Original article

The use of tranexamic acid to reduce blood loss during total hip arthroplasty: an observational study

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Introduction: To test the hypothesis that the fall in haemoglobin following total hip arthroplasty is reduced by tranexamic acid administration.

Patients and Methods: A cohort of 64 patients were studied, 32 received tranexamic acid 20 mg/kg on induction. Surgery was performed by the senior author in a standardised fashion. Haemoglobin levels were measured 2 weeks pre- and 3 days postoperatively. Any complications were noted. The study group was matched using the bone and joint research database for age, sex, procedure, disease and pre-operative haemoglobin level.

Results: In the group receiving no tranexamic acid, the mean fall in haemoglobin was 3.8 g/dl (CI of mean 3.4–4.3) and in the group treated with tranexamic acid 2.8 g/dl (CI of mean 2.5–3.2) $P < 0.05$. Complications included one non-fatal pulmonary embolus in the tranexamic acid group.

Conclusions: The administration of 20 mg/kg of tranexamic acid on induction of surgery is an effective method of reducing the haemoglobin fall following hip arthroplasty.

Key words: Total hip arthroplasty – Tranexamic acid – Blood loss

Postoperative anaemia following total hip arthroplasty has been shown to increase the length of stay in hospital, delay mobilisation and is poorly tolerated by patients with peripheral vascular and cardiovascular disease.^{1,2} Patients who have low pre-operative haemoglobin levels, those who undergo bilateral hip arthroplasties and Jehovah's witnesses who are unable to receive allogenic blood products are groups in whom efforts to reduce blood loss are of particular importance.³ The avoidance of allogenic blood transfusion is desirable in order to reduce the potential risk and cost implications.⁴

A number of strategies may be employed in order to minimise blood loss in orthopaedic surgery. Tourniquets are used where applicable in combination with meticulous surgical technique via relatively avascular approaches

ligating or cauterising vessels. Strategies to avoid allogenic blood transfusion include the use of autologous blood either by predonation, acute normovolaemic dilution or cell salvage.⁵ The evidence suggests that predonation is difficult to organise and units collected are often discarded making it relatively expensive.⁶ In addition, the most significant indicator for the likelihood of postoperative transfusion is the pre-operative haemoglobin level. There is a 69% chance of an allogenic transfusion if the haemoglobin is less than 13 g/dl and only a 13% chance if more than 15 g/dl.⁷ Therefore, patients least likely to require transfusion are the most suitable for predonation. Cell salvage requires specialised equipment and suitably trained staff and there have been reports of coagulation disorders.^{8,9} Pharmaceutical preparations such as

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erythropoietin, while effective in reducing postoperative transfusion, are very expensive.¹⁰

Antifibrinolytics such as tranexamic acid are inexpensive and routinely used in specialities such as gynaecology to reduce blood loss. It inhibits fibrinolysis by blocking the lysine binding sites of plasminogen to fibrin. Recent evidence from the orthopaedic literature indicates a role in knee arthroplasty;^{11–17} however, data regarding its use in hip arthroplasty are less common.^{18–20} In our opinion, its use in orthopaedics is relatively uncommon in this country. Therefore, we performed a study to examine the results of the effects of tranexamic acid on haemoglobin falls postoperatively in patients undergoing total hip arthroplasty in our centre.

Patients and Methods

Data on 64 patients undergoing total hip arthroplasty were collected. There were 28 patients with osteoarthritis and 4 with rheumatoid arthritis in the study group and 29 with osteoarthritis and 3 with rheumatoid arthritis in the control group. The patients were reviewed and a haemoglobin level measured 2 weeks prior to surgery. The senior author (GS) performed all the procedures via an anterolateral approach. The prosthesis used in all cases was a Freeman hip replacement (Finsbury Orthopaedics Ltd). In the group receiving tranexamic acid, there were 12 uncemented, 10 cemented and 10 hybrid total hip replacements. In the control group, there were 11 uncemented, 11 cemented and 10 hybrid total hip replacements. A single dose of tranexamic acid (20 mg/kg) was administered on induction to 32 patients. Postoperatively, the drain was clamped for 1 h before release. The haemoglobin level was measured after 3 days to allow the level to normalise. We then retrospectively examined the results from a cohort of 32 patients matched for surgeon, pre-operative haemoglobin, age, disease and procedure. This was obtained from the bone and joint research database. The senior author had operated on all patients in the preceding 18 months. Their work-up and haemoglobin levels having been monitored in the same way as the study group.

The haemoglobin falls were compared with the Student's *t*-test and matched variables were analysed using the chi-squared test and analysis of variance.

Results

There were 32 subjects in each cohort, 18 males and 16 females per group. There were 26 primary and 6 revision procedures in each cohort. In the group receiving no tranexamic acid, the mean fall in haemoglobin was 3.8 g/dl (CI of mean 3.4–4.3) and in the group treated with tranexamic acid 2.8 g/dl (CI of mean 2.5–3.2). This was

statistically significant ($P < 0.05$). Complications included one non-fatal pulmonary embolus in the tranexamic acid group and two superficial wound dehiscences that healed by secondary intention.

Discussion

This study indicates that a reduction in the fall of haemoglobin of approximately 1 g/dl is achieved by use of tranexamic acid and confirms the findings from other researchers that blood loss is significantly reduced. It should be noted that in order to be effective in hip arthroplasty it must be given pre-operatively.²¹

Since the study is not randomised, there may be concerns regarding selection bias and comparability of groups; however, we matched for variables felt most likely to influence outcomes namely age, sex, surgeon, procedure and probably most importantly pre-operative haemoglobin levels. The haemoglobin levels were assessed at 3-days postoperatively since this was part of our routine postoperative monitoring of all patients. In addition, examination of data from previous studies¹⁸ demonstrated that the haemoglobin levels plateau by this time and earlier measurements are likely to be influenced by the fluid resuscitation peri-operatively. No patients were transfused prior to 3 days. We did not evaluate blood drainage levels because if blood loss is to be measured accurately it should also quantify loss through haematoma formation and extravasation. This may be calculated using ultrasonography,²² which was not done in our study. The need for blood transfusion was not compared, since no clear parameters had been defined in either group for the indications for transfusion and, therefore, was susceptible to bias. It is of note, however, that none of the trial group were transfused at any stage.

The anaesthetic technique and the specific effect of the anaesthetic or fluid administration was not studied; however, it should be noted that the same consultant anaesthetist was involved in all cases.

Due to the small numbers of patients in the study with a pre-operative diagnosis of rheumatoid arthritis, it was not possible to examine the effect pre-operative diagnosis had on blood loss.

One of the major concerns regarding the use of tranexamic acid is the view that the risk of deep vein thrombosis and pulmonary embolus is increased. Patients in our study were only investigated for deep vein thrombosis or pulmonary embolism if clinically indicated. Mechanical thrombo-embolic prophylaxis was provided in the form of intra-operative calf stimulators, TED stockings and early mobilisation. No chemoprophylaxis was employed. The pulmonary embolus that occurred in the trial group is of interest and occurred 1 week

following surgery. It should be noted that the therapeutic concentration of tranexamic acid is maintained for approximately 3 h and evidence indicates that formation of thrombus following total hip arthroplasty occurs over a prolonged period and that a significant proportion occur from 1 week onwards.²³ Therefore, we do not feel that the tranexamic acid was responsible in this case. It should be noted that tranexamic acid does not promote clot formation but simply stabilises clot that has formed. Only one study has used Doppler to look at the incidence of deep vein thrombosis and found no increase caused by tranexamic acid; however, numbers in this study were relatively small.¹² No evidence of increase in risk, as demonstrated by clinically detectable deep vein thrombosis was noted in other trials.^{11–14}

Conclusions

The administration of 20 mg/kg of tranexamic acid on induction of surgery is an effective method of reducing the haemoglobin fall following hip arthroplasty.

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