A study of the hydroxyapatite orbital implant drilling procedure

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ARTICLE

Abstract

Purpose **The hydroxyapatite orbital implant has been introduced as a buried, integrated implant for use in the anophthalmic patient. The second stage of the procedure involves drilling the implant and inserting a motility peg that allows direct coupling of the artificial eye to the implant. Other authors have advocated an assessment of implant vascularity by imaging prior to drilling. We aimed to see whether our practice of drilling after a predetermined time interval without assessment of implant vascularity would result in a higher complication rate. We also aimed to determine how successful the drilling procedure was in improving both the motility and the stability of the artificial eye.**

Methods **The notes of 41 consecutive patients who underwent drilling were studied to determine the time interval between implantation with a hydroxyapatite sphere and drilling the nature of any complications and any further surgical procedures undertaken. A postal questionnaire was sent to all patients asking them to grade the motility of their implant before and after drilling, and to state whether or not there had been any improvement in the stability of their artificial eye.**

Results **The most frequent complication encountered was extrusion of the motility peg, which occurred in 3 patients. A total of 5 patients required redrilling. There was an 80% response rate to the questionnaire. Ninety-one per cent of patients felt that there had been an improvement in the motility of their artificial eye and 76% felt that the stability of their artificial eye had been improved.**

Conclusion **Pegging of the hydroxyapatite implant improves both the motility and the stability of the artificial eye in the majority of cases. Complications are infrequent and minor. If sufficient time is allowed after implantation for full implant vascularity to occur, it is not necessary to perform imaging studies. This practice does not result in an increase in complications, and significantly reduces the expense of the procedure.**

Key words Hydroxyapatite, Motility, Drilling, Peg, Anophthalmic, Socket

The hydroxyapatite orbital implant has been developed to improve motility of the artificial eye in anophthalmic patients and to reduce the high complication rate that has been associated with other types of implant. It is made of calcium phosphate derived from coral and becomes integrated into the orbital tissues by means of fibrovascular ingrowth. Previous studies have shown it to be well tolerated as a primary, secondary and exchange implant in adults and children.[1,2]

Good motility of the implant is achieved by directly attaching the extraocular muscles. Although many patients are satisfied with the motility of the artificial eye achieved without drilling of the implant, the motility may be further improved by direct coupling of the artificial eye to the hydroxyapatite implant by means of a motility peg. This peg is fitted into a hole that is drilled into the implant as a second-stage procedure. The peg is tolerated as a foreign body as it lies in a hole lined by conjunctiva and so does not come into direct contact with the implant. The posterior surface of the prosthesis is then modified to fit the shape of the head of the peg. This creates a ball and socket arrangement by which the movements of the implant are directly transmitted to the artificial eye. The fine conversational movements of the natural eye can then be mimicked. The stability of the artificial eye may also be improved, avoiding inadvertent rotation or loss of the artificial eye. The weight of the artificial eye is also partially supported by the peg thereby reducing the stress on the inferior fornix and lower eyelid.

The use of the hydroxyapatite orbital implant was first described by Perry.[3] He recommends that an assessment of the degree of

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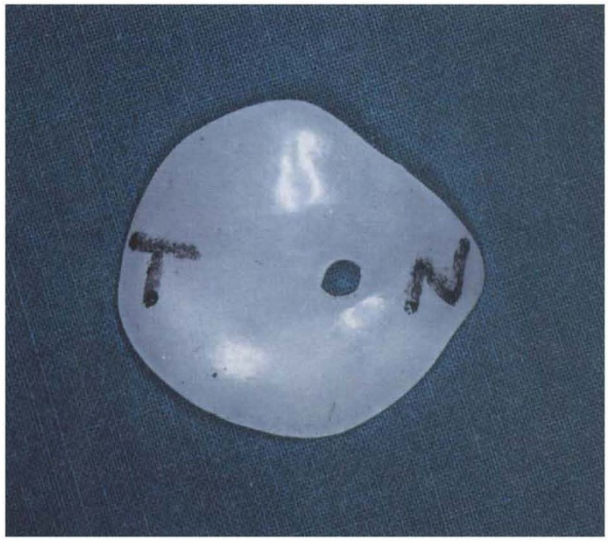


Fig. 1. *The template of the prosthesis with a hole in the area of the pupil.*

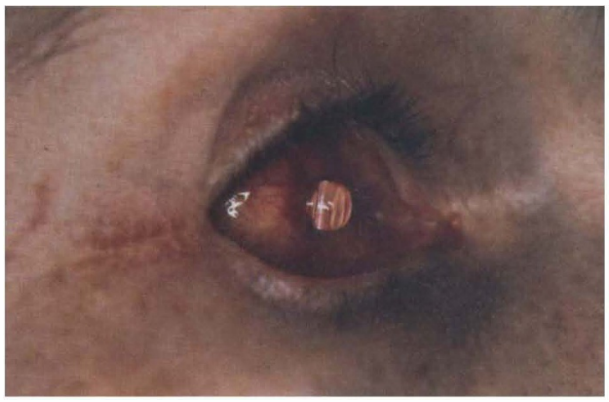


Fig. 3. *A socket with a permanent peg in place.*

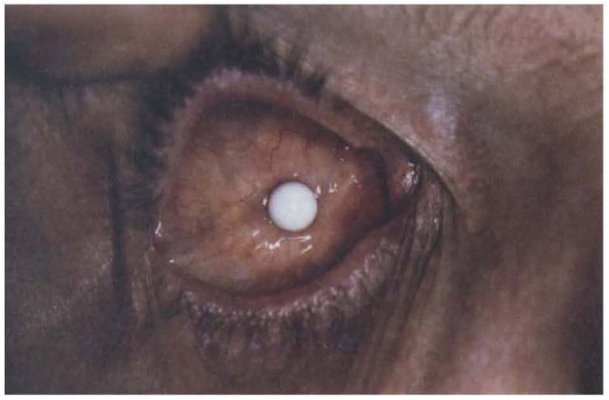


Fig. 2. *A socket with a temporary peg in place.*

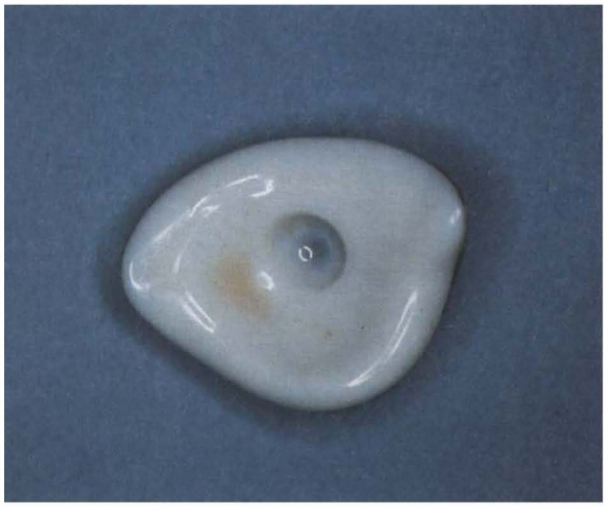


Fig. 4. *An artificial eye with an indentation on its posterior surface to couple with the peg.*

fibrovascular ingrowth into the implant is made prior to the drilling procedure. Perry performs a technetium-99 bone scan at 6 months post-operatively to determine whether or not there is sufficient vascularisation to support tissue growth, whereas Shields *et al.*[1] perform gadolinium-DPTA enhanced magnetic resonance imaging at 4–6 months. It has not been our practice at the Manchester Royal Eye Hospital to perform any formal assessment of implant vascularity prior to drilling of the implant. It has been shown using bone scan studies that a 20 mm hydroxyapatite sphere is usually vascularised fully at 6 months, but occasionally it takes as long as 10 months.[4] We do not undertake the drilling procedure until a predetermined period of time has elapsed to allow full vascularisation of the implant to occur. This study aimed to demonstrate whether or not a higher complication rate occurs as a result of this practice.

Methods

It is our practice to perform the second-stage drilling procedure no sooner than 6 months after a primary enucleation and hydroxyapatite orbital implant procedure, and 12 months after a secondary implant or exchange procedure. We prefer the patient to be at least 6 years old so they are able to cooperate with the ocularist when undergoing modification of their artificial eye.

The hospital records of all the patients who have undergone the drilling procedure at Manchester Royal Eye Hospital under the care of the oculoplastic team were studied. The time interval between the hydroxyapatite implant surgery and the drilling was recorded, as was the nature of any complications and any further surgical procedures undertaken. Each patient was sent a postal questionnaire asking them to subjectively grade the motility of their artificial eye before and after the pegging procedure, on a scale from 0 to 10 (0 representing no motility and 10 excellent motility). They were also asked whether or not the drilling procedure had improved the stability of their artificial eye and whether or not they had experienced any problems with the pegging procedure.

Surgical technique

In adults the pegging procedure is performed under retro-implant local anaesthesia, with mild sedation if the patient is anxious; in children it is performed under general anaesthesia. The ocularist makes a wax template

Table 1. *Pre-operative diagnosis in the primary group of patients*

Diagnosis	No. of patients
Blind painful eye	
Penetrating injury	8
Blunt trauma	2
Chronic uveitis	1
Retinal detachment	2
Congenital glaucoma	1
Firework injury	1
Toxoplasmosis	1
Choroidal melanoma	1
Microphthalmos	1

of the artificial eye prior to the procedure, with a hole in the area of the pupil (Fig. 1). The location of the peg is marked on the conjunctiva through this hole. A lid speculum is positioned, and a disposable cautery used to create a small hole in the conjunctiva at the site to be pegged. The conjunctiva and subconjunctival tissues are grasped with forceps to stabilise the implant during the procedure. A hole is drilled 3 mm in diameter and 10 mm in depth with the drill aimed perpendicular to the anterior plane of the orbit. A flat-headed peg 2.5 mm in diameter and 10 mm long is placed in the hole. If it is a good fit, it is removed and covered in antibiotic ointment, and then replaced (Fig. 2). This temporary peg is replaced at 3–4 weeks with a permanent peg that sits above the conjunctival surface (Fig. 3). The ocularist modifies the patient's artificial eye by drilling a small indentation that couples with the ball of the peg (Fig. 4).

As an alternative, a sleeved peg may be used that allows easy removal and insertion of the peg within a sleeve that sits in the drill hole.

Results

Two hundred and six patients received a hydroxyapatite orbital implant between October 1992 and March 1996. Forty-one of these underwent a second-stage drilling procedure between October 1993 and April 1994.

Of the 41 patients who were drilled, 18 had undergone hydroxyapatite implantation as a primary procedure at the time of enucleation. Twenty-three patients had received a hydroxyapatite implant as a secondary or exchange procedure. The patients who underwent implantation as a primary procedure had a number of different pre-operative diagnoses (Table 1). The most frequent indication was a blind painful eye caused by a penetrating injury (44%). The most frequent indication for a secondary implant was post-enucleation socket syndrome (Table 2; Fig. 5).

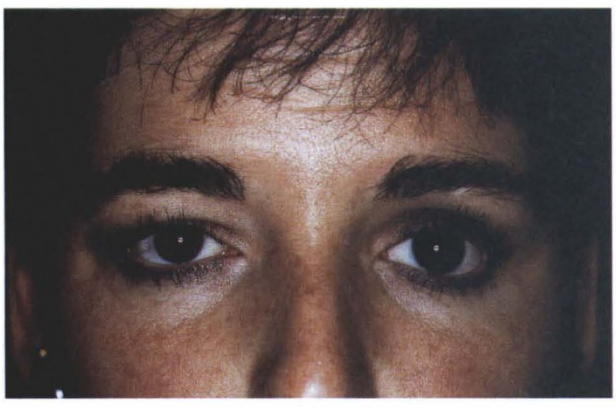


Fig. 5. *A pre-operative patient with post-enucleation socket syndrome.*

The age range of the patients was 7–60 years, with a mean of 34 years (Table 3). The majority of implants placed were 18 mm in diameter. The time interval between hydroxyapatite implant surgery and the drilling procedure ranged from 6 to 30 months in primary patients, with a mean of 13.6 months. In secondary patients the range was from 8 to 25 months, with a mean of 14.2 months.

The most frequent complication seen was spontaneous extrusion of the peg (Table 3). A 10-year-old patient was pegged 14 months after primary implantation (patient 11). The peg extruded due to the formation of granulation tissue in the drill hole. She was successfully re-drilled 11 months later. A 40-year-old patient had a primary implant that was complicated by post-operative orbital cellulitis (patient 10). He underwent drilling 2½ years later and 3 days after this his peg fell out spontaneously. Six months after this he was re-drilled but after 4 weeks the peg again fell out. A 60-year-old patient had a secondary implant and was drilled 8 months later (patient 37). The peg spontaneously extruded and he was successfully re-drilled 1 month later.

A 46-year-old patient underwent primary enucleation and implantation for a blind painful eye that was the result of a fireworks injury 25 years previously (patient 12). The injury had caused extensive corneal and conjunctival burns. After pegging at 21 months post-operatively his conjunctiva became chronically inflamed and swollen. This required his peg, along with some granulation tissue, to be removed 9 months later.

Three patients had pegs that were drilled in unsatisfactory positions. One peg was misplaced nasally, requiring re-drilling (patient 13). Another patient had poor motility after drilling as the peg did not fit snugly into the hole (patient 17). The patient was re-drilled and fitted with a sleeved peg. A secondary patient had a peg fitted that stood proud from the conjunctiva (patient 38). This was changed for a sleeved peg and screwed in until it was flush.

A primary patient was drilled at 13 months and the peg became buried beneath conjunctiva (patient 18). Two months later the conjunctiva was surgically divided and the peg moved anteriorly. A 41-year-old secondary

Table 2. *Indications for secondary hydroxyapatite implant*

Indication	No. of patients
Migrated or tilted implant	3
Post-enucleation socket syndrome	19
Extruding implant	1

Table 3. *Age of patient, time interval between implant and drilling, implant size and complications*

Patient no.	Age (years)	Implant size (mm)	Time of drilling (months post-op.)	Complications
Primary patients				
1	29	18	9	None
2	35	Not recorded	21	None
3	30	20	11	None
4	37	20	9	None
5	54	18	11	None
6	21	18	19	None
7	30	Not recorded	12	None
8	30	18	12	None
9	22	Not recorded	13	None
10	40	18	30	Peg extrusion
11	10	18	14	Peg extrusion
12	46	18	21	Conjunctival inflammation
13	25	18	14	Malposition of peg
14	28	18	12	None
15	46	18	10	None
16	9	16	6	None
17	38	18	8	Poor fit of peg
18	53	20	13	Conjunctival overgrowth
Secondary patients				
19	52	Not recorded	9	None
20	31	16	14	None
21	57	18	20	None
22	40	Not recorded	13	None
23	41	18	13	None
24	21	20	12	None
25	39	18	18	None
26	16	16	25	None
27	11	18	12	None
28	7	16	13	None
29	15	20	13	None
30	32	20	10	None
31	59	18	22	None
32	52	16	16	None
33	50	Not recorded	13	None
34	30	Not recorded	21	None
35	31	Not recorded	14	None
36	22	Not recorded	15	None
37	60	18	8	Peg extrusion
38	38	18	13	Peg proud
39	18	Not recorded	10	None
40	31	20	10	None
41	41	18	13	Peg caused discomfort

patient found the peg uncomfortable so it was removed and exchanged for a small-headed peg that resolved the problem (patient 41).

Table 4. *Further surgical procedures*

	No. of primary patients	No. of secondary patients
Re-drilling	4	2
Division of conjunctiva and peg repositioning	1	0
Peg refitting with a small head	0	1
Removal of peg and granulation tissue	1	0
Subperiosteal implant	2	1
Levator aponeurosis advancement	1	1
Lateral tarsal strip	3	0
Levator recession	1	0

Further surgical procedures that were undertaken are shown in Table 4. Some of the procedures were not related directly to the pegging itself, but rather to the problems of post-enucleation socket syndrome.

The results of the postal questionnaire are shown in Table 5. Column 1 shows the patients' subjective assessment of the motility of their artificial eye prior to drilling on a scale from 1 to 10, and column 2 shows their assessment of motility after drilling. Thirty-three patients (80%) replied to the questionnaire. Thirty (91%) of those who replied felt that the pegging of their implant had resulted in an improvement of the motility of their artificial eye. Twenty-five patients (76%) felt that the stability of their artificial eye had been improved. Several patients commented that the fine movements of their

Table 5. *Patient assessment of results of pegging*

Patient no.	Motility before drilling	Motility after drilling	Did pegging improve stability?	Patient comments
1	7	9	Yes	
2	6	9	Yes	
3	5	10	No	Discharge from socket
4	6	8	Yes	Fine movements improved
5	4	9	Yes	
6	5	9	Yes	
7	6	9	Yes	
8	3	9	Yes	
9	3	9 3/4	No	
10	5	Peg fell out	No	Not yet re-drilled
11	3	9	Yes	
12	7	4 (peg removed)		
19	7	9	No	
20	6	8	Yes	
21	1	4	Yes	
22	4	9	Yes	
23	0	5	Yes	
24	2	5	Yes	
25	5	8	No	
26	1	9	Yes	
27	1	6	Yes	Edge show of prosthesis
28	1	3	Yes	
29	8	9	Yes	
30	4	8	Yes	
31	1	9	Yes	
32	1	8	Yes	
33	1	9	Yes	
34	6	9	Yes	
35	1	2	No	
36	2	8	Yes	
37	4	0	Yes	Peg prevented prosthesis falling out
38	7	8	No	

artificial eye had been improved upon. One patient had edge show of the prosthesis on extremes of gaze after pegging.

Discussion

The second-stage drilling procedure of the hydroxyapatite orbital implant is simple to perform and confers several potential advantages to the patient. It allows direct transfer of the implant movement to the artificial eye by means of a ball and socket arrangement, so that motility can be improved in extremes of gaze (Figs. 6, 7) and the fine, conversational movements of the natural eye may be mimicked without the lag seen with many other types of implant. It also increases the support of the artificial eye and reduces the weight supported by the lower lid and inferior fornix. The results of the questionnaire show that the majority of patients felt the motility of their artificial eye had been improved by the pegging procedure, as well as its stability.

Implant size is an important consideration. If the implant is too large there will be insufficient residual socket volume to accommodate a thick enough artificial eye to allow modification of its posterior surface to couple with the peg. A minimum anterior space of 6 mm is needed to allow an adequate anterior chamber depth. A large implant will also cause protrusion of the artificial eye and poor lid closure. Once pegging has been undertaken, the excursion of the prosthesis may be too great, its edge being seen on lateral gaze. This was seen in one 11-year-old patient (patient 27) who had a secondary hydroxyapatite implant of 18 mm size. The size of the implant may also potentially affect the rate of vascularisation and hence the timing of drilling, although there is an inter-individual variation in the rate of angiogenesis.[5]

Perry, in this first descriptions of the technique of hydroxyapatite implant surgery, advocates an assessment of implant vascularity prior to drilling of the implant.[3] We made the assumption that by waiting at least 6 months after a primary hydroxyapatite implant procedure or 12 months after a secondary or exchange

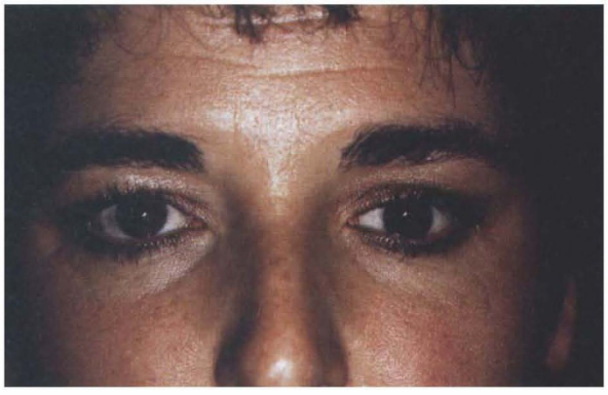
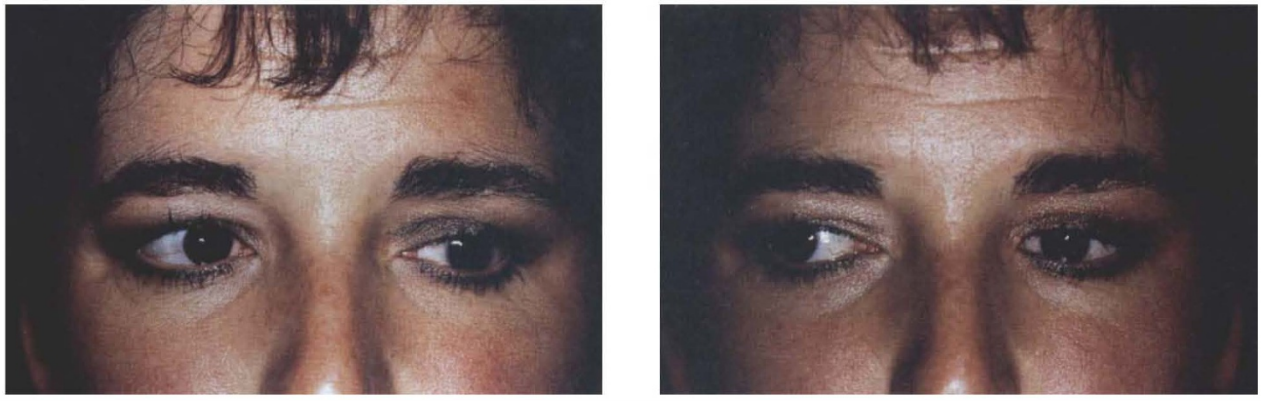


Fig. 6. *The appearance after secondary hydroxyapatite implant and second-stage drilling.*



(a) (b)

Fig. 7. *(a), (b) Movement of the prosthesis in horizontal gaze after drilling.*

procedure, sufficient time would have elapsed for full vascularisation of the implant to occur. We have not therefore routinely assessed the extent of implant vascularity prior to drilling, and have not experienced a higher rate of complications as a result of this practice. We have had problems with peg extrusion in 3 of our 41 drilled patients, as compared with the experience of Shields *et al.*[1] who had 2 cases of extrusion in 31 patients they drilled. We have had no cases of infection or exposure of the implant after pegging. These results confirm our belief that it is an unnecessary expense to make a formal assessment of the implant vascularity if sufficient time has elapsed post-operatively.

The position of the drill hole and peg is also an important factor in achieving a good result. Malposition of the peg can cause discomfort, stress on the conjunctiva with resulting inflammation, and edge show of the prosthesis. The pupil of the artificial eye must also be aligned in relation to the remaining natural eye. To ensure the correct position of the drill hole, the ocularist makes a wax template of the artificial eye to allow the conjunctiva to be marked at the site of the pupil. Unequal implant movement on excursions must be compensated for at this stage. The drill hole must also be perpendicular to the anterior plane of the orbit.

The hydroxyapatite implant is becoming increasingly popular as an implant that allows the anophthalmic patient a good cosmetic result with minimal complications. The second stage of the procedure, the drilling of the implant and insertion of the motility peg to allow direct coupling of the prosthesis to the implant, is a simple and quick procedure with few complications. A high percentage of patients who underwent drilling felt that the procedure had improved the motility of the artificial eye significantly, and also its stability.

The final result of the hydroxyapatite implant and the second-stage pegging procedure is very much dependent on the help of the ocularist, whose role is vital in making the template for the peg position, and also in the final modification of the artificial eye.

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