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ORIGINAL ARTICLE

Donor site morbidity following iliac crest bone harvesting for cervical fusion: a comparison between minimally invasive and open techniques

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Abstract We have studied the occurrence of donor site morbidity, cosmesis and overall satisfaction with graft procedure in 76 patients who had undergone iliac crest bone harvesting for anterior cervical discectomy and fusion (ACDF). Totally 24 patients underwent an open procedure and 52 a minimally invasive trephine harvesting method. Although our study demonstrated substantial donor site pain and its effect on ambulation in both groups, this was of limited duration. Two patients, one in each group, suffered long-term pain that was eventually resolved. Totally 8.3% of patients in the open group suffered minor complications and 11.5% in the trephine group. There were two cases of meralgia parasthetica. There were no major complications in either group. There was no statistically significant difference in morbidity between the open and trephine groups. There was a trend towards significance ($P = 0.076$) for pain at the donor site, with less pain reported by patients who underwent the trephine procedure for harvesting.

Keywords Bone grafting · Donor site · Morbidity · Trephine · Cervical fusion

Introduction

In the procedure of anterior cervical discectomy and fusion (ACDF) for symptomatic cervical spondylosis and cervical instability the intervertebral space is packed with bone in order to restore disc height and promote fusion. Interbody spacer cages in conjunction with spinal instrumentation are often used. The cages are packed with pulverised bone providing immediate stability to the anterior spinal column and a favourable environment for fusion. Both autograft and allograft are commonly used and to some extent synthetics but autogenous bone is considered the gold standard [9]. It has the advantage compared to allograft of lack of immunogenicity, superior grafting and minimal risk of disease transmission [27]. In cervical fusion it is necessary to use a remote donor site because there is insufficient local bone for grafting. Of the remote sources, the iliac crest is favoured because of convenient surgical accessibility and quantity of bone available. It has the disadvantage of requiring an additional surgical site and the associated donor site defect. Graft can be obtained from the anterior or posterior aspect of the iliac crest. For anterior fusion procedures with the patient in the supine position, the anterior crest is the most convenient allowing harvesting to proceed simultaneously with preparation of the recipient site although it is associated with increased donor site morbidity compared to posterior harvesting [1, 18].

Various methods have been described for harvesting iliac crest bone. Traditionally these involve significant dissection of soft tissues and elevation of musculoperioteal flaps. Although iliac crest bone harvesting using an open method is generally considered a safe procedure and major complications are rare, there have been a number of reports of minor complications. These include gait disturbance [8, 20, 30], stress fractures [16], blood loss, paraesthesia [8, 16, 20, 25] superficial infections [2, 22, 25, 28, 30], haematomas [2, 16, 31], poor cosmesis [8, 14, 25] and most commonly, acute and chronic donor site pain [8, 12–14, 16, 17, 20, 22, 24, 25, 27–29]. Occurrence of complications may depend on variables such as quantity of bone harvested [1], patient population,

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approach taken to the crest (anterior vs. posterior) [1, 18] and precise technique of harvesting. Major complications, although rare, include arterial injury, peritoneal perforation, hernia and pelvic fracture [2, 5, 21].

In common with the trend in other surgical specialties, minimally invasive methods of iliac crest bone harvesting have been tried in order to reduce morbidity and enhance the overall success of spinal fusion. These include the use of a curette [4], bone biopsy needles [3, 6] and trephines [23].

There have been five reports describing donor site morbidity after trephine harvesting at the iliac crest [3, 5, 9, 15, 23]. Of the five, only two compared trephine harvesting with open methods [9, 27]. All involved harvesting large amounts of bone for cranio-maxillofacial surgery in comparison to the small amounts used in ACDF surgery. In this study, our aim was to determine post-operative morbidity experienced by patients following iliac crest bone harvest for ACDF from the anterior iliac crest using trephine and open techniques. Our hypothesis was that there would less morbidity with the trephine compared to the open technique.

Patients and methods

During the study period May 1996–June 2004, 95 patients underwent ACDF surgery for symptomatic cervical spondylosis at a university hospital in the north east of England. Patients with co-morbidity including obesity that would affect outcome of the operation including successful fusion and bone healing were excluded. All patients were required to cease smoking for 3 months prior to the procedure and refrain post-surgery during the healing and fusion stages. The procedure was explained to the patient including the necessity for bone harvesting from the hip and that some donor site pain may be experienced. The patients were unaware of the harvesting method used.

ACDF is an inpatient procedure performed under general anaesthesia. All operations were performed by the same surgeon assisted by a rotational specialist registrar.

In the first 25 patients, an open method was used for taking bone graft. A 4–5 cm incision is made over the anterior third of the iliac crest avoiding the anterior superior iliac spine. The incision is deepened through fat and deep fascia onto the iliac crest. Using a cutting diathermy, muscle and periosteum are stripped off the top off the iliac crest as well as the adjoining inner and outer tables. Using an osteotome, the top of the iliac crest is lifted off, cancellous bone is harvested from between the inner and outer tables using a gouge, the iliac crest top is replaced and the wound closed in layers. A drain was not used.

In the following, 69 patients a minimally invasive trephine method was employed. In the trephine method the patient is positioned supine with a small sandbag under the gluteal area. A 1–2 cm incision is made through the skin, fat and deep fascia down to the periosteum on top of the iliac crest. The incision is kept away from the anterior superior iliac spine. The trephine sleeve is positioned on the top of the crest. A mallet is used to gently tap a sharp trocar introduced into the sleeve. The trocar is then replaced by a sharp 6 mm trephine which is then slowly screwed into the iliac crest between the inner and outer tables and a cylinder of cancellous bone harvested. The wound is closed in a deep layer and clips are applied to appose the skin edges. A drain was not used.

In both methods, the harvested bone once morselized is used to pack the intervertebral cage. About a 1 cm^3 bone is taken for a single level fusion. All grafts were performed on a single occasion in each patient on the right side only.

Patients were assessed post-operatively for bone graft morbidity using a self-administered postal questionnaire as part of our routine outcome assessment (Fig. 1). This consisted of nine questions about donor site pain and its effect on functional ability, complications and satisfaction with scar appearance. Also included was a global outcome question (Fig. 1, Q9) in order to assess overall satisfaction with bone graft harvesting. A repeat questionnaire was mailed to non-responders. One further attempt to contact non-responders was by telephone in which case the survey was conducted verbally (3 patients). The outcome of neck surgery was assessed using visual analog scales (VAS) for neck and arm pain severity measured at baseline and follow-up.

Statistics were obtained using SPSS for windows statistical program release 11 (SPSS Inc., Chicago, USA). Where the data was skewed, the median in addition to the mean is reported. Before applying parametric methods the data was checked for normality. If there was significant deviation from normality or if the data were ordinal then non-parametric tests were used. The assumptions of statistical tests were verified before use. Scatter plots and Pearson's correlation coefficient were used to determine relationships between continuous variables. The biserial correlation coefficient was used to determine relationships between continuous and categorical variables. Statistical significance was designated at $P < 0.05$. All Students' t tests were two-tailed. The adjusted Wald method [7] was used to calculate 95% confidence intervals. Self-reported complications were checked with patient records to determine their validity.

Results

Of the 95 patients in the study one had died from causes unrelated to the surgery. Of the remaining patients, 77 (47

BONE GRAFT QUESTIONNAIRE

These questions ask you about the problems you may have experienced arising from the bone graft that was taken when you had your neck operation. Please answer the questions by putting a tick ☑ in the appropriate box.

Q1 Did you experience pain at the hip donor site

- ❑ Yes
- ❑ No
- ❑ Can't remember

Q2 How long did you experience pain at the hip donor site ?

- ❑ I had no pain
- ❑ 1-2 weeks
- ❑ 3-6 weeks
- ❑ 7-10 weeks
- ❑ 11-14 weeks
- ❑ More than 14 weeks - if more than 14 weeks is it still painful now? YES/NO
- ❑ Can't remember

Q3 On the scale of 0 to 10 tick the box which indicates the worse pain that you experienced at the bone graft site (0 = none – 10 worst imaginable)

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Q4 Did you have problems with walking after surgery due to your bone graft ?

- ❑ I had no problems
- ❑ Yes for 1 - 6 weeks
- ❑ Yes for 7 – 10 weeks
- ❑ Yes for 11 – 14 weeks
- ❑ Yes for more than 14 weeks
- ❑ Can't remember

Q5 Did you need to use a walking aid (stick, crutches, frame, wheelchair etc) after your operation ?

- ❑ No
- ❑ Yes - for how many weeks ……

Q6 Was there any numbness in the hip or leg from the side where the bone graft was taken ?

- ❑ No
- ❑ Yes
- ❑ Can't remember

Q7 As far as you are aware did you experience any of the following problems at your hip donor site ?

- ❑ Deformity at hip
- ❑ Blood collection at wound
- ❑ Wound breakdown
- ❑ Infection at donor site
- ❑ Fracture at donor site
- ❑ Hernia
- ❑ Other problems…….

Q8 How satisfied are you with the scar at the hip donor site

- ❑ Extremely satisfied
- ❑ Very satisfied
- ❑ Somewhat satisfied
- ❑ Neutral
- ❑ Somewhat dissatisfied
- ❑ Very dissatisfied
- ❑ Extremely dissatisfied

Q9 Considering the experience would you be willing to have bone graft taken from your hip if you needed further neck surgery ?

- ❑ Yes
- ❑ No
- ❑ Not sure

Fig. 1 The bone graft questionniare used in the study

females, 30 males; mean age at surgery, 46.1 years; age range 14–73 years) responded to the questionnaire (82% response rate). The mean duration of follow-up for both bone graft and ACDF surgery outcome was 19.8 months (range 5–48 months). The 17 non-responders (7 females, 11 males; mean age at surgery, 41.6 years; age range 18–57 years) were younger with a higher proportion of males compared to the responders Of the 77 responders, 25 (32.5%) underwent the open procedure and 52 (67.5%) the trephine method. Totally 24 out of 25 patients (96%) who underwent the open procedure responded (12 females, 12 males; mean age at treatment, 45.6; age range 14–61) and

52 out of the 69 patients (75%) who underwent the trephine procedure responded (35 females, 17 males; mean age at treatment, 45.9; age range 27–73). There were no intra-operative complications at the donor site in either group.

Table 1 compares post-operative morbidity, scar satisfaction and global outcome for the two groups.

Pain at the donor site was experienced by 91.3% of patients in the open and 73.1% in the trephine group but the difference was not statistically significant ($\chi^2 = 3.157$; $df = 1$; $P = 0.076$). Figure 2 shows pain duration for the two groups. Of those who suffered pain, 62.0% in the open and 52.6% in the trephine group still reported pain at 3 weeks post-harvest. There was no significant difference between the two groups in the numbers who suffered pain for greater than 2 weeks ($\chi^2 = 0.472$; $df = 1$; $P = 0.492$). Two patients, one in each group, experienced chronic pain. A patient in the open group developed a large haematoma at the graft site and suffered intermittent flare-ups of pain for 14 months. This resolved with a steroid injection at the donor site. The patient in the trephine group suffered pain for 7 months until re-exploration and excision of a neuroma at the graft site.

Figure 3 shows the intensity of pain measured using a visual analog scale (VAS). The mean pain intensity for the open group (valid responses = 23) was 4.3 and 3.5 for the trephine group (valid responses = 48) but the difference was not statistically significant [0.8 (−0.64 to 2.16); $P = 0.28$]. Although there was little correlation of pain intensity with age for the open group (Pearson's $r = 0.013$; $P = 0.953$) there was a moderate inverse correlation with age for the trephine group (Pearson's $r = -0.46$; $P = 0.001$).

Due to graft harvesting 54.6% in the open and 37.3% in the trephine group had problems with ambulation, but the difference was not statistically significant ($\chi^2 = 1.881$; $df = 1$; $P = 0.170$). Three patients in the open and one in the trephine group suffered problems with ambulation for more than 14 weeks all of which had resolved in the long-term. There was little correlation of problems with ambulation with age for both the open (Point biserial $r = -0.19$; $df = 20$; $P = 0.384$) and trephine group (Point biserial $r = -0.21$; $df = 49$; $P = 0.145$).

A walking aid (stick, crutches, frame, wheelchair, etc.) was used by 19.1% (4 patients) in the open and 3.9% (2 patients) in the trephine group. The maximum duration of use was 6 weeks in the open group. Of the two patients in the trephine group a walking aid was needed for 2 weeks but the other patient who had complications needed extended use of a walking aid.

Parasthesias at the donor site was experienced by 34.8% in the open and 20.4% in the trephine group but the difference was not statistically significant ($\chi^2 = 1.725$; $df = 1$; $P = 0.189$). There was little correlation of parathesis with age for both the open (Point biserial $r = -0.05$; $df = 21$; $P = 0.805$) and trephine group (Point biserial $r = -0.02$; $df = 47$; $P = 0.905$).

Notable donor site complications other than acute parasthesias and acute pain were experienced by two patients (8.3%) of the open group and six patients (11.5%) in the trephine group. Table 2 summarises the characteristics of the eight patients who suffered complications. Predominant complications included haematoma, infection and parathesis. In the open group both patients underwent steroid injections at the graft site in order to resolve symptoms. One patient in the trephine group (patient 3, Table 2) experienced chronic parathesis and pain that resolved after re-exploration and excision of a neuroma at the graft site at 7 months.

On a Likert scale (Fig. 1, Q8) of extremely satisfied to extremely dissatisfied two patients (8.3%) in the open and one (2%) in the trephine were somewhat dissatisfied with their scar.

As an overall measure of satisfaction with the graft procedure, the global outcome question of whether the

Table 1 Comparison of post-operative morbidity, scar satisfaction and global outcome for open and trephine methods

Question	Method					
	Open ($n = 24$)			Trephine ($n = 52$)		
	% (n)	Valid responses	95% CI	% (n)	Valid responses	95% CI
Experienced pain at donor site	91.3 (21)	23	72.0–98.8	73.1 (38)	52	59.7–83.3
Had problems with ambulation	54.6 (12)	22	34.7–73.1	37.3 (19)	51	25.3–51.0
Used walking aid after operation	19.1 (4)	21	7.1–40.6	3.9 (2)	51	0.3–13.9
Parasthesias at donor site	34.8 (8)	23	18.7–55.2	20.4 (10)	49	11.3–33.8
Experienced other complications	8.3 (2)	24	1.2–27.0	11.5 (6)	52	5.0–23.3
Dissatisfied with scar	8.3 (2)	24	1.2–27.0	2.0 (1)	51	0–11.3
Would undergo graft again	100 (23)	23	NA	98.0 (49)	50	88.5–100

NA not applicable, *CI* confidence interval

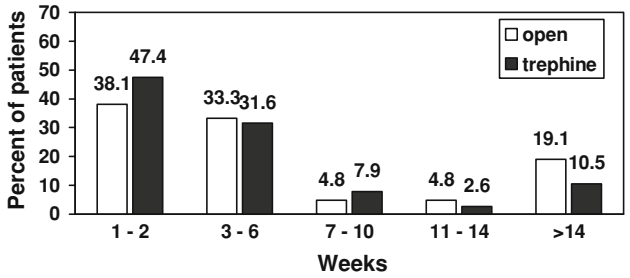

Fig. 2 Duration of post-operative pain at the donor site as percent of those who suffered pain

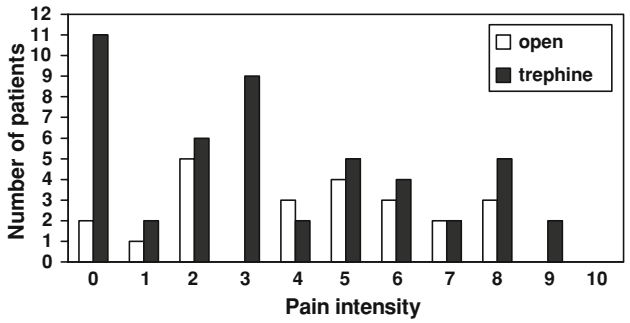

Fig. 3 Intensity of post-operative pain at the donor site

patient would undergo bone graft again (Fig. 1, Q9), elicited nearly a unanimous positive response apart from one patient in the trephine group. This was patient three (Table 2) who suffered long-term paraesthesis and intense pain (9 on VAS) for 7 months.

In both groups there were clinically and statistically significant improvements in VAS neck and arm pain scores between baseline and follow-up. Patients in the open group had a mean improvement in VAS neck pain score of 6.0 compared to 5.1 in the trephine group and the difference was significant between the groups [1.0 (0.37–1.51); $P = 0.002$]. Similarly the mean improvement in VAS arm pain score of 5.8 in the open group was significantly higher than the 3.7 of the trephine group [2.1 (1.26–2.94); $P = 0.000$].

Discussion

We have studied the occurrence of donor site morbidity in patients undergoing iliac crest bone harvesting for ACDF surgery. We have also measured patient satisfaction with the graft procedure. The primary aim of this study was to compare outcomes from two different methods of bone harvesting and reject the null hypothesis of no difference. The secondary aims were to determine the intensity and extent of pain due to harvesting and its effect on ambulation, the incidence of complications and scar cosmesis. Although the iliac crest is widely used as a source of autogenous bone in a variety of surgical specialities and is considered to be generally safe, there have been reports of morbidity and complications resulting in the search for less invasive harvesting methods. Although our study demonstrated substantial donor site pain and its effect on ambulation in both open and trephine groups, this was of limited duration and in all but one patient had resolved at follow-up. Furthermore, there were a small number of minor complications that resolved with conservative treatment in all but one patient. We also found no statistically significant difference in morbidity between the two methods although there was a trend of lower morbidity in the trephine group.

In comparing our results with the literature, various authors have reported their experience with iliac crest donor site morbidity (Table 3). However harvesting technique (open/trephine), site (anterior/posterior), patient population, amount of bone harvested and definition of a complication all make comparison with our study problematic. With this in mind we have particularly looked at publications involving

Table 2 Characteristics of patients in the series who suffered complications

Patient	Age	Sex	Complication	Outcome
Open group ($n = 24$)				
1	44	F	Haematoma/chronic pain	Pain resolved after steroid injection
2	46	F	Meralgia parasthetica	Complete resolution after steroid injection
Trephine group ($n = 52$)				
3	33	M	Meralgia parasthetica	Complete resolution after re-exploration
4	55	F	Superficial infection	Complete resolution
5	43	F	Superficial infection	Complete resolution
6	47	F	Haematoma	Complete resolution
7	56	M	Superficial infection	Complete resolution
8	44	F	Superficial infection	Complete resolution

Table 3 Comparison of bone graft morbidity in our study with those of other authors

Author	Approach	Procedure	Population	Acute pain	Chronic pain	Complications	Cosmesis
Open methods							
Our study	Anterior	ACDF	24 adults	17.4% at 15 weeks	4.2% at 14 months	8.3% minor	92.7% satisfied
Kager et al. [17]	Posterior	Spinal deformity	71 children	NA	10% at 12 months	NA	NA
Shamsaldin et al. [26]	Anterior	ACDF	49 patients	10% at 2 months	6% at 12 months	14.3%	Satisfactory
Sasso et al. [24]	Anterior	ALIF	220 adults	43% at 3 months	33% at 12 months	NA	82% satisfied
Silber et al. [27]	Anterior	ACDF	134 adults	NA	26% at 24 months	1.5% minor	92.5% satisfied
Heary et al. [13]	Ant/post	Spinal fusion	105 adults	NA	34% at 19 months	No major	NA
Skaggs et al. [28]	Posterior	Spinal deformity	Children	NA	24% at 24 months	2% minor	NA
Goulet et al. [12]	Ant/post	Spinal fusion	Adults	NA	18.3% at 24 months	5.3% minor	NA
Schnee et al. [25]	Anterior	ACDF	Adults	2.8% at 3 months	NA	5.6% minor	86.1% satisfied
Summers et al. [29]	Anterior	ALIF	Adults	NA	13.5% at 8 months	NA	NA
Robertson et al. [22]	Posterior	Spinal fusion	Adults	NA	12% at 12 months	10% parathesis	NA
Burstein et al. [5]	Anterior	Maxillofacial	21 children	NA	NA	9.5%	NA
Eufinger et al. [9]	Anterior	Maxillofacial	26 children/adults	NA	0% at 12 months	3.9%	Satisfactory
Trephine							
Our study	Anterior	ACDF	52 adults	73.1% at 3 weeks	1.9% at 7 months	11.5% minor	90.2% satisfied
Sandor et al. [23]	Anterior	Maxillofacial	84 adults/children	1.2% at 3 weeks	0% at 6 months	3.6% minor	NA
Ilankovan et al. [15]	Anterior	Maxillofacial	15 adults/children	13.3% at 7 days	NA	0%	NA
Billmire et al. [3]	Anterior	Maxillofacial	20 harvests/ children	0% at 2 weeks	NA	0%	good
Burstein et al. [5]	Anterior	Maxillofacial	21 children	NA	NA	0%	NA
Eufinger et al. [9]	Anterior	Maxillofacial	26 children/adults	NA	0% at 12 months	0%	Satisfactory

ACDF anterior cervical fusion and discectomy, *ALIF* anterior lumbar interbody fusion, *NA* not applicable

spinal fusion where harvest amounts will be small compared to that in reconstructive oral and maxillofacial surgery.

The incidence in the spinal literature of donor site pain in the short-term using an open method varies between 10 and 43% (Table 3). In our series this was 17.4% at 15 weeks. This compares favourably although it is based on only three reports.

Prevalence of pain at long-term follow-up ranges between 6 and 34% (Table 3). In our series this was 4.2%.

Although other authors have reported long-term affects on ambulation due to donor site pain [12, 27] there were no patients in our open group who reported ambulatory difficulties at long-term follow-up.

Satisfaction with graft site cosmesis where reported [24, 25, 27] varies between 82 and 92.5% for open procedures. In our series this was an encouraging 92.7%.

Reports of minor complications besides pain and acute paraesthesia for open procedures varies between 1.5 and 14.3% most of which had resolved at follow-up [12, 22, 25–28]. Our complication rate of 8.3% therefore compares favourably with these reports.

Donor site morbidity using a trephine may be expected to be less than with open methods because of the smaller incision and lack of muscle stripping. Because there have been no reports of morbidity using a trephine in spinal surgery we have examined the oral and maxillofacial literature for comparison with our results.

There are five reports of donor site morbidity using a trephine including two that compared trephine with an open method (Table 3). Sandor et al. [23] found 1.2% of pain at 3 weeks and no pain at 6 months follow-up and was the only author who experienced minor complications of 3.6% all of which had resolved at follow-up. Ilankoven et al. [15] reported 13.3% pain at 7 days post-operatively and no complications but the series consisted of only 15 patients. Billmire et al. [3] found no pain lasting greater

than 2 weeks in 20 harvests from children, no complications and good cosmesis. Burstein et al. [5] compared complications in 21 children undergoing harvesting by trephine with 21 using an open method in non-randomised study. They found no complications in the trephine group compared to two patients (9.5%) in the open group but the difference was not significant. Pain levels were not measured. Eufinger et al. [9] compared pain, complications and cosmesis for open and trephine harvesting with 26 patients in each group. There was no pain in either group at 1 year follow-up. There was one complication in the open group (3.9%). Cosmesis was rated satisfactory in both groups.

Because of the small number of studies and the fact that they involved larger harvests of bone and mainly children makes comparison with our results difficult. They show very much lower levels of acute pain compared to our results. Chronic pain in our series was 1.9% which was due to one patient who developed a neuroma. Our complication rate of 11.5% is substantially greater than these reports (Table 3).

The present study has failed to demonstrate substantial donor site morbidity apart from acute pain regardless of which of the two methods were used for harvesting. In our series there was only one major complication in the trephine group necessitating re-exploration of the graft site. Two patients in the open group required a steroid injection to resolve their problems. These findings are in agreement with other studies in which iliac crest bone has been harvested for use in a variety of surgical procedures. However techniques of harvesting, the patient population and particularly the amount of bone graft harvested all differ greatly between spinal and maxillofacial surgery. Harvesting relatively small amounts of bone as we did in this study would be expected to result in limited morbidity.

Although acute pain at the donor site as in any surgical site is to be expected it was generally self-limiting and had resolved in the majority of patients in both groups by 6 weeks. At 14 weeks approximately 30% of all patients were still complaining of pain including two who suffered long-term pain (Fig. 2). There was a trend towards significance ($P = 0.076$) for open graft patients reporting pain more than those in the trephine group. Increasing the sample size for the open group may have made this significant.

As far as pain intensity is concerned the majority of patients in both groups suffered only mild to moderate acute pain. At long-term follow all patients were pain free. Parasthesias was also a significant problem and appeared to show a trend towards being more common in the open group. This may be expected considering the greater risk of damage to the lateral femoral cutaneous nerve during an open procedure. There is also the problem which occurs in 10% of the population of the nerve taking an anomalous course over the anterior crest [11].

The inverse correlation with age of pain intensity that we observed in the trephine group is in agreement with similar reports in the literature of the general phenomenon of decreased acute pain sensitivity with age [10, 19]. The lack of similar correlation in the open group may be due to the smaller sample size.

Our overall rate (open and trephine) of 5.3% for minor complications (excluding pain and acute paraesthesis) is comparable to those of other studies. Similarly satisfaction with graft cosmesis was similar to the few studies where it had been reported. Surprisingly this was the case in both groups. Overall satisfaction with the harvesting procedure was almost unanimous suggesting that the inconvenience of some graft site morbidity is a small sacrifice for the success of the primary surgical procedure.

We can offer no explanation for the superior outcome of neck fusion in the open group compared to the trephine patients. It may be due to the fact that there were fewer patients in the open group and the result is due to the small sample size.

The limitations of this study are that it was not a randomised controlled design. The trend that this study has shown towards a reduced incidence of pain in the trephine group can only be tested by conducting a randomised controlled trial of sufficient power. Furthermore, in any retrospective survey of this nature there will always be the problem of recall bias. Patients who have had graft site problems are more likely to be able to recall their experiences than those who did not or suffered only mild problems. Our follow-up rate although very good for the open group (96%) was less for the trephine patients (75%). This was despite exhaustive attempts to elicit response in the trephine patients. The non-responders in the trephine group were predominately younger males and we have found follow-up in such patients a problem in our other studies (RD Pollock, personal communication).

This study has highlighted the acute pain experienced at the graft donor site in agreement with the findings of previous studies. Although there was a trend towards less morbidity in the trephine compared to the open group this was not statistically significant. The two previous studies comparing methods also found no significant difference. Only by carrying out a randomised study of adequate sample size can the efficacy of the two methods be determined. This will enable surgeons to make an informed choice about which technique to use for harvesting. In our patients we initially began using the open method only because trephine instrumentation was unavailable in our hospital even though we were aware of the advantages of the trephine method. We now routinely use the trephine method for harvesting and patients are not given the option of the open method. The advantages are less possibility of infection, less chance of fracture of the ilium, reduced

blood loss and reduced operating time. In our opinion the trephine method should be the method of choice for harvesting small amounts of bone.

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