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Effect of Bipolar Sealants on Total Hip Arthroplasty Using the Direct Anterior Approach

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Abstract

Introduction: To determine the effect of bipolar sealant on transfusion rates in primary total hip arthroplasty (THA) using the direct anterior approach (DAA).

Methods: Fifty-nine patients in total were recruited for the study. The first group (n:37) underwent THA DAA using the conventional bipolar diathermy and the second (n:22) group underwent THA DAA with the aid of aquamantys bipolar sealant. Mean difference in post-operative drop in haemoglobin levels were charted and transfusion rates were compared. The statistical analysis was performed using SPSS 2.0 software for windows.

Results: The use of bipolar sealants did not significantly reduce hemoglobin drop ($p>0.05$). It did, however, significantly reduce the rate of transfusion ($p=0.013$)

Conclusion: Our study suggests that the use of bipolar sealants were superior to conventional bipolar cautery in patients undergoing primary THA using the DAA, causing a significant drop in the need for post-operative packed cell transfusions. Hence, the use of bipolar sealant is recommended in primary THA using the DAA.

Keywords: Bipolar sealant; Total Hip Arthroplasty (THA)

Introduction

Total Hip Arthroplasty (THA) is associated with a large amount of blood loss and a high transfusion rate [1]. It has been demonstrated that blood loss during THA ranged from 700 ml to 2000 ml and the transfusion rate is 16% to 27% [1-4]. The blood loss and subsequent transfusion will increase the risk of morbidity, length of hospital stay, and add additional cost to patients. Therefore, effective control of blood loss after THA is of paramount importance for postoperative management of patients. There are several blood-preservation techniques used to minimize post-operative drop in haemoglobin for patients undergoing THA: hemostatic agents, erythropoietic agents, minimally invasive

surgery, intraoperative and postoperative salvage of blood with reinfusion, hypotensive or epidural anesthesia, and preoperative autologous blood donation [5-7]. Our study aims to illustrate the advantage that the bipolar sealant has in reducing blood loss in comparison to a conventional monopolar diathermy.

In direct anterior approach for total hip arthroplasty, there are various potential sources of blood loss which may contribute to the substantial post-operative bleeding. Of particular concern in this surgical approach is the ascending branch of the lateral femoral circumflex artery, which has been commonly identified as a source which requires haemostasis [8]. To achieve haemostasis intra-operatively, suture ligation or electrical cautery are commonly used. Standard electrocautery is commonly adopted to achieve intraoperative haemostasis. However, standard electrocautery has been reported to cause severe burns and severe tissue necrosis in patients, and operating room fires; moreover, viruses and carcinogens have been detected in the smoke generated by the device during surgery [9-12]. In addition, investigators have also noted that skin incision healing is quite slow, because of which, they argued, application of electrocautery should be limited to reduce the postoperative complications [13]. In comparison to conventional bipolar cautery, a new blood loss device known as a bipolar sealant is able to provide haemostasis at lower temperatures ($<100^{\circ}\text{C}$) [6-10]. The bipolar sealant delivers radiofrequency energy in a saline medium for haemostatic sealing and coagulation of tissue. The advantage of this bipolar sealant is to induce coagulation of small vessels at about lower than conventional bipolar cautery, thereby minimizing thermal necrosis [14-18]. It is also used in other surgeries such as hepatic transplantations, cirrhotic liver resections, cholecystectomies, and oncological surgery [17,19,20].

To our knowledge, there is no literature available that has assessed the impact of a bipolar sealant on THA using DAA. We decided to perform this study to assess and compare the efficacy of using bipolar sealants in direct anterior approach of total hip arthroplasty against another group of patients using conventional bipolar diathermy and evaluate the post-operative transfusion rates and drop in haemoglobin levels.

Methods

This is a retrospective international review board-approved single institution study under a single fellowship trained arthroplasty surgeon with data obtained from patients from April 2015 to March 2017. They underwent total hip arthroplasty using the direct anterior approach. The first group of patients (n: 37) had conventional bipolar cautery used during the operation and the second group of patients (n: 22) underwent the operation using the bipolar sealant.

The first group of patients had mean age of 63.2 +/- 12.6 years old and consisted of 17 males and 19 females. Most patients had comorbidities of hypertension and hyperlipidemia. There were 2 smokers. 9 patients had aspirin and 1 patient was on warfarin pre-operatively. The second group of patients had mean age of 60.4 +/- 13.1 years old and there were 8

males and 15 females. The patients also usually have hypertension and hyperlipidemia. There were also 2 smokers and 1 ex-smoker. 10 patients were on aspirin and one patient was on ticlodipine. A summary of the demographics of the patients are available in **Table 1**.

For haemoglobin levels, we obtained pre-operative values and charted the post-operative values on day of surgery and post-operative day 1. The post-operative drop in haemoglobin levels was recorded, the difference in the pre-operative and post-operative haemoglobin levels using both methods were recorded and compared; and the need for transfusion of blood products post-operatively was documented. Transfusion was ordered if the patient's post-operative haemoglobin levels were less than 9.0 g/dL. The results were then charted and SPSS version 2.0 was used to run the tests to look for significance.

Table 1 Patient demographics in the two groups of patients.

Variables	Bipolar Sealant	Conventional Monopolar
Number of patients, n	22	35
Age (years)	60.4 +/- 13.1	63.2 +/- 12.6
Gender	8 males 15 females	17 males 19 females
Anticoagulation medication	10 aspirin, 1 ticlodipine	9 aspirin, 1 warfarin
comorbidities	12 (Hypertension + Hyperlipidemia) 1 rheumatoid arthritis 1 rheumatic heart disease 1 mixed connective tissue disease 1 IGA nephropathy renal failure patient	19 (Hypertension + Hyperlipidemia) 3 CVA patients 1 ischemic heart disease patient 1 renal transplant patient
Smokers	2	3

Results

The independent sample mann-whitney – U test was used to measure the significance between the two groups. We found that the level of haemoglobin drop between the two groups was not significant (0.618, p>0.05) but there was a significant difference in the need for post-operative transfusion in the group which had the bipolar sealant group (p=0.013) compared to the group that used the conventional bipolar diathermy (**Table 2**).

Discussion

Total hip arthroplasty using the direct anterior approach is a very successful intervention. It allows early weight bearing and quick return to joint function. This is because of the muscle-sparing approach adopted by this surgeon. Less soft tissue dissection is performed in comparison to other more traditional approaches such as the hardinge approach or the posterior approach. Primary total hip replacement is complicated by perioperative blood loss ranging in amount from 1,000 to 2,000 ml [1-4]. Blood transfusion was needed to correct anemia in 3% to 50% of patients [21]. There are several blood-preservation techniques are in regular clinical use:

hemostatic agents, erythropoietic agents, minimally invasive surgery, intraoperative and postoperative salvage of blood with reinfusion, hypotensive or epidural anesthesia, and preoperative autologous blood donation [16-18].

Table 2 Comparison of haemoglobin values and need for transfusion of bipolar sealant vs conventional monopolar diathermy.

Variables	Bipolar Sealant	Conventional Monopolar	p-value
Pre-op Hb	13.5	13.1	0.2
Hb Drop	2.8	2.98	0.618
Need for transfusion	0%	25%	0.013

Haemostatic agents such as tranexamic acid, fibrin sealant, thrombin based sealant can be used to minimize blood loss. Erythropoietic agents such as the bipolar sealant is an effective means of haemostasis, but of date there is no literature which supports its use in direct anterior approach of total hip arthroplasty. This current study compares the efficacy of the bipolar sealant with a conventional bipolar cautery and its impact on blood loss and transfusion rates.

The most recent iteration of this technology genre, the Aquamantys® System is a bipolar sealing device (BPS 6.0-VT Tissue Link Medical, Dover, NH), which combines a bipolar electrosurgical generator with a rotary peristaltic saline pump [22]. The current hand-held device has both the aforementioned combined into a single unit. Electrothermal bipolar vessel sealants produce a hemostatic seal by applying radiofrequency energy in combination with continuously-flowing saline irrigation at the electrode tip directed at a vessel, thereby denaturing the blood vessel wall's elastin and collagen and causing contraction of vascular collagen, occlusion of blood flow, coagulation and subsequent soft tissue sealing at a much lower temperature (<100°C) than occurs with standard electrocautery [23-25]. The saline flow serves to cool the temperature of tissues, and serves as a conductive fluid to distribute energy over a larger, more even surface of the vessel while performing haemostatic sealing [15,26]. Typically, the depth of penetration of these saline-coupled bipolar sealing technologies is only 2mm or less [26]. By contrast, conventional monopolar electrocautery risks producing an eschar and tissue charring from temperatures exceeding 300°C, and thereby poses a risk of subsequent postoperative bleeding with eschar breakage or detachment [26].

Indeed, in THA, pretreatment of areas expected to bleed is as important as coagulating large open muscle and bone beds from the femoral canal or extended trochanteric osteotomy sections. Of note, it is imperative in these procedures to avoid contact with skin edges, subcutaneous tissues, tendons and ligaments with the bipolar sealing devices due to potential harm from their shrinking effect on collagen [27].

In this study, we have showed that bipolar sealant can reduce the need for transfusion post-operatively, and the result was statistically significant. ($p=0.013$). This result also means that the bipolar sealant may reduce the economic cost involved in the use of blood products during transfusion.

The bipolar sealant has been shown to not significantly reduce the drop in haemoglobin level ($p>0.05$) as compared to the conventional bipolar cautery. This is because bone is a special tissue that contains mostly inorganic components that are poor conductors of electricity [28]. This is one of the reasons that lead to a large amount of intra-operative blood loss since electrocautery is unable to effectively stop blood loss from bleeding bone [28].

In addition, there have also been other studies which show that bipolar sealant has the ability to decrease post-operative pain and swelling, resulting in quicker recoveries from arthroplasty [26].

Our study has a few limitations. Firstly, this is a retrospective case-control and there is no randomization of patients; so the surgeon and the patients were aware of the instruments used. Secondly, the numbers involved could be larger to increase the power of the study.

Conclusion

Total hip arthroplasty using the direct anterior approach is one of the most successful surgical interventions. Patients have early ambulatory function and faster return of joint function. Bipolar sealants are an effective adjunct in total hip arthroplasty performed using this approach. Our study showed that there is a significantly lower rate of transfusion when the bipolar sealant is used in comparison to conventional bipolar cautery. ($p=0.013$). Further prospective, randomized controlled trials which involve larger number of patients can be undertaken in future to study the effect of bipolar sealants on lowering blood transfusion rates when using direct anterior approach in total hip arthroplasty.

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