

APPLICATION OF LOW-LEVEL LASER THERAPY (LLLT) FOR REDUCTION OF CONGENITAL DISLOCATION OF THE HIP

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Low-level laser irradiation was given to the area surrounding the hip joint in 113 cases with congenital dislocation of the hip (27 with luxation, 86 with subluxation), in order to eliminate soft tissue strain around the hip joint during reduction of the dislocation. The patients were all infants below 6 months of age at presentation. Treatment of congenital dislocation of the hip consisted of functional treatment using a Pavlik harness in 107 cases, re-wearing of the harness after horizontal traction in 2 cases, and abduction traction in 4 cases.

Low-level laser therapy was effective for eliminating soft tissue strain around the hip joint, proving to be useful as a physical therapy procedure prior to the use of the harness. Following laser irradiation, the femoral head could be readily elevated, even during horizontal traction.

Thanks to the use of low-level laser, which was introduced in 1993, reduction could be conservatively attained in all the patients and no avascular necrosis of the femoral head occurred in any of the cases.

It is important to make the best attempt to achieve reduction by conservative methods in the treatment of congenital dislocation of the hip. As low-level laser irradiation is nonstimulating, noninvasive, and easy to deliver, and has no adverse effects, it is useful as physical therapy for eliminating soft tissue strain around the hip joint before and after reduction of congenital dislocation of the hip.

Key words: Fcongenital dislocation of the hip A low level laser A reduction A avascular necrosis of the femoral head

Introduction

Prevention and treatment strategies for avascular necrosis of the femoral head in children have not yet been established. We have reported that near-infrared-ray irradiation promotes repair of necrosis in Perthes disease, thereby preventing deformity of the femoral head⁽¹⁾ In this paper, we report on the effectiveness of low-level laser irradiation, which has been in use since 1993, in reducing the tension of the muscles acting on the hip joint, especially the adductor muscle group, as a novel technique for alleviating the restriction of hip

abduction due to congenital dislocation of the hip. Also, we report a comparative review of cases treated by low-level laser irradiation against those not treated by irradiation before and after reduction of congenital dislocation of the hip with a Pavlik harness or traction of the lower extremities, to explore the possibility of preventing avascular necrosis of the femoral head, which inevitably occurs in about 10% of cases treated by conventional reduction treatment.

Subjects and Methods

Subjects had visited Shinano Handicapped Children's Hospital between 1993 and 2006. The results in 113 cases with congenital hip dislocation (dislocation: 27 cases, subluxation: 86 cases), including 2 cases with bilateral dislocation, are presented. All were infants under 6 months of age, with a mean age of 3 months

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at the time of the initial visit. The treatments included the use of a Pavlik harness alone (107 cases) (**Fig.1**) use of a Pavlik harness after horizontal traction (2 cases), and abduction traction (4 cases) (**Fig.2**). The control group included 63 infants under 6 months of age at the time of the initial visit who were not treated by irradiation.

The laser used was a gallium aluminum arsenide (GaAlAs) diode laser, UQ305, (Minato Medical Science, Co.,Ltd., Japan) giving output powers in continuous wave of 100mW, at a wavelength of 810nm. The laser was applied to the target points using the contact method for 30 to 60 seconds per point. The spot size at the tissue was 1.04 mm² giving power densities of 9.61 W/cm² at 100mW, respectively. Energy densities per point ranged from 86.55J/cm² to 288.3 J/cm², depending on the combination of output power and irradiation time.

Three sites, the hip adductor muscle, the anterior hip joint, and the lateral hip joint were irradiated (**Fig.3**). Each site was irradiated for one minute, and in principle, the structures on both sides of the body were irradiated, with a total irradiation time of 6 minutes. The outpatients received the irradiation three times a week, while the hospitalized patients under traction received the treatment daily. The irradiation was continued while the Pavlik harness was worn in the outpatients, and while the traction was on in the inpatients, and the mean irradiation period was 3 months. The period of follow-up ranged from 7 months to 12 years and 6 months, with a mean of 3 years and 6 months.

Results

The patients with restricted hip abduction showed



Fig.1: Pavlik harness



Fig.2: Abduction traction of the hip

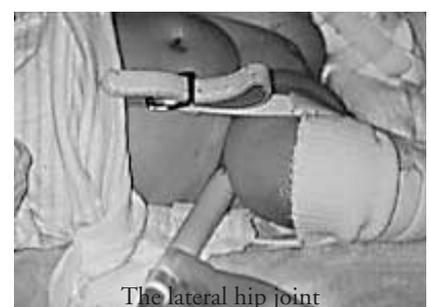
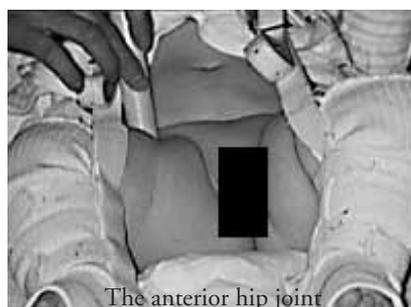


Fig.3: LLLT target points

improvement of the hip abduction immediately after the irradiation by a mean angle of 20° , and the change could be clearly recognized by the parents (Fig.4). In addition, in 3 cases, the hip click sign which was not observed before LLLT, could be appreciated when the hip joint was abducted gently after LLLT. Of the cases treated with the Pavlik harness, improved abduction was observed on the day following the attachment in 103 cases, and in the remaining 3 cases also, the

abduction range improved within 3 days; consequently, reduction could be achieved in all the cases (Figs.5 a.b.c, Figs.6 a.b.c, Figs.7 a.b.c).

In the cases treated by traction, the femoral head was lowered by 5 mm (1 joint), 6 mm (2 joints), 7 mm (2 joints) and 12 mm (1 joint), with a mean of 7.2 mm, from the Hilgenreiner line by horizontal traction (for a mean duration of 1 month). The results for these joints were superior to those in the 5 cases treated by con-

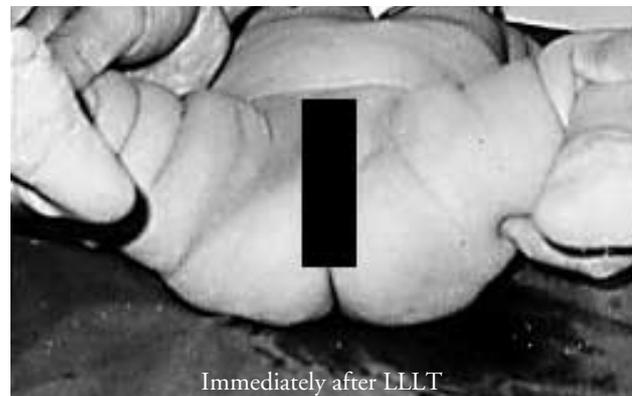
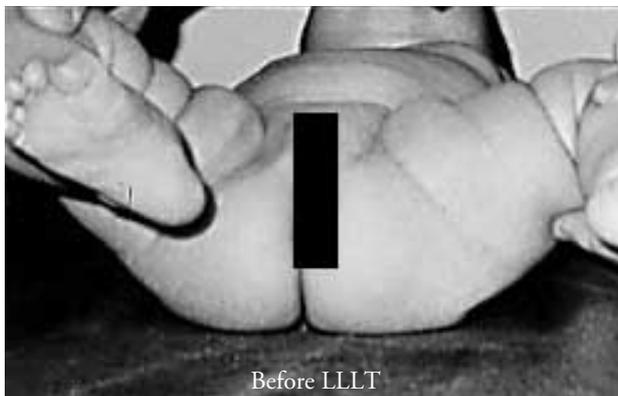


Fig.4: Restriction of right hip abduction



Fig.5: a) Congenital dislocation of the bilateral hip at the initial visit
 b) Horizontal traction was conducted for one month, by which the femoral head was lowered by 7 mm on the right side and 6 mm on the left side, from the Hilgenreiner line.
 c) Reduction of dislocation was satisfactory, and the femoral head was approximately circular.



Fig.6: a) Congenital dislocation of the left hip at the initial visit
 b) Horizontal traction was conducted for one month, by which the femoral bone was lowered by 12 mm on the left side, from the Hilgenreiner line.
 c) Reduction of dislocation was satisfactory, and the femoral head was approximately circular.



Fig.7: a) Congenital dislocation of the bilateral hip at the initial visit
 b) Horizontal traction was conducted for one month, by which the femoral bone was lowered by 7 mm on the right side and 6 mm on the left side, from the Hilgenreiner line.
 c) Reduction of dislocation was satisfactory, and the femoral head was approximately circular.

ventional traction alone with a mean descent length of 5.2 mm, and reduction could be conservatively achieved in all cases. In the 63 cases treated with the conventional Pavlik harness and traction, reduction could not be achieved in 8 cases (13%), who were then treated by open reduction.

Comparison of the incidence of avascular necrosis of the femoral head before and after introduction of LLLT revealed that while 6 of the 63 cases with congenital dislocation of the hip examined before the introduction of LLLT developed avascular necrosis of the femoral head (classified into type II (2 cases) or type IV (4 cases) deformity according to the Kalamchi classification) (**Fig.8**), none of the 113 cases examined after the introduction of LLLT in 1993 developed avascular necrosis of the femoral head.

To prevent recurrence of restricted hip abduction after LLLT, the parents were instructed on the hip abduction stretch exercise and on how to change the diapers prior to the attachment of the Pavlik harness, therefore, there were no cases of recurrence. No adverse effect due to irradiation were found. In the event of fever due to upper respiratory infection, the irradiation was temporarily discontinued.

Discussion

Low-level laser light has a high penetration depth in the living body at a single wavelength and diffuses in living tissues because of low-power nevertheless is less irritating in irradiation because of its low power, it is less harmful to the body, and there are no reports of severe adverse effects, except in the case of direct irradiation of the eyes. The therapeutic effects include muscle relaxation and relief of soft tissue contracture, and promotion of wound healing. In pain clinics, the neighborhood of the stellate ganglion has been

increasingly irradiated with low-level laser instead of stellate block. As for the reported mechanism, the Na channel in the nerve fibers are opened to cause depolarization, secondary vasodilation occurs because of sympathoinhibitory effects, and decrease of the free Ca^{2+} ion concentration in the vascular smooth muscle cell directly relaxes the blood vessels (2). As for other photostimuli, synostosis(3), cell division, cell activity, immune cells and antiinflammatory activity were also studied.

When low-level laser of 100 mW output is used, it takes from 30 seconds to one minute at each site to obtain sufficient effects of the irradiation on the muscle tone and soft tissue contractures, and irradiation of a longer duration causes weakness.

It has been reported in the past, that successful reduction could not be achieved in approximately 15% of patients in whom conservative therapy was begun for congenital dislocation of the hip before the age of



Fig.8: Avascular necrosis of the right femoral head after Pavlik harness in a case not treated by LLLT.

6 months, whereas after the introduction of LLLT, reduction has been achieved in all the patients under 6 months of age at the initial visit who were treated conservatively. In addition, according to one report, 10% of patients in whom a Pavlik harness is used develop avascular necrosis of the femoral head, which inevitably causes hip pain in later life, with significant disability. When the hip joint is forcedly reduced with a Pavlik harness, the retinacular vessels are occluded, resulting in avascular necrosis of the femoral head. One of the most important aspects of reduction of congenital dislocation of the hip is to prevent avascular necrosis of the femoral head by the use of a moderate reduction force. Reducing the tension of the soft tissues around the hip joint by LLLT is a useful physiotherapeutic technique in the treatment of congenital dislocation of the hip, because it is non-invasive, simple to perform, is associated with no side effects, is a useful pretreatment procedure prior to the fixation of a Pavlik harness, and facilitates lowering of the femoral head when the irradiation is administered during horizontal traction to achieve reduction.

We propose to publish a study on the effects of improved blood flow following low-level laser irradiation on the development of the acetabular cartilage and the femoral head in the future.

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Conclusions

- 1) LLLT was carried out in order to reduce the restriction of hip abduction due to congenital dislocation of the hip, and relax the tension of the soft tissues around the hip joint during traction of the lower extremities.
- 2) LLLT is less irritating, non-invasive, simple in operation, is associated with no side effects and is a useful pretreatment procedure prior to fixation of a Pavlik harness.
- 3) The femoral head could be easily lowered by irradiation during traction treatment for congenital dislocation of the hip.
- 4) Since the introduction of LLLT in 1993, reduction of the hip dislocation has been successfully achieved in all the 113 patients (under 6 months of age at the initial visit) treated conservatively, without the development of avascular necrosis of the femoral head.
- 5) Reduction of the tension of the soft tissues around the hip joint by LLLT may have contributed to the moderate reduction force during the use of a Pavlik harness and during traction, and the prevention of avascular necrosis of the femoral head.

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