# DONOR SITE MORBIDITY AS A PROBLEM OF SPINAL SURGERY: SYSTEMATIC REVIEW

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Iliac crest bone autograft is most commonly used grafting material in spinal surgery. Despite the high efficiency of bone autograft in spinal fusion, its application is associated with a number of negative points including so called donor site morbidity, i.e. complications of bone graft harvesting. Major complications are associated with harvesting technique. The most significant minor complication is chronic postoperative pain which incidence is 28–31 %. Chronic donor site pain may be caused by muscle mobilization, external cortex destruction in the iliac wing, and nerve damage. The treatment of chronic donor site pain is still exclusively symptomatic. Main factors influencing the rate of iliac crest bone harvesting complications and preventive techniques are reviewed.
**Key Words:** donor site morbidity, iliac crest, bone autografting.

Please cite this paper as: *Kosulin AV, Elyakin DV. Donor site morbidity as a problem of spinal surgery: systematic review. Hir. Pozvonoc. 2016;13(2):45–51. In Russian.*
*DOI: http://dx.doi.org/10.14531/ss2016.2.45-51.*

Formation of proper bone block is the objective and one of the success criteria of most orthopedic surgeries conducted for deformities and degenerative diseases of the spine. The nature of plastic material is one of the factors that influence this process. Autogenous bone, having osteoconductive and osteoinductive properties and containing living osteogenic cells that are genetically authentic to recipient zone in contrast to allograft and synthetic materials, is a generally recognized gold standard. The use of autograft does not bear the risk of transmitting blood-borne infections or reactions to foreign chemicals.

Free grafts (i.e., grafts devoid of natural sources of blood supply) made of the local bone tissue [45], iliac crest, rib, fibula [31], and tibia [66] are used as autologous bone material in spine surgery. The episternum [41, 62] and a graft harvested from the adjacent vertebral body [7, 53] are considered as alternative sources of plastic material. Preservation of the vascular pedicle supplying the graft enhances its viability under adverse conditions, prevents possible resorption, and provides direct fusion of the graft with the recipient site without a phase of creeping substitution [15]. In the spinal surgery, non-free bone plasty graft is virtually limited to the use of the vascularized costal graft [22, 38, 59]. In the case of en block resection for malignant tumors [4, 57] and repeated bone grafting for vertebral osteomyelitis [6, 46], free vascularized graft from the fibula or iliac crest [60] can be used. Since the revascularization of the graft significantly increases surgical trauma due to prolonged microsurgical stage, the indications for this technique are significantly limited.

Among the numerous options for bone grafting in the spine surgery, free bone graft harvested from the iliac crest [1, 20] is the most common option. Its advantages include a large amount of material available, the possibility of obtaining cellular, cortical-cellular, or tricortical transplants, as well as high performance when assessing surgery outcomes [20, 24].

However, the use of autografts is associated with a number of negative factors:

– the amount of available bone tissue is limited and this factor can be critical in the case of reoperation;

– autograft harvesting increases the duration of the surgery and surgical trauma;

– graft harvesting can be the direct cause of surgical complications, e.g. soft tissue injury, damage to major blood vessels, nerve trunks, and even internal organs [14]. Currently, these complications are rather a sort of casuistry owing to the development of the detailed technical regulations;

– donor site morbidity can occur after graft harvesting, which adversely affect the patient's quality of life [3], but sometimes they are considered as inevitable consequences of the operation and/or escape the attention of researchers, being unaccounted when assessing surgical outcome. Thus, the only report on the assessment of pain at the donor site available in the Russian literature focuses on the comparison of different methods of graft harvesting [2].

## Classification and statistics

*Clinically insignificant early complications.* Some complications of early postoperative period may have no

long-term effect, but require additional therapeutic measures and increase the duration of hospital stay. Sometimes, severe pain at the graft harvesting site disturbs patients in the early postoperative period even more than the main surgical area [51], which is often observed in the case of anterior fusion in the cervical spine [34]. Complications, such as hematoma, seroma [14], delayed wound healing, inflammatory and purulent processes [50] at the donor site are quite common. Silber et al. [50] observed wound dihescence in 2.2 % of cases, used antibiotics in order to manage local inflammatory processes in 7.5 % of cases, and had to drain purulent lesions in 1.5 % of cases. Singh et al. [51] recommend systematic application of local anesthetics to relieve pain.

*Major complications.* Complications of the late postoperative period, such as pelvic ring destabilization, pathologic fractures, formation of muscular and visceral hernias, and contracture of the muscles adjacent to the donor site require more or less long-term inpatient or outpatient treatment. Obviously, these complications result from technical features of the graft harvesting.

*Delayed minor complications.* They are significantly more common and include hypertrophic scars, deformation of soft tissues, as well as the variety of chronic pain syndromes, such as local pain, kinesalgia, and spontaneous pain [8, 10, 28, 33, 40, 49, 65]. These conditions are not life threatening and do not result in disability, but they may influence the psychosomatic condition, limiting patient's quality of life. The incidence and severity of complications at the donor site are shown in the Table 1.

The incidence of spontaneous chronic pain at the donor site is 28–31 % [47, 54], but it can reach 60 % [19]. With the course of time after the operation, the pain persists in the smaller number of patients [28, 36], but in some cases it may occur several months after the surgery [54]. Pain severity is on the average 3.8–10 points on VAS scale; 3 to 11 % of such patients require systematic administration of analgesics [29, 50]. In some cases, pain is extremely resistant to treatment [54]. Patients subjectively describe this pain as burning, comparable to the toothache; more rarely, as acute lumbago. In most cases, patients cannot lie on the side of graft harvesting; in many patients, pain intensifies when walking and, more rarely, when sitting or standing. The site of maximum painfulness usually corresponds to the operation site [54].

The data on the incidence of chronic pain syndromes after graft harvesting from the iliac crest in children are highly interesting; it accounts for 10–24 % of cases [16, 32, 52], which is less than in adult patients (Table 2).

## Pathogenesis of chronic pain

It is anticipated that chronic pain at the donor site may be associated with muscle mobilization, destruction of the external cortex of the iliac wing, nerve injury with subsequent formation of terminal neuroma [31]. Interestingly, the same traumatic actions during graft harvesting from other sites (ribs, fibula) do not result in formation of chronic pain syndromes [31]. The following pattern of chronic pain development was observed depending on the level of the spinal surgery: the lower fusion level, the more common chronic pain [18, 44]. Furthermore, Delawi et al. [18] came to the conclusion that the incidence of pain is overestimated, since patients do not distinguish between back pain and pain at the donor site. Varga et al. [56] showed that biomechanical properties of the pelvis somewhat change after graft harvesting. Moreover, when taking into account the additional load arising from lumbar fusion, the observation by Bednar and Al-Tunaib [12], who noted that chronic pain at the donor site is more common after the operations for the degenerative diseases of the lumbar spine, can be explained. The authors attributed this chronic pain to stress microfractures of the posterior segment of the ilium and altered load distribution at the sacroiliac joint. However, it should be kept in mind that chronic pain at the donor site also occurs after graft harvesting for fusion at the thoracic spine, as well as surgical treatment of pseudarthrosis.

## Prevention

Treatment of chronic pain is almost exclusively symptomatic, and the key role belongs to its prevention. It seems appropriate to highlight several key factors that influence the subsequent development of pain at the donor site.

1. Graft harvesting site.

Graft harvesting from the posterior segment of the iliac crest is preferred, since it is associated with lower incidence of complications [5].

2. Incision site.

In the case of graft harvesting from the anterior segment of the iliac crest, it is advisable to make a 3–6 cm-long oblique incision directly in the projection of the iliac crest or slightly below, because in this case pain after the operation is the least severe [31].

Graft harvesting from the posterior segment of the crest is possible using two approaches: from the main incision, if fusion is performed at a sufficiently low level, or from an individual incision. Harvesting from the main incision is preferred, since it not only provides a better cosmetic result, but also results in lower incidence of pain [17, 26]. If the graft is harvested through a separate incision in the projection of the posterior superior iliac spine, it is advisable that the latter had the vertical direction, since in this case the probability of damage to the superior gluteal cutaneous nerves is minimal [31].

3. Nerve injury.

When harvesting grafts from the iliac crest, damage to the lateral femoral cutaneous nerve, superior gluteal cutaneous nerves, iliohypogastric, ilioinguinal, and femoral nerves can occur [23, 34]. The significance of the intraoperative injuries of nerve trunks for the subsequent development of pain syndrome was confirmed by the report about successful treatment of chronic pain using the superior gluteal nerve block [63].

4. Muscle mobilization.

The technique that avoids mobilization of muscles and the periosteum of the external surface of the iliac wing was developed in order to reduce injury to the local soft tissues and prevent

the development of pain syndrome. Approach to the iliac wing using the osteotome is performed in an oblique direction, thus providing separation of the external and internal cortical layers of the future graft; wire sutures are used for subsequent drawing together of the external and internal cortical layers [61]. However, data on the impact of this technique on the incidence of chronic pain at the donor site are not available.

5. Damage to the musculoskeletal structures.

Graft harvesting from the iliac crest may result in damage to the anterior superior iliac spine, which can lead to stress fracture caused by muscular strength of the sartorius and rectus femoris in the future [23, 34]. Cases of damage to the sacroiliac joint have also been reported [25].

6. Bone defect after graft harvesting.

Bednar and Al-Tunaib [12] radiographically examined both symptomatic and asymptomatic patients, who underwent graft harvesting from the iliac crest, and found that there is no regeneration of bone structures at the donor site. In this regard, there were numerous attempts to repair the defect that remain after graft harvesting, but not all of them were successful. Thus, according to Dusseldorp and Mobbs [21], donor site reconstruction using cement based on calcium phosphate did not led to significant reduction in the incidence of pain. Bojescul et al. [13] used for this purpose coral hydroxyapatite and obtained radiographic evidence of the recovery; however, they could not clearly assess the impact of the technique on the occurrence of chronic pain due to the small sampling population. Wang et al. [58] showed that filling of the iliac crest defect with polylactate resorbable mesh reduces the intensity of pain in the early postoperative period. Positive results of donor site reconstruction were also obtained with tricalcium phosphate [43], bioactive ceramics [9, 30], and methyl methacrylate cement. [37] Niu

**Table 1**

The incidence and severity of complications at the donor site according to the literature

| Source | Donor site | Sampling population, n | Complications, % | |
|---|---|---|---|---|
| | | | Major | Minor |
| Ahlmann et al. [5] | IC* | 88 | 6 | 9 |
| Arrington et al. [8] | IC* | 414 | 5,8 | 10 |
| Banwart et al. [10] | IC* | 261 | 10 | 39 |
| Calori et al. [14] | IC* | 35 | 2,85 | 14,28 |
| Goulet et al. [28] | IC* | 192 | 2,4 | 21,8 |
| Palmer et al. [40] | IC* | 30 | 26,6 | 46,6 |
| Pollock et al. [42] | Anterior segment of the IC | 24 | – | 8,3 |
| Younger et al. [65] | IC (216), other sources (23) | 239 | 8,6 | 20,6 |

*Iliac crest (IC) without details on harvesting site.

**Table 2**

The incidence and severity of chronic pain at the donor site according to the literature

| Source | Characteristics of the material | Sampling population, n | Incidence of chronic pain, % |
|---|---|---|---|
| Goulet et al. [28] | IC | 192 | 18,7 |
| Heary et al. [29] | IC | 105 | 34 |
| Palmer et al. [40] | IC | 30 | 16,6 |
| Robertson et al. [44] | Posterior segment of the IC | 106 | 45 |
| Dimar et al. [19] | Posterior segment of the IC | 224 | 60 |
| Kim et al. [33] | Posterior segment of the IC | 110 | 15,1 |
| Schwartz et al. [49] | Posterior segment of the IC | 170 | 19 |
| Loeffler et al. [36] | Anterior segment of the IC | 92 | 2 |
| Sasso et al. [47] | Anterior segment of the IC | 206 | 31 |
| Silber et al. [50] | Anterior segment of the IC | 134 | 26,1 |
| Summers et al. [54] | Anterior segment of the IC | 290 | 28 |
| Clarke et al. [16] | Anterior segment of the IC; children | 33 | 11 |
| Kager et al. [32] | Posterior segment of the IC; children | 71 | 10 |
| Skaggs et al. [52] | Posterior segment of the IC; children | 87 | 24 |

IC — iliac crest.

et al. [39] obtained good results by applying an equivalent iliac cres allograft for the reconstruction of donor site. Finally, Bapat et al. [11] used the autogenous rib to replace the defect. Based on these results, the authors recommend this technique, if the approach to the vertebral column requires rib resection during thoracotomy or thoracophrenolumbotomy. However, simple treatment of bone defect edges with drill to remove all palpable protrusions and sharp corners also reduces the incidence of pain [55]. An alternative approach to preservation of the integrity of the iliac crest is the use of minimally invasive graft harvesting techniques [2, 20, 42].

## Conclusion

The fundamental solution to the problem of donor site morbidity is to avoid using bone autograft. Despite the limitations of the use of allogeneic bone, this material is still important and in some arthrodesis operations it was proved to be equivalent to autograft [27, 48, 64]. Numerous synthetic alternatives to bone graft have been suggested. Unlimited number of such synthetic grafts, having standard predictable properties, can be manufactured industrially [35]. Very substantial experience with these materials, both in pure form and in combination with autologous materials (blood, bone marrow, local bone tissue) has been accumulated. Detailed analysis of this experience is beyond the scope of this review. Nevertheless, it is a graft from the iliac crest that is still the gold standard of the plastic material in bone surgery. According to scientific methodology, comparative evaluation of different materials requires to compare the results of their application under identical conditions. It is possible that accumulation of evidence-based information on the use of alternative plastic materials will enable avoiding the use of bone grafts in most standard clinical situations. However, the gold standard will inevitably retain its importance as a universal comparative model.

*The authors thank Prof. A.Yu. Mushkin for advice when writing this article.*

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*Received 16.02.2016.*

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