



## Comparison of autogenous bone graft donor site haemostatic agents used in spinal surgery

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**Objective:** The aim of our study was to investigate the effects of haemostatic agents used at the autograft donor sites in spinal fusion.

**Methods:** The study included 66 patients (26 men, 40 women; mean age: 42.9 years) who underwent spinal fusion surgery between March 1999 and October 2002. Patients were randomly assigned to 4 different groups according to the haemostatic agents used during surgery. In Group 1, bone wax was used on the graft donor site. In Group 2, spongostan was used. In Group 3, spongostan was applied to the donor site and removed after 10 minutes. Group 4 was the control group and no haemostatic agent was applied. Age, sex, diagnosis and incision shape were not taken into consideration during the selection of patient groups. Closed suction drainage systems were used for the evaluation of drainage amount. The drainage system was removed after 48 hours in patients with a daily drainage of less than 30 cc.

**Results:** In Group 1, there was significantly less drainage than the other groups. Group 2 and Group 3 had less drainage than the control group. When a separate incision was used for graft harvesting, keeping the spongostan at the application site (Group 2) was more effective than its removal (Group 3).

**Conclusion:** The application of bone wax and spongostan to bleeding cancellous bone surfaces at the donor site is a safe and effective method to reduce bleeding and hematoma. Bone wax is more effective than spongostan for haemostasis.

**Key words:** Bone wax; drain; haemostatic agent; spongostan.

Bone grafting to repair bone defects and restore mechanical stability has been used in orthopedic surgery for many years. Depending on the need of the reconstruction, cortical or cancellous bone grafts are harvested from the donor site in a vascularized or non-vascularized manner. Autogenous bone graft is a frequently preferred graft material because of its osteoinductive and osteoconductive properties. The iliac crest is a frequently used donor site because of

its cortical and cancellous bone content but it has a high potential for donor site morbidities.<sup>[1,2]</sup>

Graft usage is common in spinal surgery. However, local bleeding may occur after graft harvesting from the iliac crest because of the spongy bone pattern of the area. Surgical haemostasis has an important role in decreasing postoperative edema, erythema and pain. The hematoma may be a good

culture area for microorganisms. Closed suction drainage systems are frequently used in order to decrease postoperative hematoma. The use of closed suction drainage systems evacuates surgical field hematoma and improves bone healing.<sup>[3]</sup> Use of haemostatic agents concomitant with the drainage systems to the donor site has recently become popular.<sup>[4-6]</sup> Bone wax and gelfoam (spongostan) are frequently used because they are safe and effective.<sup>[7]</sup>

Bone wax is a haemostatic agent which is applied topically to bone surfaces in order to stop bleeding after resections. Bone wax (a mixture of straight-chain monohydric alcohol esters and straight-chain fatty acids) is composed of almond oil and salicylic acid. As it provides a physical barrier, it has a tamponade effect. General indications are to provide bone haemostasis in conditions in which fusion and fast bone regeneration are not desired.

Curaspon or spongostan is a haemostatic, sterile and absorbable gelatin-like sponge which can be used in spinal surgery. It has the capability to absorb 50 times its weight of blood over a maximum of 42 days, following its application to the cancellous bony surface. Some surgeons leave the curaspon in the donor site and some surgeons apply and then take it out.<sup>[5,6,8]</sup>

We aimed to assess the effectiveness of haemostatic agents used at the autograft donor sites in spinal fusion surgery.

## Patients and methods

We evaluated 66 patients (26 men, 40 women) who underwent spinal fusion surgery between March 1999 and October 2002. Mean age of the patients was 42.9 (range: 17 to 86) years. Preoperative bleeding and clotting times were measured. The patients with normal clotting times and who did not use anti-coagulants were included to the study. After graft harvest blood was aspirated and the haemostatic agents were applied.

Indications of the operations and gender differences of the patients are shown in Table 1.

Graft harvest was performed in two different ways. In the first group (n=28), the same incision of the spinal surgery (midline fascial splitting incision) was used for graft harvesting. In the second group (n=38) a separate incision was used for graft harvesting (modified incision). In the same incision group

**Table 1.** The distribution of the diagnoses of the patients.

Diagnosis	Women	Men	Total	%
Spondylolisthesis	17	4	21	31.8
Vertebral fracture	8	9	17	25.7
Lumbar instability	5	1	6	9.1
Scoliosis	4	1	5	7.5
Spinal stenosis	3	2	5	7.5
Pott	0	4	4	6.1
Spondylodiscitis	3	2	5	7.5
Ankylosing spondylitis	0	1	1	1.6
Scheuermann's disease	0	1	1	1.6
Metastatic tumor	0	1	1	1.6
Total	40	26	66	100

the bleeding from the main surgical site is expected to affect the hematoma at the donor site. In contrast, this will not be the case with a separate incision. The size of the graft was determined depending on the diagnosis and the need of the patient. The volume of the graft was measured by putting some serum physiologic into an empty coverless injector and after putting the grafts, measuring the graft amount by the increase in the liquid level in the injector.

Hematoma amount was followed by applying a suction drain to the graft donor site. Suction drainage was used for mean 2 days and was removed only when daily drainage was less than 30 cc. The same brand and type of drainage system was used in all patients (Fig. 1).

After graft harvesting, patients were randomly assigned to one of the four study groups, depending on the haemostatic method used. In Group 1 (20 patients; 10 men, 10 women; mean age: 42.9 years; range: 17 to 86 years), bone wax was used as the



**Fig 1.** The closed suction drainage system. [Color figure can be viewed in the online issue, which is available at [www.aott.org.tr](http://www.aott.org.tr)]

haemostatic agent. In Group 2 (17 patients; 8 men, 9 women; mean age: 42.7 years; range: 22 to 71 years), spongostan (curaspon, gelfoam) was applied and not removed. In Group 3 (15 patients; 3 men, 12 women; mean age: 44.8 years; range: 18 to 64 years) spongostan was applied to the donor site and removed after 10 minutes. Group 4 (14 patients; 5 men, 9 women; mean age: 41.2 years; range: 17 to 65 years) was the control group and received no haemostatic agent. The drained liquid amounts were measured using a 50 cc injector. The effectiveness of the haemostatic agents was measured taking the control group as a reference. While the groups were being formed, diagnosis, gender, age and incision type were not taken into consideration.

Statistical analysis was made with the Statistica Axa 7.1 statistical program. The normality of the data was assessed with the Shapiro-Wilk test. For the normally distributed data, comparison between the groups was made with the analysis of variance and the post-hoc Tukey's test. For the data with no normal distribution, comparison between the groups was performed with the Kruskal-Wallis variance analysis and Mann-Whitney U test. Comparison between the single and double incision groups was performed with a two-directional variance analysis. The Pearson's  $\chi^2$  test was used for qualitative data. As descriptive statistics, mean  $\pm$  standard deviation was given. P values less than 0.05 were considered significant.

The study was approved by the institutional review board with a protocol number of EKA EK 2009/30.

## Results

Bone wax was applied at the donor site in Group 1. In 8 patients the graft incision was the same with the

spinal surgery incision and in 12 patients graft incision was separate from the spinal surgery incision. Drainage of more than 48 hours was observed in 3 patients.

In Group 2, spongostan (curaspon, gelfoam) was applied. In 8 patients the graft incision was the same as the spinal surgery incision and separate in 9. Drainage of more than 48 hours was observed in 6 patients.

Spongostan (gelfoam) was applied and removed in Group 3 patients. In 8 patients the graft incision was the same with the spinal surgery incision and separate in 7 patients. Four patients required the drains to remain in place for 3 or more days.

Group 4, the control group, received no haemostatic agent. In 3 patients the graft incision was the same as the spinal surgery incision and was different in the remaining 11. Drains were removed after 48 hours in 4 patients and after three or more days in 10.

Comparisons between the groups are shown in Table 2.

The amount of grafts harvested according to the groups is shown in Fig. 2.

Significant decrease in the drainage was observed in the bone wax applied group. Decrease of the hematoma was also observed in the spongostan applied and left in the surgical field groups. When the incisions for the spinal surgery and incisions for graft harvest are not taken into consideration, decrease of the hematoma was observed in the spongostan applied and re-taken group. In patients with a separate incision for graft harvesting, hematoma decrease was more significant than in the group where spongostan was left in the surgical field.

The total drainage amounts of different groups are shown in Fig. 3.

**Table 2.** Graft size and drainage of the different groups.

Variable	Group 1 (n=20) (mean $\pm$ SD)	Group 2 (n=17) (mean $\pm$ SD)	Group 3 (n=15) (mean $\pm$ SD)	Group 4 (n=14) (mean $\pm$ SD)	p value
Graft amount	12.0 $\pm$ 3.756	11.0 $\pm$ 3.571	13.07 $\pm$ 4.183	12.07 $\pm$ 3.452	0.494
1 <sup>st</sup> day drainage	51.45 $\pm$ 17.896*	105.18 $\pm$ 54.516	94.67 $\pm$ 41.807	141.14 $\pm$ 54.947	0.000
2 <sup>nd</sup> day drainage	27.10 $\pm$ 20.958**	30.71 $\pm$ 9.597***	39.87 $\pm$ 8.709	55.79 $\pm$ 22.440	0.000
3 <sup>rd</sup> day drainage	2.50 $\pm$ 7.459	5.00 $\pm$ 7.583	5.07 $\pm$ 9.483	19.79 $\pm$ 16.503	0.002
Total drainage	80.75 $\pm$ 33.586	140.82 $\pm$ 63.077	139.60 $\pm$ 39.301	216.71 $\pm$ 80.992	0.000

\*Group 1 compared with Group 2,3,4; p<0.005 \*\*Group 1 compared with Group 4; p<0.005 \*\*\*Group 2 compared with Group 3 and 4; p<0.005

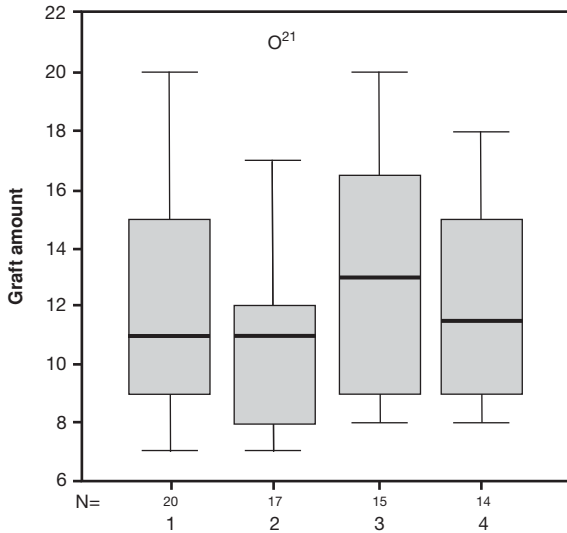


Fig 2. Harvested graft amount of the groups.

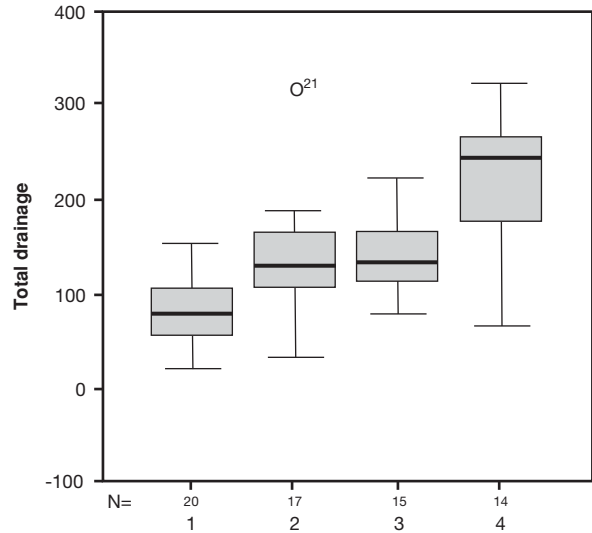


Fig 3. Total drainage amount according to the groups.

In the bone wax and spongostan groups, edema, infection and pain degree was low and no local tissue reaction was observed during the postoperative follow-up period.

There were no statistical differences between the groups in respect to age or gender ( $p=0.941$ ). There was a statistically significant difference between the groups according to total drainage ( $p=0.000$ ), but no difference according to the use of the same or a separate incision for graft harvesting ( $p=0.53$ ). When the groups and the incisions were evaluated concomitantly, there was no difference according to total drainage amounts ( $p=0.041$ ). Drainage amount according to the incisions is shown in Table 3.

No significant difference depending on morbidity could be observed between the patients who had

the same incision or a separate incision for graft harvesting ( $p>0.05$ ).

**Discussion**

Autogenous bone grafts are effective in achieving spinal fusion due to their high osteoinductive properties and are often the first choice in the posterior spine. However, graft harvesting has some disadvantages, such as donor site morbidity, infection, vascular injuries, and injuries to the sensorial nerves. Bleeding and hematoma formation can occur following graft harvest from the cancellous bony surface of the posterior iliac wing. Hematoma can delay tissue healing and increase infection risk and donor site pain.<sup>[9]</sup>

Several haemostatic measures can be used. Options include the application of haemostatic agents (gelfoam, spongostan, curaspon, bone wax) to the donor site, application of suction drainage systems in order to prevent hematoma formation or the application of both to keep the hematoma at the lowest level.

Closed suction drainage systems are thought to decrease the incidence of hematoma and wound infection. However, use of the suction drain catheter for more than 48 hours may increase the risk of infection.<sup>[10,11]</sup>

Willet et al. showed that closed drainage systems following orthopedic procedures decreases wound hematoma and infection rate significantly and recommended their use.<sup>[12]</sup>

Table 3. The drainage of patients who had graft harvesting with the same or a separate incision.

Group	Same incision	Separate incision
	(drainage, cc, mean±SD) Median (min-max)	(drainage, cc, mean±SD) Median (min-max)
1	80.625±44.307 66.5 (21-153)	80.833±26.440 89.0 (37-110)
2	181.375±60.365 174 (126-317)	104.778±40.776 174 (126-317)
3	130.125±31.188 135.5 (79-173)	150.429±47.038 135 (87-223)
4	259.333±12.423 266 (254-267)	205.091±26.634 235 (68-324)

Beer et al.<sup>[13]</sup> also recommended the use of closed suction drainage systems. They demonstrated that the hematomas extracted from the drainage systems have no opsonic proteins which can increase the risk of bacterial infection.

However, Sasso et al. showed that closed suction drainage systems have no effect on wound healing.<sup>[5]</sup> Chandratreya et al. did not observe any difference between drained and non-drained patients.<sup>[10]</sup>

In our study, we also applied closed drainage systems to the graft donor sites in all patients and no wound complication was observed.

Some clinical studies have shown that maximum tissue reaction occurred at the 6th or 9th month after bone wax application. Reversely, no chronic inflammatory changes have been reported after spongostan application. As bone wax cannot be absorbed and may cause fibrosis, it is regarded less useful than other agents.<sup>[7]</sup>

In an experimental study, the reaction of bone wax in rats was researched. Bone wax was implanted in the lateral femoral condyles and biceps femoris muscles of the rats. Evaluations were made after the rats were killed. No infection or tissue reaction was observed in any rats. Biopsy of the adjacent lymph nodes revealed no wax particle, foreign body, giant cell or abscess formation.<sup>[7]</sup>

Taheri conducted a study on the use of spongostan in patients with anterior fusion.<sup>[14]</sup> He showed that spongostan may cause an anaphylactic reaction when given with a thrombin solution. The author suggested its use with a saline solution.

In a study comparing absorbable bone wax and casual bone wax, it was observed that absorbable bone wax causes less tissue irritation and is more elastic.<sup>[7]</sup> We did not observe any skin or tissue hypersensitivity or allergic reaction in the bone wax and spongostan applied patients.

Zirna et al, compared the application of bone wax and spongostan to cancellous bone surfaces.<sup>[7]</sup> They evaluated postoperative pain and edema formation. Edema decreased by 80% in the early postoperative period in patients who received bone wax and decreased by 91% in the early postoperative period in patients who received spongostan. Pain decreased by 90% in the bone wax applied group and by 75% in the spongostan applied group.

Bone wax and spongostan are topically effective haemostatic agents<sup>[15-18]</sup> which act as a physical barrier.

In some studies, it was found that leaving the spongostan in the donor site may increase the amount of hematoma.<sup>[6,9]</sup> In our study, when the graft was taken with a separate incision and the spongostan was left in the surgical field, hematoma amount was found to be less.

Wilkinson et al. studied the effects of bone wax and spongostan on bleeding and osteogenesis in an experimental study with rabbits.<sup>[20]</sup> They found no difference between the haemostatic effect of the two materials.

In our study, we observed that spongostan and bone wax are both effective haemostatic agents that decrease postoperative pain, edema and hematoma when applied to cancellous bony surfaces. Bone wax is more effective in reducing hematoma than spongostan. Keeping spongostan in place appears to be more effective than removing it 10 minutes after its application.

**Conflicts of Interest:** No conflicts declared.

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