Imaging of Osteo-odontokeratoprosthesis(OOKP) Using Multidetector Computed Tomography: A UKMMC Experience

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SUMMARY

Osteo-odontokeratoprosthesis (OOKP) surgery is a technique used to replace damaged cornea in blind patients for whom cadaveric transplantation is not feasible. OOKP surgery is a complex procedure requiring lifetime follow–up. The preservation of the osteo–odontolamina is the vital feature in maintaining the stability of the OOKP. Early detection of lamina resorption enables early prophylactic measures to be taken and prevent resorption-related complications. This case illustrates the radiological findings of the first OOKP surgery in Malaysia and the role of multidetector computed tomography (MDCT) in postoperative management of OOKP surgery.

KEY WORDS:
Osteo-odontokeratoprosthesis; OOKP; MDCT

CASE REPORT

A 55-year-old male presented to us with a history of severe chemical injury to both eyes. He had evisceration of the left eye and a corneal transplant on the right eye. Subsequently, he developed failure of the right corneal graft secondary to glaucoma and was referred to Universiti Kebangsaan Malaysia Medical Centre (UKMMC) for osteo-odontokeratoprosthesis (OOKP) of the right eye.

Assessment of the right eye showed reduced visual acuity with only perception to light. OOKP were performed twice on him resulting in improvement of the visual acuity of the right eye to 6/ 60.

Multidetector CT scan (MDCT) of the orbit was performed for assessment of the OOKP. CT scan (Siemens Somatom Sensation 64, Siemens AG, Erlangan, Germany) was performed in the axial plane from the level of the floor to the roof of orbit. The patient was scanned in the supine position at 5 mm slice thickness. The images were reconstructed and two-dimensional (2D) data sets in axial projection were acquired in bone algorithm (Figure 1a). Three-dimensional (3D) data sets were post processed using shaded surface display technique (Figure 1b). Measurements of the 3D reconstruction osteo-odontolamina were made at the lateral, superior, nasal and inferior rim of the osteo-odontolamina (Figure 2). The inferior rim of the lamina measured 2.9mm at CT while intraoperatively measurement of the lamina was 4 mm. This discrepancy is in keeping with erosion at the inferior rim of the lamina (Table I).

DISCUSSION

Osteo-odontokeratoprosthesis (OOKP) surgery was first performed in the 1960s in Italy. It is performed in less than ten centers in the world with barely 573 patients had undergone this procedure worldwide [2]. This technique offers good lasting results in restoring vision in patients who are not amenable to any other type of conventional corneal transplantation. The main advantage of the OOKP is that it can withstand a dry and keratinised eye surface [2]. Therefore, this technique is valuable for cases of corneal blindness due to chemical injury as in our case.

Also known as "tooth-in-eye" surgery, OOKP involves a two-stage surgical procedure that is usually performed about two to four months apart. Our patient had his two-stage procedure performed four months apart. The first stage of the procedure involves the removal of a canine tooth (with its root and part of the adjacent bone) from the patient. The tooth is then fashioned into a cube with a hole drilled into its centre. An artificial plastic corneal device called an optical cylinder is implanted into the hole. The optical cylinder will channel light to the retina. This tooth structure is inserted into the patient's cheek to grow new blood vessels. At the same time, scar tissue from the surface of the eye is carefully excised and removed and tissue from the inner mucosal lining of the cheek is harvested and transplanted onto the surface of the eye [2].

In the second stage of the procedure, the patient's damaged eye which was previously covered with cheek lining is opened. A circular opening in the cornea is made, and the iris and lens are removed.The tooth structure is then removed from the patient's cheek, implanted within the eye and covered with the cheek lining. At the end of the procedure, light can pass through the plastic cylinder to allow clear vision [2].

OOKP surgery is a complex procedure, requiring lifetime follow–up in order to detect and treat complications, which include oral, oculoplastic, glaucoma, vitreoretinal complications and extrusion of the device. A critical feature to ensure long term stability of an OOKP is in the maintenance of the osteo-odontolamina. The OOKP lamina is made up by the optical cylinder, cement, bone, alveolar ligament and dentine (Figure 3). One of the issues in OOKP surgery is resorption. A study showed that the main factor resulting in anatomical failure was OOKP lamina resorption [2]. This can lead to leakage around the optic cylinder which in

This article was accepted: 18 October 2012
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Table I: Comparison of the dimensions of osteo-odontolamina during surgery and at CT.

	Dimensions of lamina during surgery	Dimensions of lamina in CT
Tooth dimensions	13 x 9 x 2.5	13 x 8.7 x 2.5
Superior rim	2.0	2.0
Inferior rim	4.0	2.9
Nasal rim	7.0	7.0
Lateral rim	3.0	3.0

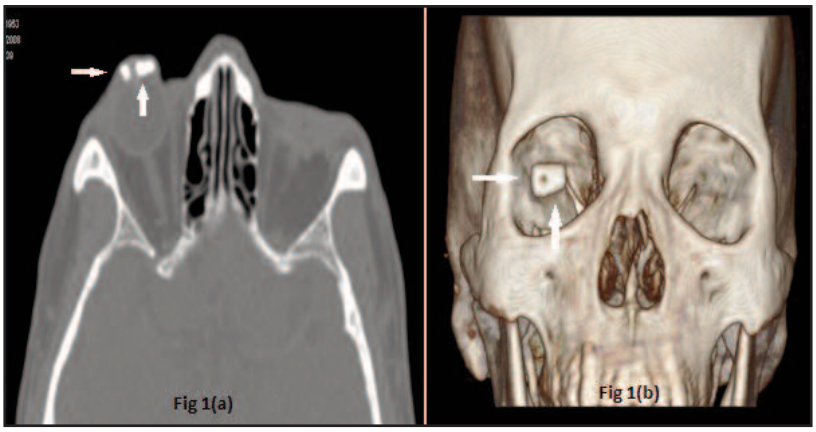

Fig. 1(a,b) : Non contrasted CT orbits in the axial projection (1a) and 3D reconstruction of the CT orbits (1b) showing the OOKP (⇨)

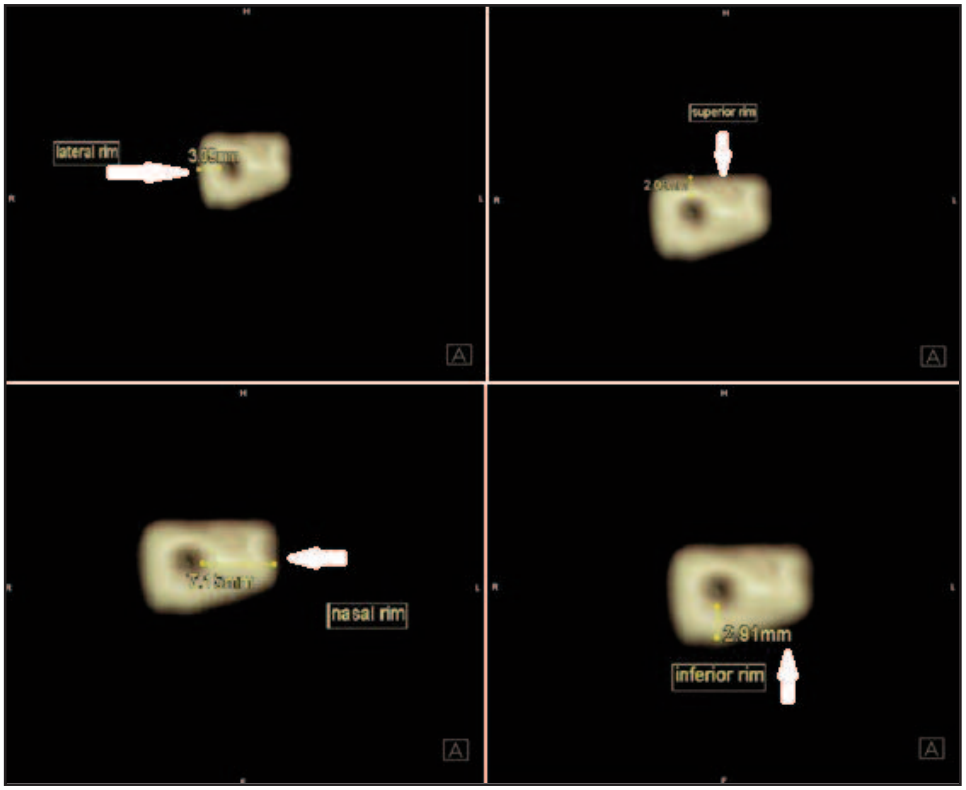

Fig. 2: 3D reconstruction of the osteo-odontolamina showing the measurement made at the lateral, superior, nasal and inferior rims of the osteo-odontolamina (⇨)

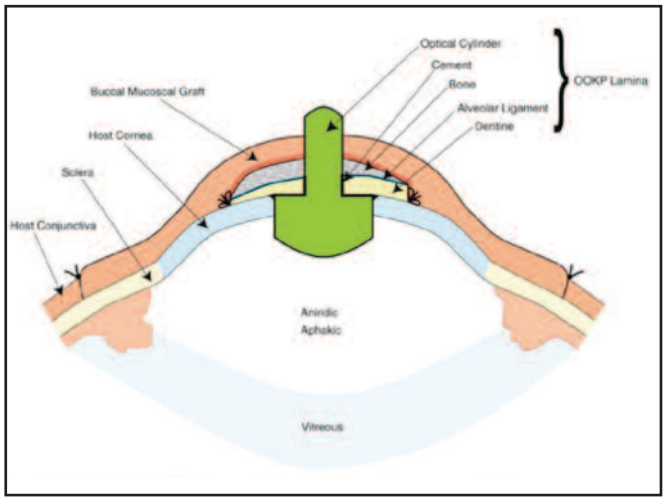

Fig. 3 : Schematic diagram of cross section anatomy of an OOKP eye (2).

turn can predispose to microbiological infection and the risk of the resorbed lamina harbouring organisms [4]. Reduction in the dimension of the lamina can also result in aqueous leakage, and extrusion of the optical cylinder [1]. An early detection of lamina resorption enables early prophylactic measures to be taken to maintain the lamina and prevent resorption-related complications. Currently, clinical method that facilitates in vivo precise measurements of the dimensions of the osteo-odontodontolamina is unavailable.

Glaucoma is the most frequent complication of OOKP surgery and has an incidence of up to 75% [2]. It is difficult to establish whether glaucoma is caused by surgery per se or related to preexisting abnormalities of the anterior segment involving trabecular meshwork and angle. This is complicated by the fact that there is no reliable measurement of intraocular pressure and the optics of a keratoprothesis may not allow detection of early visual field defects due to decentration and design of the optics. Management of glaucoma in keratoprosthesis involves systemic medication (acetazolamide) or surgery [1].

There are only a few published papers on the radiological findings for the detection of early lamina resorption [1, 3]. Plain radiography allows evaluation of the position of the prosthesis and the detection of possible displacements or variations in the prosthesis thickness. However, the intraocular soft tissues cannot be evaluated. MDCT scan enables optimal evaluation of the intra-orbital structures and early detection of the presence and extension of inflammatory complications that would affect the outcome of the OOKP. MRI is similar to CT in its capacity to assess intra-orbital tissues with a better contrast resolution. However, this method is subject to movement artifacts because of the longer image acquisition times.

Previous studies using electron beam tomography (EBT) and CT scan on the bone reduction in OOKP found that minor reductions of the osteo-odontodontolamina size are mainly in the anterior and inferior parts, and found not to compromise the stability and integrity of the lamina cylinder complex. No correlation between the degree of reduction in the dimensions and patient age, diagnosis, or length of follow up could be found [1]. The findings in our case were comparable with the earlier studies, whereby minor erosion had occurred in the inferior rim of the lamina. The histopathological basis of the resorption of lamina has yet to be concluded. One of the postulations offered was that there may be lack of tension in the inferior rim causing gradual resorption in that area [1].

A baseline morphological assessment of the OOKP by either EBT or MDCT after OOKP surgery has been implanted to define the dimensions radiologically [1]. Although previous studies have recommended the usage of periodic radiological monitoring for resorption of OOKP, there are no protocol recommendations for the radiological assessments as yet [1, 3]. Lifetime follow-up for these patients is necessary and that MDCT is a practicable diagnostic tool for evaluation of osteo-odontodontolamina reduction in OOKP [1]. MDCT is easily available in most tertiary hospitals in Malaysia and thus it would be the modality of choice to monitor lamina erosion. To our knowledge this was the first OOKP surgery performed in Malaysia.

In conclusion, the OOKP shows good long term results but the surgeon must be constantly aware of signs of resorption of the osteoodonto-lamina. Dissolution of the osteo-odontolamina may occur after OOKP surgery resulting in loss of stability of OOKP complex. The potential risks associated with reduction of the lamina means that regular assessment of its state is needed. MDCT scan with 3D reconstruction is a useful tool for monitoring the osteo-odontolamina.

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