ACETABULAR AUGMENTATION INDUCED BY EXTRACORPOREAL SHOCK WAVES IN RABBITS

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**INTRODUCTION:** Acetabuloplasty has been performed for acetabular dysplasia as radical therapies. If it was possible to induce bone formation on the acetabular roof nonoperatively, it would be possible to treat acetabular dysplasia. We came up with the idea that the technique to induce organic reaction by giving a local dynamic loading would be the most rational method to locally induce the bone formation nonoperatively. Extracorporeal shock wave therapy, which was developed for lithotripsy, is thought to be also useful to give dynamic loading to organs noninvasively. Shock wave demonstrates its physical action specific on bone as on calculus (1). It was reported that exposure to shock waves caused fracture of cancellous trabecula or periosteal lifting (2). In addition, it was shown that shock waves were effective for the treatment of non-union or delayed union after fracture (1), indicating that shock waves could induce bone formation, locally. We conducted this study using immature rabbits to verify whether or not bone formation is induced by irradiation of extracorporeal shock waves on acetabular roof, and our final goal is to apply the extracorporeal shock waves to the clinical practice for the treatment of acetabular dysplasia.

**METHODS:** This study was conducted in accordance with the Guide for Animal Experimentation, Inohana Campus, Chiba University, Chiba City, Japan. Eight male New Zealand White rabbits aged 9 weeks weighing 1.0-1.2 kg were used. Piezolith 2300 (Richard Wolf Inc., Germany) was used to produce extracorporeal shock waves. Ultrasonic waves were used for focusing. The focus was set in 3 mm cranial from superolateral edge of the acetabulum and 2 mm inside from lateral margin of the acetabular roof. Each 4 animals of the 8 animals were grouped into Group I and II. Shock waves were irradiated on the right acetabular roof from outside. The strength and the number of the shock waves were set to be 100 MPa and 5000 times respectively. The animals were monitored for 4 weeks in group I, and for 8 weeks in group II, and after the end of monitoring period, pelvises were taken and the pelvises were cut into 1-mm serial sections (0.3 mm in width) which were parallel to the plane including the center of the body of the last lumbar vertebra and bilateral acetabular fossa. Contact microradiograph of each section was taken, and the section that has the widest space between bilateral superolateral ossified edge of the acetabulum in all sections was selected. In the contact microradiograph of this section, the distance “y” (the breadth of the acetabular roof) was determined and the laterality was examined (Fig. 1). Line “a” was drawn from left to right superolateral ossified edge of the acetabulum, and then Line “b1” and “b2” were drawn perpendicular to the Line “a” from bilateral medial margin of the acetabulum. The distance from line b1 or b2 to the lateral margin of the acetabular roof at “x” (0-8) mm cranial from line “a” was determined as “y”.* Statistical analysis was conducted using the unexposed side as control by Student’s paired t-test.

**RESULTS:** No fracture was observed on the plain X-ray photo during the monitoring period after irradiation. No laterality was observed on the soft X-ray photo of femurs. Fig. 2 shows the results of measurements of the breadth of the acetabular roof. Four weeks after irradiation, the distance “y” in exposed side was significantly increased 1.3 and 4 mm cranial area from the line “a”. Eight weeks after irradiation, the distance “y” in exposed side was significantly increased at (“x”=) 4, 5 and 6 mm cranial area. Fig. 3 shows the contact microradiographs of the acetabular roof 4 weeks after irradiation. Woven bone formation was shown on the lateral margin of the acetabular roof in exposed side. Fig. 4 shows the contact microradiographs of the acetabular roof 8 weeks after irradiation. Woven bone formation was not observed, however, augmentation of the acetabular roof and the thinning of the cortical bone of the acetabular roof were observed in exposed side. Similar findings were demonstrated in all animals.

**DISCUSSION:** This study was intended to induce bone formation at the area, which has no requirements of covering in biomechanically, and the extension of cartilage coverage in the hip joint was out of this scope. As shown in these results, woven bone formation on the acetabular roof and significant increase in the breadth of the acetabular roof suggested that there would be a possibility to use extracorporeal shock wave therapy for the treatment of acetabular dysplasia. The number of test subjects was not sufficient to conduct a statistical analysis, but histological changes were observed markedly. We supposed the area of woven bone 4 weeks after irradiation moved to cranial side accompanying with the bone growth in the proliferation zone in the acetabular roof (3) and the breadth of the acetabular roof at cranial increased as a result of that. We also supposed the thinning of the cortical bone was due to no biomechanical requirement of the excess bone in the acetabular roof. In conclusion, irradiation of the extracorporeal shock wave wave induced acetabular augmentation. The clinical application of the extracorporeal shock wave is still far from its actualization. This report is the first step to actualize the nonoperative acetabuloplasty.

**REFERENCES:**

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