The use of hydroxyapatite blocks for innominate osteotomy: a report of three cases

M Amemiya, I Kikkawa, H Watanabe
Department of Orthopedics, Jichi Children’s Medical Center, Tochigi, Japan

Y Hoshino
Department of Orthopedics, Jichi Medical University, Tochigi, Japan

K Ito
Horinouchi Hospital, Niizashi, Saitama, Japan

ABSTRACT
We evaluated the use of hydroxyapatite blocks as spacers in pelvic osteotomy. The hydroxyapatite blocks fused with autologous bone tissue within 10 months and were highly biocompatible even after 10 years. They prevent pelvic deformities and are as effective as autogenous bone grafts.

Key words: durapatite; hip dislocation, congenital; osteotomy; pelvis

INTRODUCTION
Studies on the use of artificial bone grafts for innominate osteotomy in children are scarce. We evaluated the long-term outcomes of 3 children (4 hips) with lateralisation and residual subluxation of the hip joint who underwent Pemberton or shelf osteotomies using hydroxyapatite (HA) blocks (Pentax; Tokyo, Japan) as spacers, with a Ca/P ratio of 1.67 and a porosity of 40%. The blocks were cubic or rectangular in shape (Fig. 1), and were trimmed using an airtome.

The time to union (defined as radiographic disappearance of a clear zone around HA blocks), changes in the area of the HA blocks (measured by the Scion Image software), Severin’s criteria, and the activities of daily living levels (based on the Japanese Orthopaedic Association [JOA] score) were assessed. All patients achieved bone union within 10 months with favourable compatibility even after 10 years.

CASE SERIES

Case 1
In July 1992, a 3-month-old girl with bilateral congenital hip dislocation underwent reduction using a Pavlik harness (Riemenbugel) and overhead traction, but these failed and she was referred to our hospital. At 11 months of age, she underwent manual reduction under general anaesthesia but this again failed. At one year of age, she underwent open reduction using the Ludloff method, but subluxation progressed gradually (Fig. 2a). At 3.8 years of age she underwent Pemberton osteotomy plus a femoral varus osteotomy in the right hip, and at 4.3 years of
age she underwent the same procedure in the left hip (Figs. 2b–2e). Immediately after surgery, the HA block areas of the right and left hips were 3.65 cm$^2$ and 2.49 cm$^2$, respectively. Bone union was achieved 6 months later in the right hip and 4 months later in the left. At the 10-year follow-up (when she was 13.8 years old), complete bone union was evident in both hips (Fig. 2f). The HA block areas of the right and left hips had decreased to 3.5 cm$^2$ and 2.48 cm$^2$, respectively. Both hips were classified as Severin group IIa, with a JOA score of 100 with no interference with activities of daily living.

**Case 2**

In May 1992, a 1.3-year-old girl with congenital dislocation of the left hip underwent reduction using the Pavlik harness (Riemenbugel), but this was unsuccessful and she was referred to our hospital. At 2.2 years of age, she underwent manual reduction (under general anaesthesia) and Ludloff’s open reduction, but coxa valga and subluxation progressed gradually (Fig. 3a). At 4.5 years of age, she underwent a Pemberton osteotomy and femoral varus osteotomy. Immediately after surgery, the HA block area was 2.23 cm$^2$ (Fig. 3b). Bone union was achieved 7 months later (Fig. 3c). At the 10.4-year follow-up (when she was 14.9 years old), complete bone union was evident and the HA block area had decreased to 1.45 cm$^2$ (Fig. 3d). The hip was classified as Severin group IIb, with a JOA score of 95. The left leg was only 1 cm shorter than the other leg, and she experienced no interference with activities of daily living.

**Case 3**

In December 1992, a 2.8-year-old girl with congenital dislocation of the left hip underwent open reduction and a Salter innominate osteotomy, but femoral head lateralisation and subluxation developed gradually (Fig. 4a). She was referred to our hospital at 3.9 years of age. At the age of 4.3 years, she underwent open reduction and shelf osteotomy. Immediately after surgery, HA block area was 2.68 cm$^2$ (Fig. 4b). Bone union was achieved 10 months later (Fig. 4c). At the 11.5-year follow-up (when she was 15.8 years old), complete bone union was evident and the HA block area had decreased to 1.46 cm$^2$ (Fig. 4d). The hip was classified as Severin group III, with a JOA score of 100.

**DISCUSSION**

HA blocks have been used as spacers in Salter innominate osteotomies, and complete bone union was achieved within 6 months. The use of HA blocks as spacers is as effective as the Salter’s original technique in improving the acetabular angle; they do not disturb pelvic growth and can reduce operating time and blood loss.

Bone tissues begin to form around the porous HA surface days after implantation. Inner pores are filled with newly formed compact bone tissues within months. Areas around the porous HA and inside
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Figure 3  Case 2: radiographs taken (a) before, (b) immediately, (c) 7 months, and (d) 10.4 years after Pemberton osteotomy and femoral varus osteotomy showing the hydroxyapatite block area (arrow).

Figure 4  Case 3: radiographs taken (a) before, (b) immediately, (c) 10 months, and (d) 11.5 years after shelf osteotomy showing the hydroxyapatite block area (arrow).

pores are filled with marrow-like tissues similar to those in cancellous bones.2–5

HA blocks have also been used as a load-bearing bone substitute in young patients to provide mechanical integrity without affecting the morphology of bone growth.6 A 13-year-old boy was reported to be able to return to sports 5 months after tumour removal and filling HA blocks in the cavities of the tibia.6 In our patients, HA blocks were implanted in a load-bearing site above the hip joint, with no interference with their activities of daily living and sports.

In both Pemberton7 and Salter8 innominate osteotomies, iliac crest growth cartilage is resected partially to obtain autogenous bone grafts. As a result, pelvic deformities associated with abnormal growth of the iliac crest are common.9 In case 3, deformity of the left iliac was probably due to the previous Salter procedure. Such problems may recur secondary to iliac hypoplasia of the hip abductor strength and cosmetic deformities. Innominate osteotomy using HA as an autogenous bone graft instead of the iliac bone or the anterosuperior iliac spine has the least effect on the hip abductor and cosmesis.

The use of HA blocks as spacers for innominate osteotomy in children is recommended. They are biocompatible and mechanically stable, prevent pelvic deformities, and are as effective as autogenous bone grafts.

REFERENCES