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Are the additional grafts necessary?

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The goals of surgery for spinal deformity are to correct or improve the deformity to get a stable, balanced and fused spine. The long-term success of any procedure for scoliosis depends on a solid arthrodesis. Getting fusion of the instrumented segment with the aid of copious autogenous iliac graft has been the most important goal of treatment. However, harvesting copious graft from teenage iliac bone has its limitation in the quantity of graft, surgical time, and other complications of graft sites. Bone substitute is a promising concept, but there is not ideal bone substitute with all the characteristics of an autogenous bone graft. Several alternative graft materials like tricalcium phosphate, hydroxyapatite, and demineralized bone matrix have osteoinductive properties. Bone morphogenic protein has osteoconductive properties. The limitations with bone substitutes are osteoinduction and osteoconduction properties, sterilization, chances of transmitting infective disease and cost. We consider that the introduction of segmental spinal instrumentation which enables strong and firm correction and fixation of the scoliotic deformity has enabled getting fusion with less graft. We can obtain that quantity of graft after laminae and spinous process decortication. This retrospective study has been done in our hospital from January 2002 to December 2004. A total of 188 patients underwent posterior corrections for adolescent idiopathic scoliosis using segmental fixation by Moss-Miami. No autogenous iliac crest graft was taken or graft substitutes. After meticulous decortication and destruction of facet joints, we used local graft taken from spinous process and laminae. All patients had minimum thirty months follow-up. We have excellent results. Out of these 188 patients, 177 patients have fused spine, no implant failure, no pain, no infection and no loss of correction. Eleven (5.8%) patients underwent re-operation; four among them because of infection, three for symptomatic implants and four due to pseudarthrosis. We consider that the use of local harvesting graft is enough for getting good spondylodesis.

Key words: scoliosis, spondylodesis, grafts.

INTRODUCTION

The goals of surgery for spinal deformity are to correct or improve the deformity to get a stable, balanced and fused spine. The long-term success of any procedure for scoliosis depends on a solid arthrodesis. Getting fusion of the instrumented segment with the aid of copious autogenous iliac graft has been the most important goal of treatment. Can in patients with adolescent idiopathic scoliosis posterior spinal fusion be performed without additional grafts? The purpose of the present study is to give an answer to this question? A spine fusion is a slow biological process that requires the body to create a new bony bridge between many bones that used to move independently of each other. This usually requires some sort of bone graft to bridge the gaps where the new bone needs to form in order for the fusion to occur.

There are many sources of bone for bone grafts, and most forms of scoliosis surgery use some form of autogenous bone graft, which is taken from a different part of the patient's body. When this is done during spinal fusion surgery, the bone often comes from the patient's spine, ribs, or pelvis. A more common source of bone for bone graft comes from the patient's own pelvis. The iliac crest is an excellent source of extra bone that can be used to help the spine to fuse.

Unfortunately there is only a limited amount of autogenous bone available, and harvesting bone from certain places can cause problems later on. If bone is harvested from the iliac crest, the patient can experience pain, numbness, and persistent discomfort in this area after surgery. Removing bone for bone graft also increases the amount of time required for the surgery, the amount of blood that is lost during surgery, and usually requires a separate incision to be made in the skin. Efforts continue

to enhance the process of achieving spine fusion and to eliminate the need for autogenous iliac crest bone graft harvest. In order to avoid the downside of taking bone from other parts of the patient, several alternate sources of bone graft have been developed. Allograft bone can be used during spinal fusion. Allograft is extensively tested and processed in order to make sure that it is safe to use in patients.

The principal risk of allogenous bone graft is risk of infection, in particular hepatitis at the rate of one in one million and AIDS at the rate of one in ten million. To overcome these limitations synthetic grafts are preferred in place of autogenous grafts.

Hydroxyapatite is available in various physical forms. HA in ceramic and crystalline form is slow in resorption and bone formation, where as non ceramic, non crystalline form is fast in resorption and in bone formation. Collagen is added to hydroxyapatite to give mechanical strength. Interest in mesenchymal stem cells has increased with the introduction of two mineralized allograft products that are claimed to have cryopreserved stem cells.

In general, the number of stem cells present in bone marrow is relatively small, and without specific signals (e.g., BMP) it is not clear whether sufficient numbers of cells are present to initiate bone formation de novo. Since the approval of rhBMP-2 in 2002 and rhBMP-7 late in 2004, the use of recombinant bone morphogenetic proteins (BMPs) in spine fusion continues to grow. Although much focus remains on recombinant osteoinductive proteins, their relatively high cost has continued to encourage research involving other bone-grafting solutions.

A primary concern associated with the off-label use of recombinant BMPs is related to local adverse events. The three most commonly reported local side effects have been heterotopic bone formation in the surgical approach track, transient bone resorption when used near exposed cancellous bone, and sterile seroma fluid collections and/or local edema.

MATERIALS AND METHODS

This retrospective study has been made in our hospital from January 2002 to December 2004.

A total of 188 patients underwent posterior corrections for adolescent idiopathic scoliosis using segmental fixation by Moss-Miami. No autogenous iliac crest graft was taken or graft substitutes. After meticulous decortication and destruction of facet joints, we used local graft taken from spinous process and laminae. All patients had minimum thirty months follow-up. Our study hypothesis was that the segmental spinal instrumentation would be found to have provided spinal fusion without additional grafts or bones substitutes.

METHODS

Segmental instrumentation with dual-rod fixation was used in all cases. Radiographs were assessed for pseudarthrosis.

OPERATIVE TECHNIQUE AND POSTOPERATIVE TREATMENT

The Miami-Moss instrumentation was applied according to the established guideline. Intervention: The operation involved a standard posterior midline incision and exposing the spine. After preparation of the hook sites and before rod insertion, the cartilage of the lumbar facet and thoracic joints was removed. The rods were inserted, the deformity was corrected. At the end meticulous decortications, we used local graft taken from spinous process and laminae and then packed in the areas where the fusion was going to occur. The patients treated were allowed to walk on the third postoperative day, without restrictions and with no postoperative immobilization.

First Six Months - No strenuous physical activity. Activities are limited to "activities of daily living, and no heavy lifting. In addition, no running or jumping is allowed. In six months, a physical examination, including X-rays, is performed. If all is well, more activity, such as swimming, will be allowed. In around eight months, the patient begins closed chain kinetic exercises. An example is bicycling, where the foot is on a pedal as the lower limb rotates. In ten months running, jumping and solo sports are allowed. In twelve months X-rays will be taken. If all is well, the patient will be allowed to return to unrestricted activities.

STUDY DESIGN

Preoperative and postoperative data were collected from the medical and hospital records. Standing posteroanterior radiographs of the whole spine were made preoperatively, two years postoperatively, and at the final follow-up visit, we made also oblique radiographs two years postoperatively. Loss of 10 degrees of correction or implant failure has been identified as an indicator of potential pseudarthrosis or fusion instability.

Radiographic Evaluation

Standard standing posteroanterior and lateral radiographs of the entire spine were made. The thoracic and lumbar curves were measured with the use of the Cobb technique. Spinal balance was determined on the basis of horizontal distance, in millimeters, of the C7 spinous process from the center sacral line. The status of the instrumentation was defined as in place and stable, loose, or removed. In last follow-up we made in all cases oblique radiographs to estimate spinal fusion.

The questionable sensitivity of plain radiographs to detect nonunion in the presence of internal fixation is a weakness of that and many similar studies. Definite pseudarthrosis (direct visualization of a defect during surgical exploration of the fusion or broken instrumentation seen on a radiograph) and possible pseudarthrosis (persistent midline moderate-to-severe back pain, a defect in the fusion mass, an unfused facet visible on a radiograph, or curve progression of 10° from that seen on the initial erect postoperative radiograph).

RESULTS

The mean age at the time of operation was 14.9 years (range 10.5-18 years). The average follow-up was forty - eight months and ranged from thirty to sixty-six months

RADIOGRAPHIC RESULTS

Preoperatively, main thoracic curve was 47,6+/-12.53, and mean lumbar curve was 43.2+/-15.3. Postoperatively main thoracic curve at last follow-up was 18.6+/-10.2 and mean lumbar curve was at last follow-up 14.6+/-7.2. Statistical analysis (Students T Test p>0.005) didn't show significant loss of correction during follow up period.

CLINICAL RESULTS

The mean magnitude of the thoracic rib hump, as measured with a scoliometer at the final follow-up evaluation 11° (range 1° to 21°), respectively.

COMPLICATIONS

Eleven (5.8%) patients had a complication. The caudad hook became dislodged during the follow-up period in three patients. Four patients had a delayed deep infection develop. The deep infections resolved after removal of implants in all patients.

Main results: Four patients met the criteria for pseudarthrosis (2%). All of them complained about mild back pain, and had progression of postoperative curve for more than 10 degrees (22+/-5). All four patients had preoperative curve of more than 60 degrees (65+/-2.2). There were no neurological complications.

DISCUSSION

The iliac crest as a source of bone graft has remained popular and continues to be the standard source of bone graft material in spinal arthrodesis surgery. Kager AN , Marks M, showed that 21 (24%) children reporting pain at the iliac crest site, with 13 (15%) reporting problems with daily activities, and one (0.5%) instance of arterial injury in the sciatic notch. Two (1%) patients had infections, both of which resolved with a single irrigation and debridement. Among 88 patients was one documented instance of sacroiliac penetration that did not cause clinical problems. The chart review showed three (1.4%) instances of continued pain and one (0.5%) of numbness. The true extent of pain and numbness after posterior iliac crest bone grafting in children was severely underreported in the medical records and may be unrecognized.

There has been an explosion of commercial products for the orthopedic surgeon to choose from. Calcium phosphate ceramics, calcium sulfate, bioactive glass, biodegradable polymers, and recombinant human BMPs (OP-1 and BMP-2) are all offered as solutions to the problem of bone-healing. Another important issue is whether these more expensive bone-graft substitutes will improve clinical outcomes and whether improved rates of fusion will correlate with better outcomes. The answers to these questions will take longer follow-up Autologous bone-grafting was described by Fred Albee in 1915. Although Albee also described the use of calcium phosphates as an alternative to bone in the 1920s, it was not until 1965, when Marshall Urist identified bone formation by autoinduction that new options unfolded. Twenty-three years later, Wozney et al. and Luyten et al. discovered the proteins responsible for this phenomenon, BMPs-2, 3, and 4. Today these proteins can be harvested from a variety of bone sources or synthesized through recombinant gene therapy, and they are available to the practicing orthopedist. Sartor is studied the radiological incorporation of hydroxyapatite and noticed absence of total resorption of hydroxyapatite. Delecrin compared ceramic and autologous graft for fusion of scoliosis spine and found equal results in both.

Betz RR, et al. in his work didn't use allograft at all. Autogenous bone harvested from spinous processes or ribs was discarded, rather than used for bone graft, as is standard clinical practice. 28 patients in the study had follow-up of ≥5 years, with no sign of problems developing after 2 years. It remains to be seen whether problems will develop later. If patients do well with intermediate follow-up under the extreme condition of no bone graft at all, local autograft should be sufficient in most patients with idiopathic scoliosis, if adequate facet destruction is performed at every level.

CONCLUSION

We consider that in patients with adolescent idiopathic scoliosis treated with the multisegmented hook-screw and rod system use of local harvesting graft is enough for getting good spondylodesis.

SUMMARY

DA LI SU DODATNI GREFONI NEOPHODNI KOD OPERATIVNOG LEČENJA SKOLIOZA?

Cilj hirurškog lečenja deformiteta kičme je da se koriguje deformitet pri čemu treba da se dobije stabilni kičmeni stub u balansu sa čvrstom spondilodezom. Dobar rezultat bilo koje hirurške intervencije kod lečenja skolioza zavisi od dobre spondilodeze. Dobijanje veće količine autografona sa ilijačne kosti kod dece, ima svoja ograničenja jer produžava vreme operacije, uz komplikacije povezane sa mestom uzimanja grefona. Zamena autografona sa veštačkom kosti je obećavajući koncept. Ograničenja kod korišćenja ovih veštačkih materjala su osteoinduktivne i osteokonduktivne karakteristike, potreba za sterilizacijom, opasnost od prenošenja bolesti i visoka cena.

Smatramo da se segementnom spinalnom instrumentacijom postiže korekcija i rigidna fiksacija deformiteta, a što omogućava dobijanje čvrste spondilodeze sa manjom količinom autografona, dobijenih dekortikacijom spinozusa i lamina.

U cilju dobijanja spondilodeze kod svih bolesnika su samo korišćeni grefoni dobijeni dekortikacijm spinozusa i lamina. Kod svih bolesnika postoji minimum praćenja od trideset meseci.

Na osnovu naših rezultata smatramo da je upotreba samo lokalno dobijenih autografona dovoljna za dobijanje čvrste spondilodeze, a što je pored korekcije osnovni cilj uspešnog operativnog lečenja skolioze.

Ključne reči : skolioza, spondilodeza, grefoni.

REFERENCES

1. Betz RR, Petrizzo AM, Kerner PJ, Falatyn SP, Clements DH, Huss GK. Allograft Versus No Graft With a Posterior Multisegmented Hook System for the Treatment of Idiopathic Scoliosis.Spine . 2006 Jan15 ;31:121 -7

2. Cotrel Y, Dubousset J. A new technic for segmental spinal osteosynthesis using the posterior approach. Rev Chir Orthop Reparatrice Appar Mot. 1984;70:489 -94.

3. Coe JD, Arlet V, Donaldson W, Berven S, Hanson DS, Mudiyam R, Perra JH, Shaffrey CI. Complications in spinal fusion for adolescent idiopathic scoliosis in the new millennium. A report of the Scoliosis Research Society Morbidity and Mortality Committee.Spine 2006;31:345 -9

4. Cotrel Y, Dubousset J, Guillaumat M. New universal instrumentation in spinal surgery. Clin Orthop.1988; 227:10 -23.

5. Delawi D, Dhert WJ, Castelein RM, Verbout AJ, Oner FC. The incidence of donor site pain after bone graft harvesting from the posterior iliac crest may be overestimated: a study on spine fracture patients. Spine. 2007;32:1865-8.Š

6. De Long WG Jr, Einhorn TA, Koval K, McKee M, Smith W, Sanders R, Watson T. Current concepts review. Bone grafts and bone graft substitutes in orthopaedic trauma surgery. A critical analysis.J Bone Joint Surg Am 2007; 89:649 -58.

7. Dickson JH, Mirkovic S, Noble PC, Nalty T, Erwin WD. Results of operative treatment of idiopathic scoliosis in adults. J Bone Joint Surg Am.1995; 77:513 -23

8. HarringtonPR. Treatment of scoliosis. Correction and internal fixation by spine instrumentation. J Bone Joint Surg Am. 1962;44:591 -610

9. Helenius I, Remes V, Yrjönen T, Ylikoski M, Schlenzka D, Helenius M, Poussa M. Comparison of long-term functional and radiologic outcomes after Harrington instrumentation and spondylodesis in adolescent idiopathic scoliosis: a review of 78 patients. Spine.2002; 27:176 -80

10. Kanayama M, Hashimoto T, Shigenobu K, Yamane S, Bauer TW, Togawa D. A prospective randomized study of posterolateral lumbar fusion using osteogenic protein-1 (OP-1) versus local autograft with ceramic bone substitute: emphasis of surgical exploration and histologic assessment. Spine. 2006;31:1067 -74.

11. Lenke LG, Bridwell KH, Blanke K, Baldus C, Weston J**.** Radiographic results of arthrodesis with Cotrel-Dubousset instrumentation for the treatment of adolescent idiopathic scoliosis. A five to ten-year follow-up study. J Bone Joint Surg Am.1998; 80:807 -14

12. Lewandrowski KU, Nanson C, Calderon R. Vertebral osteolysis after posterior interbody lumbar fusion with recombinant human bone morphogenetic protein 2: a report of five cases. Spine J. 2007;7:609-14.

13. Leah YC, Rolando MP, Lawrence GL, Daniel JS, MD,John BE, Non-Neurologic Complications Following Surgery for Adolescent Idiopathic Scoliosis The Journal of Bone and Joint Surgery (American*)*. 2007;89:2427-2432.

14. McClellan JW, Mulconrey DS, Forbes RJ, Fullmer N. Vertebral bone resorption after transforaminal lumbar interbody fusion with bone morphogenetic protein (rhBMP-2). J Spinal Disord Tech. 2006;19:483 -6.

15. Price CT, Connolly JF, Carantzas AC, Ilyas I. Comparison of bone grafts for posterior spinal fusion in adolescent idiopathic scoliosis. Spine.2003; 28:793 -8.

16. Skaggs DL, Samuelson MA, Hale JM, Kay RM, Tolo VT. Complications of posterior iliac crest bone-grafting in spine surgery in children. Spine.2000; 25:2400 -2.

17. ShufflebargerHL, Clark CE. Fusion levels and hook patterns in thoracic scoliosis with Cotrel-Dubousset instrumentation. Spine. 1990;15:916 -20.