneous flaps. Ultra sound examinations are already used for the assessment of the an astomotic vessels in free flap surgery. Contrast enhanced ultrasound(CEUS) with high resolution linear probes is an advanced technique delivering images with high spatial resolution. In this study the comparision of vitality of microvascular free flaps using contrast enhanced ultrasound (CEUS) with bone scan in bone only flap.

Objectives :

The aim of the study is to compare Contrast enhanced ultrasound with bone scans in post operative assessment of microvascular flap for adequate perfusion ,in patients undergoing bone reconstruction.

Methods: The prospective study was done over a period of three years, consisting of 10 patients, in which secondary reconstruction in 2 patients (in which, Ameloblastoma in 1 patients & Odontogenic keratocyst in 1 patient were the cause for resection) and in 8 patients primary reconstruction were required for the mandible. The cause for mandibular defect was Ameloblastoma, Odontogenic keratocyst, Ameloblastic carcinoma. There were 5 male and 5 female patients. The age ranged from 16 to 45 years (mean age = 33.78 years).

All the 10 patients were classified under HCL classification as all of them had mandibular defects. In order to restore the form & functions of the defective mandible microvascular free fibular flap surgery was planned. Apart from the routine investigations, the patients were undertaken for preoperative CT angiography for the legs to study the vascular pattern, course etc.

Similarly the recipient vessels were assessed for the size, site, diameter and blood flow (For 7 patients facial vessels and for 3 patients superior thyroid vessels were used for anastomoses).

After an informed consent was obtained, all patients were subjected to surgical reconstruction under general anesthesia. The mandibular reconstruction was done with free fibular microvascular flap for, in which, anastamosis of the vessels was done using conventional suturing technique with 8'0' or 9'0' prolene for arterial and venous anastamosis respectively for 5patients and in the rest of 5 patients anastamosis were done with vascular couplers.

Patients were divided into 2 groups for assessment of the flap vitality and in each group 5 patients were taken.

In group I, the postoperative vitality of the flap was assessed using bonescan and in group II contrast enhanced ultrasound scan (CEUS) was used.

In group I, Bone scintigraphy was done in a series of 2nd, 5th & 10th post operative days. For bone scintigraphy, 370 MBq 99m-Tc-oxidronate was administered intravenously. Static planar scintigramms of 300 seconds were obtained starting 3 to 4 hours after
injection in the anterior and lateral views. Scans were acquired on a double-head gamma camera with a low energy, high resolution collimator in a 128 × 128 matrix.

Grade Uptake in the graft as compared with the cranium
1 Highly increased
2 Moderately increased
3 Slightly increased
4 Same level or inhomogeneous tracer uptake
5 Decreased
6 Absence of tracer uptake

Table 1: Evaluation of the grafts with scoring system in bone scintigraphy

The uptake was defined as increasing from grade 6 to grade 1 (Table above). Grade 1 corresponded to high uptake in the flap compared with the calvarium, grade 2 indicated moderately increased uptake, grade 3 shows slightly increased uptake, grade 4 indicated the same level or inhomogeneous tracer uptake, grade 5 represented decreased uptake, and grade 6 indicates to total absence of tracer uptake in the graft.

In group II patients post operative contrast enhanced ultrasound scan was performed in a series of 2nd, 5th & 10thpostoperative day.

An intravenous bolus of 2.5 ml SonoVue (BRACCO) was injected through 20-18 gauge peripheral cubital cannula, followed by a bolus of 10cc NaCl. Ultrasound examination was performed with a multi-frequency linear probe.

As our routine protocol, informed consent was obtained from all the patients prior to the procedure and Contrast enhanced ultrasound (CEUS) performed by the sonologist.

Data Analysis

S. No	Age/Sex	Disease	Flap considerations	Monitoring tool
1	20/M	Odotogenic keratocyst	Osseous flap	Bone Scintigraphy
2	30/M	Ameloblastoma	Osseous flap	Bone Scintigraphy
3	21/F	Odotogenic keratocyst	Osseous flap	Bone Scintigraphy
4	17/F	Odotogenic keratocyst	Osseous flap	Bone Scintigraphy
5	30/M	Odontogenic keratocyst	Osseous flap	Bone Scintigraphy
6	30/M	Odontogenic keratocyst	Osseous flap	CEUS
7	34/F	Ameloblastic carcinoma	Osseous flap	CEUS
8	42/F	Odotogenic keratocyst	Osseous flap	CEUS
9	28/F	Ameloblastoma	Osseous flap	CEUS
10	22/M	Odotogenic keratocyst	Osseous flap	CEUS

Table 2 : Patient details and flap used

This Prospective study on comparison of assessment of flap vitality using Bone scintigraphy versus Contrast Enhanced Ultrasound Scan (CEUS) in mandibular reconstruction with microvascular free fibular flap was conducted in our department.

The patients were divided into two groups, in which the first group consists of 5 patients where bone scintigraphy alone was done and in the second group consisting of 5 patients CEUS was done to assess the flap vitality. In both the groups, all the ten patients had been operated for mandibular defects restored with microvascular free fibular flap.

In group I, bone scintigraphy analysis was performed on the 2nd, 5th & 10th post operative days. In all the five patients the uptake of the tracer found to be increased and therefore the viability of the graft is confirmed (Statistical mean percentage is 100%).

Armed in a series of 2nd, 5th & 10th post operative days and the viability was assessed. Out of the five, four patient's bone shows absolute uptake of the tracer which clearly proved the vitality. In one patient, the 2nd and 5th day evaluation of anastomosed vessels was performed but could not be assessed due to hematoma, but 10th day evaluation showed the graft viability. In this patient bone scan was performed on third day to verify and the uptake of the tracer showed the viable flap. Then the Statistical mean percentage

is 86%. In all the ten patients the vitality was confirmed by clinical follow up examinations up to at least six months (6 to 18 months).

Discussion

Reconstruction of mandibular defects is a challenging task for the reconstruction maxillo-facial surgeon due to its complex anatomy and complicated functions.Vascularised grafts are used since a century for reconstructing such a complex form and restoring its functions to the maximum.Thus grafted free flap must always be periodically assessed in order to explore the flap at the right time as well as for further functional restorations.To assess such transplanted flap vitality,a wide range of methods have been practiced including conventional skin paddle test.However the critical period for any flap must be identified at the earliest to prevent the graft failure.The first two weeks after transplantation is considered as golden period for such salvage surgeries when the need arises

In the immediate post operative period it is difficult to monitor by clinical evaluation and diverse radiological imaging modalities where the reliability is questionable. Lack of vitality as a result of vascular occlusion,either arterial or venous which cannot be detected by clinical examination in purely osseous transplants.X ray is unreliable for determining bone graft viability during the first month because changes in mineral content can only be detected if the alteration amounts to atleast 30%-40%. CT and MRI are restricted by well known artifacts from teeth,their fillings and metallic devices.If a skin island is present,the healing process can be followed directly by observing its colour,temperature and capillary refill.The skin island is not always incorporated in the flap when the defect doesn't require soft tissue component.On the other hand skin paddle incorporation is not advisable just for the flap monitoring purpose as it reveal a false positive sign.Similarly clinical monitoring of the skin flap is not always sufficient for the assessment of overall viability,especially in mandibular reconstruction,which usually requires multiple osteotomies of the graft to create a shape that mimics the mandibular contour.

Angiography can detail the microvascular surgery but it cannot show the microcirculation that determines viability and its invasiveness particularly in the nutrient vessels which precludes its routine use.

In bone scintigraphy ,the absorption of the radiopharmaceutical agents(Tc-99m MDP) depends on adequate blood flow as well as on a living network of the osteocytes.Its uptake on bone reflects blood flow and metabolic activity of bone tissues.

Therefore the uptake of the Tc-99m MDP in the grafted bone is usually interpreted as evidence of bone survival and patent microvascular anastomoses. Some authors also insisted to alleviate the need for skin paddle just for the flap monitoring purpose when skin paddle is not functionally required. Whereas in the case of bone scans, periodic assessment is desperately needed for flap salvage in earlier stage before the flap undergoes irreversible ischaemia. Metabolically active revascularized bone typically shows normal or diffusely increased tracer uptake.

Weiland reported the need for series of bone scans as the newly forming bone will show a clear vitality in various intervals due to fluctuation in the blood pressure value.

In this study, a definitive protocol was used to compare early postoperative bone scan in a series of 2nd, 5th and 10th day after surgery. The viable grafts showed significantly increased tracer uptake (grade 1-3) and 1 showed the same level tracer uptake compared to cranium (grade 4). In the failed grafts decreased uptake was observed (grade 5 and 6). Therefore, in our study, early postoperative scans were very useful, additional tool in assessing graft viability. Their high sensitivity, which was superior to those of clinical monitoring alone, helped in the decision-making process on whether or not to perform revision surgery.

Contrast enhanced ultrasound scan (CEUS) can also evaluate the perfusion following free tissue transfer and can predict the outcome of healthy and compromised flaps. According to P. Lamby et al with increasing availability of high resolution linear transducers of CEUS these techniques could become a standard for the evaluation of free microvascular soft tissue flaps in plastic surgery[7].

CEUS appeared to be able to detect flap ischemia earlier in comparison to standard clinical monitoring which has favorable implications in terms of improving flap salvage rates, particularly for buried flaps.

CEUS provides a direct and up-to-date visual assessment of microcirculatory flow within the free flap, based on the unique acoustic properties of micro bubbles. The technique provides information on regional and overall flow within the flap with both qualitative and quantitative assessment being available.

Conclusion

Bone scan serves as a useful prognostic tool in monitoring the vitality of free microvascular bone flap and also in early recognition of complications. Sensitivity of bone scan is superior to clinical monitoring, as it relies only on the skin paddle, in which the assessment of the flap vitality is not dependable. Whereas CEUS is a new method for the evaluation of microcirculation in the purely osseous free flaps in the early postoperative days. Apart from its limitations in applications, like swelling in the early post operative period, capillary rupture due to the contrast agents administered for the study, CEUS is also reliable means of monitoring the flap for its patency.

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