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ORIGINAL PAPER

Intra-operative cell salvage in pelvic and acetabular fracture surgery: a retrospective comparative study

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Abstract

Aim of the study To determine if the intraoperative use of cell salvage (CS) led to a decrease in allogeneic blood transfusion by comparing with a control group that did not receive CS. We also looked at the effects of injury severity and surgical approach.

Methods This was a retrospective study at a major trauma center. One hundred and nineteen patients underwent open reduction and internal fixation of pelvic and acetabular fractures with (59 patients) or without intra-operative blood cell salvage (60 patients). The main outcome measurements were allogeneic blood transfusion during and after surgery with respect to CS, injury severity and surgical approach.

Results We did not find any significant difference in the allogeneic blood transfusion between the CS and non-CS groups (rate—62% vs. 48%, p value 0.12 {significant at < 0.05}, volume 5.56 units vs. 5.58 units, p value 0.33). The rate (71.1% vs. 48.9%, p = 0.02) and volume (7.6 units vs. 4.3 units, p value 0.00057) of post-operative blood transfusion was significantly higher in the more severely injured (ISS > 20), but there was no significant difference between the CS and non-CS groups. No significant difference was seen between either patients who had anterior or posterior surgical approaches.

Conclusions We did not find CS clearly efficacious clinically or cost effective, even in the more severely injured patients or when different surgical approaches were used. We do not advocate the routine use of CS in pelvic and acetabular surgery, but selectively, based on surgeon and patient preference.

Keywords Cell salvage · Pelvic fracture · Acetabular fracture · Allogeneic blood transfusion

Introduction

Pelvic and acetabular fracture surgery is commonly associated with significant blood loss. Many of these patients also require several other surgical interventions in the context of polytrauma. As a result, surgery in these patients is associated with significant peri-operative blood loss and significant risk of post-operative transfusion. [1, 2]

One of the strategies for re-using the blood lost from the patients themselves is cell salvage (CS). Intra-operative CS involves collection of blood loss during surgery using a suction device. The blood is centrifuged and washed so that only concentrated red cells are collected and returned to the patient. Blood is usually returned to the patient intra-operatively, but this can continue post-operatively. Post-operative CS and re-transfusion uses a post-operative drain system. This consists of a blood collection suction bellows connected to an autologous transfusion bag with a filter. A drain is inserted into the surgical wound before closure and blood collected up to six hours post-operatively is re-transfused [3].

The use of intra-operative CS in surgical procedures is an established practice, particularly in vascular and cardiothoracic surgery [4]. In orthopaedics, it is widely used in revision hip surgery [5] and spinal surgery [6]. As CS enables re-using blood loss during surgery, which can be quite significant, it is being used more frequently in pelvic and acetabular fracture surgery, but as such its benefit as regard to use of allogeneic blood products, and its cost-effectiveness is not clearly established.

We aimed to determine in this study if the use of CS led to a decrease in intra-operative and post-operative allogeneic

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blood transfusion by comparing with a control group that did not receive CS. We also looked for such an effect of CS within subgroups of patients, based on injury severity (injury severity score, ISS > 20 vs. < 20) and effect of surgical approach (anterior ilioinguinal/pelvic vs. posterior acetabular Kocher Langenbach).

Materials and methods

Institutional review board approval was obtained. We retrospectively collected data on 119 patients covering a period of five years (2009–2014) who underwent open pelvic or acetabular fracture surgery by two fellowship trained orthopaedic consultants. Data was obtained from the patient records, departmental pelvic fracture database (maintained by one of the consultants), picture archives and communication systems (PACS) and the hospital pathology department. Patients who had external fixators only anteriorly and/or iliosacral (IS) screws only posteriorly were excluded.

Demographic information (age, sex distribution), ISS and type of injury (pelvic/acetabular or both) were recorded.

Most recent preoperative haemoglobin level (Hb) was recorded, and first-day post-operative Hb (in g/dl) was also noted. Intra-operative and post-operative blood product transfusion was recorded, and the decision to use these was determined by physiological and clinical parameters. Unless contraindicated, all patients received chemical thromboprophylaxis with enoxaparin.

CS (Cell Saver 5+, Haemonitics, USA) was used in 66 operations (59 patients) and not used in 64 surgeries (60 patients). CS use was mainly determined by availability of machine and/or a trained operator but in a few cases was by surgeon preference.

Costs of CS and allogeneic blood were obtained from the hospital finance department. The cost of one unit of allogeneic blood transfusion was £161.30. As for the CS, collection only costs £38.40, while collection and re-transfusion costs £111.4. Both of these excluded staffing costs.

Statistical analysis was performed using the *Stata 14* software. Non-parametric (Kruskal-Wallis and Mann-Whitney) tests were used for comparison of means using a p value of < 0.05 for significance.

Results

One hundred and nineteen patients were identified (130 surgical episodes). Average age was 39 years (range 16–68 years). Eighty-nine (75%) were male. Thirty-eight had an ISS > 20, while the rest had ISS < 20. Mean ISS score was 17. 29 patients had a pelvic bony injury, 74 had acetabular fractures, and the remaining 16 had combined pelvic and acetabular injuries. All pelvic injuries were OTA (modified Tile) type C. There was a broad distribution of different types of acetabular fractures. (see Table 1).

An average of 435 ml was re-transfused in the cell salvaged patients. More than half of all patients (55.4%) needed allogeneic blood perioperatively. Nineteen (14.6%) needed fresh frozen plasma (FFP) as well.

We were not able to demonstrate *any statistically significant difference* in the use of blood products between the cell salvaged and non-cell salvaged patients (Table 2). A higher but not significant proportion of CS patients needed blood products during this period. (see Table 2).

There was a *significantly higher number* of patients needing blood transfusion (Table 3) in the more severely injured (ISS > 20). Also, the actual volume transfused was *significantly higher* in the (ISS > 20) group. However, within both subgroups, there was no significant difference between CS and non-CS patients. (see Table 3).

We were not able to demonstrate any statistically significant difference in the use of blood products between patients who had surgery by anterior or posterior or combined anterior and posterior surgical approaches (Table 4). Within the subgroups of anterior (38 CS vs. 34 non-CS) approach and posterior approach (16 CS vs. 17 non-CS), there was no significant difference found with use of CS. (see Table 4).

Table 1 Comparable characteristics of the cell salvage (CS) and non-cell salvage (non-CS) groups

Variable	CS	Non-CS
Number	66 cases (59 patients)	64 (60)
Age	39.7	38.2
Sex (male:female)	48:18	46:18
Average injury severity score (ISS)	16	18
Patients with ISS > 20	14	24
Pelvic ring injury (P)	14	15
Acetabular fracture (A)	36	39
Combined P & A injuries	9	7
Days to surgery	7.4 (range 1–53)	7.8 (range 0–23)

Table 2 Effect of using cell salvage (CS) on blood parameters/transfusion

Variable	CS yes	CS no	*p* value
Preop Hb (g/dl)	109.7	108.6	0.76
Postop Hb (g/dl)	97.5	95.3	0.39
Change in Hb (g/dl)	− 12.2(8.6%)	− 13.3(10.9%)	0.71 (0.38)
Numbers needing blood	41 (62%)	31 (48%)	0.12
Average packed cells given (units)	5.56	5.58	0.33

Hb haemoglobin

Discussion

Pelvic and acetabular injuries are associated with significant blood loss. They are also associated with more peri-operative complications [7]. Hemodynamically unstable patients due to pelvic fracture-related bleeding have a mortality rate up to 60%, and therefore need an emergent multidisciplinary approach involving external fixation of the pelvis, and retroperitoneal pelvic packing complemented by angio-embolization where needed [8]. Such an approach not only lowers mortality but also morbidity and usage of blood products [9].

In more stable patients with such injuries who undergo surgery in a more controlled environment, CS of blood loss intra-operatively is an option. Blood CS is frequently used in many areas of orthopaedic surgery, particularly in revision hip arthroplasty and spine surgery. It is also used in paediatric orthopaedics in osteotomies around the hip [10]. A related meta-analysis [11] of related studies concluded that cell salvage use in orthopaedic surgery decreases the proportion of patients needing blood transfusion peri-operatively.

However, there have been very few studies on its use in pelvic and acetabular trauma surgery, with conflicting reports of the benefits and cost efficacy of its use. Scannell et al. [1] found that in acetabular surgery, there was no reduction in the volume or rate of allogeneic blood transfused intra-operatively or post-operatively, but blood-related expenses were significantly increased. However, Bigsby et al. [12] concluded that CS use was cost-effective, particularly in associated-type acetabular fractures, and recommended its routine use to limit the need for allogeneic blood transfusion. Odak et al. [13] in their study involving pelvic trauma patients also found it clinically efficacious and cost effective. The most recent study by Firoozabadi et al. [14], however, did not recommend its routine use in acetabular fracture repair, but its use may be warranted with anterior approaches if large amounts of blood loss are anticipated. Studies from hip arthroplasty [5, 15–17] and spine surgery [17–19] also differ regarding clinical benefit and cost-effectiveness.

At our institution, intraoperative CS is used in major trauma and elective orthopaedic surgical procedures, while post-operative CS using autologous drain systems is not routinely used. Moreover, during these often long procedures, there is significant intra-operative blood loss which can be harvested at the time and re-transfused during the procedure itself but would have been lost to post-operative salvaging. In this study, we have attempted to compare the allogeneic blood transfusion rates in relatively similar patient groups, all of whom underwent open repair of pelvic or acetabular fractures or of both. There was no significant difference between those that underwent intra-operative CS and those that did not. Even subgroup analysis of more severely injured patients (ISS > 20) who had significantly more blood product requirements overall, did not show any significant differences between CS and non-CS groups.

As for the effect of the surgical approach used, we did not find a significant difference between anterior vs. posterior vs. combined approaches or any advantage conferred by using CS in the anterior or posterior approaches. But, we had a higher re-transfusion rate than Firoozabadi et al. [14] both overall and in the different approach groups (around 50%).

There is a renewed focus on health economics and cost-effectiveness of treatment measures, particularly in the NHS. CS intra-operatively requires both specialised equipment and trained staff. Allogeneic blood is a resource of limited

Table 3 Effect of injury severity score (ISS) on blood parameters/transfusion

Variable	ISS > 20 (38)	ISS < 20 (92)	*p* value
Preop Hb (g/dl)	104.6	111.1	0.12
Postop Hb (g/dl)	94.8	97.1	0.41
Change in Hb (g/dl)	− 9.8(7.5%)	− 14.0 (10.6%)	0.18
Numbers needing blood	27 (71.1%)	45 (48.9%)	0.02
Average packed cells given (units)	7.6	4.3	0.000057
Cell salvage (yes:no)	14:24	52:40	–

Hb haemoglobin

Table 4 Effect of surgical approach on blood parameters/transfusion

Variable	Anterior (A) approach (72)	Posterior (P) approach (33)	A + P approaches (14)	Significance between groups
Preop Hb (g/dl)	109.6	110.6	103.1	No
Postop Hb (g/dl)	96.9	96.2	94.7	No
Change in Hb (g/dl)	− 12.7 (9.6%)	− 14.4(11.2%)	− 8.4 (6.0%)	No
Numbers needing blood	44 (55.7%)	20 (54.0%)	8 (57.1%)	No
Average packed cells given (units)	5.8	5.7	4.25	No
Cell salvage (yes: no)	38:34	16:17	7:7	No

Hb haemoglobin

availability and is associated with well-documented risks, including transfusion reactions, infection transmission, immunomodulation and transfusion error [20], and all measures to decrease their use should be adopted. But, CS at pelvic fracture surgery made no significant difference to their usage, while the cost to run it is not insignificant.

The studies that have showed its cost-effectiveness have self-admittedly either not factored in significant cost factors [13] or predicted costs using logical assumptions [12]. Also, most of these patients have multiple injuries with many sites of blood loss from their injuries, so possibly cell saving at one operation would therefore not make a big difference to their overall blood requirements.

Limitations of this study include that it is retrospective and there was no protocol to determine who received CS and who did not. But, in most cases, non-usage was due to lack of trained staff to run the CS at the time of surgery.

In conclusion, we did not find intra-operative CS clearly efficacious clinically or cost-effective, even in the more severely injured patients or when different surgical approaches were used. We do not advocate the routine use of CS in pelvic and acetabular surgery, but selectively, based on surgeon and patient preference.

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Author contribution All authors have been directly involved with the different aspects of this clinica lstudy.

Compliance with ethical standards

Institutional review board approval has been obtained.

Conflict of interest The authors declare that there are no conflicts of interest.

Informed consent Informed consent has been obtained from the patients of this study.

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