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RESEARCH ARTICLE

Optimizing Prophylactic Anticoagulation in Burns is Associated with Low Incidence of Venous Thromboembolic Complications

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ABSTRACT

Venous thromboembolism (VTE) complications in burn patients are often under-diagnosed and potentially serious. Thromboprophylaxis in this population remains controversial.

Objective: Assess the impact of optimizing prophylactic anticoagulation with enoxaparin in burn patients on the incidence of venous thromboembolism (VTE).

Methods: Case-control study conducted in intensive burn care department in Tunisia during 24 months, (February 2018- February 2020). Patients were divided into 2 groups according to the prophylactic anticoagulation modalities:

- G1 (Equation) receiving enoxaparine en mg/12H = 22.8 + (3.3 × % TBSA/10) + (1.89 × (weight in kg)/10))
- G2 (No équation) receiving enoxaparine at a dose of 0.5mg/kg, twice daily

The goal of prophylactic antifactor Xa level was 0.2- 0.4 IU/ml

Results: During study period, 216 patients were included divided into 2 groups: G1 (n= 108) et G2 (n= 108). The groups were comparable in terms of sex, age, weight, burned skin surface and VTE risk. Also, severity of the 2 groups was comparable regarding: smoke inhalation (p=0.46), use of mechanical ventilation (p=0.22), use of catecholamines within 48 hours (p=0.56) and rescue incision (p=0.77). In the equation group, initial dose of enoxaparin was 0.42± 0.12 mg. Target anti Xa was reached at the 1st dosage in 55 patients 55 (50.9%). The median final dose of enoxaparin required to reach the anti Xa target was 52 mg every 12 hours (range, 35-69 mg). No episodes of bleeding, thrombocytopenia, or heparin allergy were documented in either group.

The incidence of VTE complications was higher in group 2 than in group 1 (8.3% versus 3.7%; p=0.001 with an OR=1.6 and CI [0.47-1.03]). The length of stay was longer for G2 with a significant difference (30 days vs 22 days; p=0.001). Mortality was the same for two groups.

Conclusion: Optimizing thromboprophylaxis in severely burned patients with enoxaparin, using the enoxaparin dosing eqauation allows to achieve prophylactic anti-Xa level and to reduce risk of VTE complications.

Introduction: Thromboembolic disease in burn patients is often under-diagnosed and potentially serious complication. Its occurrence is explained by major inflammatory state secondary to burns, the combination of general (catheterization, immobilization...) and burn-specific risk factors for thrombosis[1]. The incidence of venous thromboembolic complication Venous thromboembolic events remain rare, but varies according to series, ranging from 0.9% to 53%[2,3]. Thromboprophylaxis and its modalities remain controversial in the literature, going against pharmacological prophylaxis explained by low incidence of this complication and the risk of bleeding. In addition, many physicians recommend its use only in high-risk burn patients. Moreover, even standard doses of anticoagulants prescribed for patients in medical or surgical intensive care units are probably not suitable for burn patients. Infact, the pharmacokinetics and pharmacodynamics of drugs are significantly altered in the burn patient. In addition, no study was focus on the efficacy of antithrombotic prophylaxis in the burn patient in terms of preventing thromboembolic complications. In the littérature, previous studies have been reported that inadequate anti-Xa activity in burn patients is common and is associated with a high risk of thromboembolic complication[4,5]. Frakalas[4] reported that the standard dosage of Enoxaparin prescribed in burn patients was inadequate. So, he demonstrated a strong correlation between Enoxaparin dose, burn patient weight and extent of burns ($r2 = 0.68$; $p<10-3$), and this generated the following equation: Enoxaparin dose in mg: Q12Hrs = 22.8 + (3.3 × % TBSA/10) + (1.89 × (weight in kg)/10). Optimization anticoagulation with Enoxaparin, according to this formula, allowed to reach prophylactic levels of anti-Xa, necessary condition to decrease risk of thromboembolic complications. In view of the limited and controversial data concerning the efficacy of antithrombotic prophylaxis according to this equation, this work was carried out to assess the impact of optimizing preventive anticoagulation with Enoxaparin in burn patients on the incidence of thromboembolic complications.

Methods: Case-control study conducted in intensive burn care department in Tunisia during 24 months, (February 2018- February 2020). Were included adult patients admitted within 24 hours post-burn for a stay >72 hours, with a total body surface area (TBSA) greater than 20%. Were excluded those with a contraindication to anticoagulation: a proven or suspected bleeding, post-traumatic (< 48 hours) cerebral hemorrhage, or vascular hemorrhage and those with acute renal failure (creatinine clearance < 30ml/min or blood creatinine >1.6mg/dl).

Protocol of the study: Patients receiving preventive anticoagulation with Enoxaparin, between day 1 and day 2 after admission, according to the following equation: Enoxaparin dose in mg/12H = 22.8 + (3.3 × % TBSA/10) + (1.89 × (Weight in kg)/10)[6].

- Anti-Xa assay was performed at the peak of activity, 3 to 5 hours after the third injection, with a prophylactic target level of 0.2 to 0.4 IU/mL. The dose of Enoxaparin was adjusted by a 20% decrease or increase from the initial dose to reach the recommended prophylactic anti-Xa level.

This group of patients (G1; equation) was compared to another group (G2; no équation) from the same center receiving anticoagulation by enoxaparine owing to weight at a dose of 0.5mg/kg, twice daily. Two groups of patients were matched in terms of age, sex, weight, extent of burns, and risk of thromboembolic complications. For all patients, screening for thromboembolic complications was based in clinical signs and confirmed by duplex ultrasound and/or phlebography if burns of lower limbs for deep venous thrombosis (DVT) and chest CT angiography for pulmonary embolism

Patients were followed up until hospital discharge for the development of any adverse effects associated with enoxaparin; unexpected bleeding, thrombocytopenia, or heparin-associated allergy

Data Collection: Demographic, clinical and injury data were collected included age, sex, weight, body mass index (BMI), total body surface area (TBSA), full-thickness burn injury, inhalation injury, outcome, and hospital length of stay. Treatment data collected included antifactor Xa level (anti-Xa) and enoxaparin doses.

Thromboembolic risk has been classified into 3 stages, low, average and high-risk, by adopting the Maghit classification[5]:

1- **Low risk:** TBSA < 20% of body surface, Lower limbs not affected
2- **Average or medium risk**: TBSA between 20 and 50%; burns of the lower limbs; skin grafts of the lower limbs, removal of grafts from lower limbs.
3- **High risk:** TBSA > 50%; electrical burns ; documented biological hypercoagulability ; femoral catheterization

Statistical Analysis Statistical analysis was performed using SPSS Statistics 23 software.
-We calculated absolute and relative frequencies (percentages) for qualitative variables. We calculated means, medians, and standard deviations and determined extreme values for quantitative variables.
-Percentage comparisons were performed by Pearson's chi-square test, and in case of invalidity by Spearman's test.
-The McNemar test was used as an alternative nonparametric statistical test to the T test for paired samples.

Results: During study période, 1208 patients were admitted. Two hundred sixteen were incuded (Figure 1). Patients were assigned into 2 groups and received enoxaparin as follows:

- G1 (Equation: n= 108)
- G2 (No Equation: n= 108)

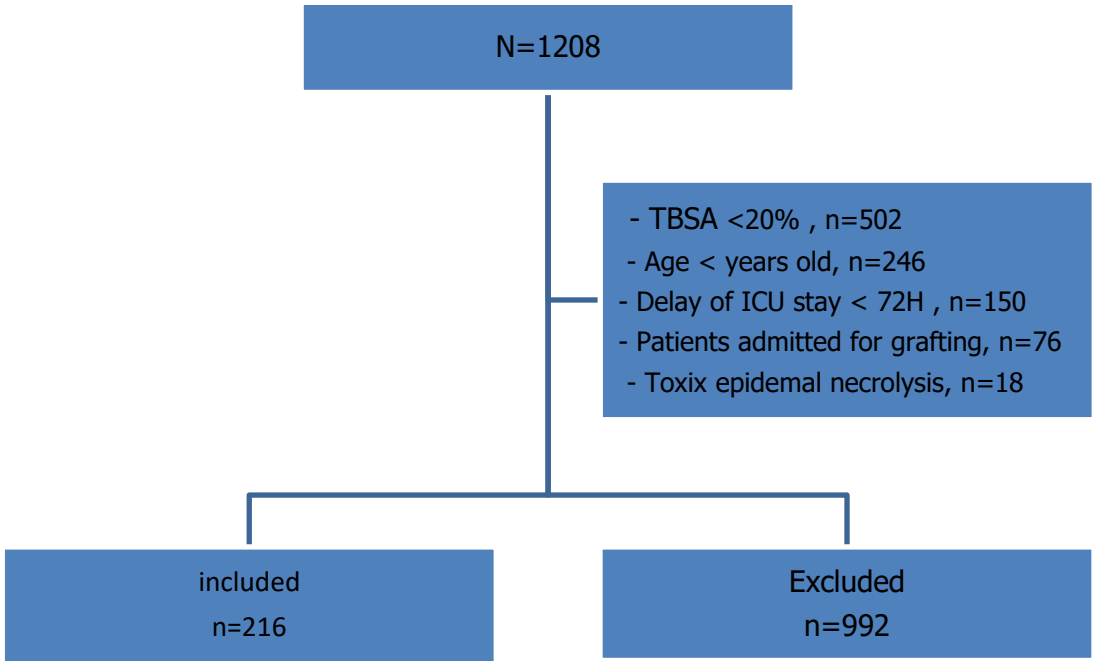

Figure 1. Patient flow diagram

There were no significant demographic or injury characteristic differences between the Eq and No-Eq groups (table 1). The median time to admission was similair for two groups. Also, patients of 2 groups were comparable in terms of clinical data regarding to: smoke inhalation (p=0.46), mechanical ventilation (p=0.22), requirement of catecholamines within 48 hours (p=0.56), and escharotomy (p=0.77) (Table 2).

Table 1. Patient demographics*

	Group 1 n=108	**Group 2 n=108**	**p**
Age (yrs)	36±16	35±16	0,55
Genre-ratio	2,55	2,55	ns
Delay of admission (H)	13	11	ns
TBSA (%)	33,5±17,7	32,6±20,4	0,34
Weight (Kg), moyenne±DS	73±17	70±16	0,34
High TBE risk, n (%)	56 (51,9)	50 (46,3)	0,41

TBSA: Total body surface area ; TBE:Thromboembolism

Table 2: Clinical data of 2 groups

	G1 n=108	G2 n=108	P
Smoke inhalation, n (%)	14 (13)	07 (6,7)	0,465
Mechanical Ventilation, n (%)	58 (53,7)	49 (45,5)	0,22
Uses of vasopressors, n (%)	54 (50)	43 (39,8)	0,56
Escharotomy, n (%)	8 (16,66)	17 (15,7)	0,77

Distribution of patients according to thromboembolic risk according to the Martin Maghit classification was as follows (table 2):

Table 2. Distribution of patients according to TBE risk

TBE risk	Groupe 1 n=108	Groupe 2 n=108	p
Low TBE risk, n (%)	12 (11)	15 (14)	0,67
Average TBE risk, n(%)	40 (37)	44 (40,7)	0,57
High TBE risk, n (%)	56 (52)	50 (46,3)	0,41

VTE prophylaxis by Enoxaparin was administered in 2 groups of patients according to 2 different regimens:
- G1 (equation group): receiving ATC according to the following equation taking into account the weight and extent of burns:
Enoxaparin dose in mg/12H = 22.8 + (3.3 × % SCB/10) + (1.89 × (Weight in kg)/10)
- G2 (No equation group): reveiving ATC according to weight at 0.5 mg/kg, twice/day.
Enoxaparin was started within 48 hours post admission for 2 groups.
Eq patients reached anti-Xa target initially in half of cases (Figure 2)

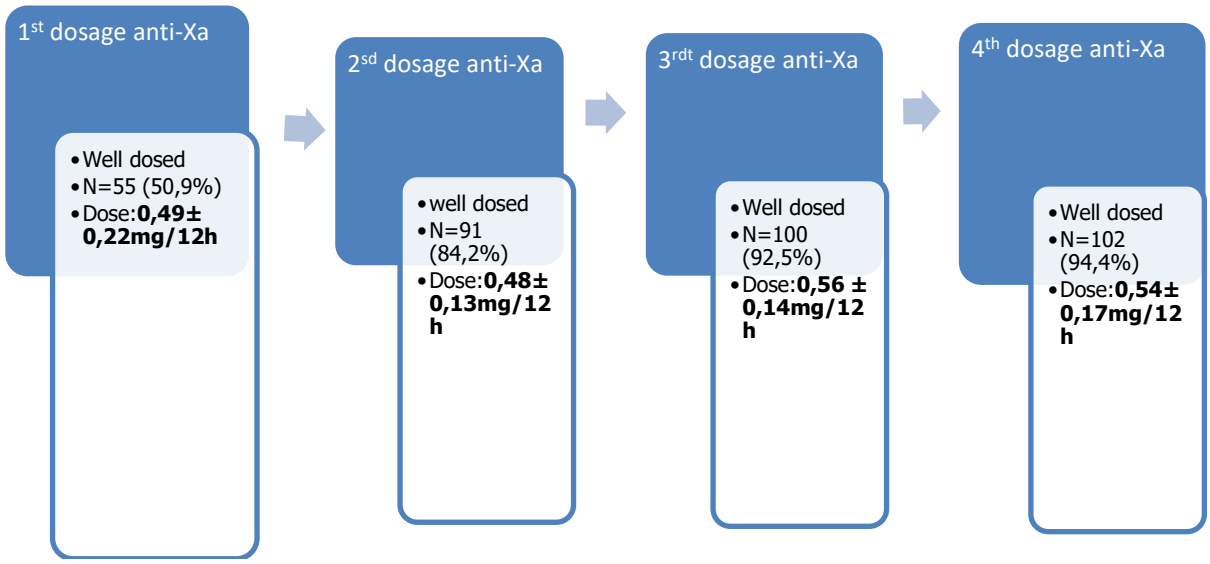

Figure 2. Percentage of patients who achieve target anti-Xa level

Thromboembolic complications:

- **Diagnosis**

Thromboembolic disease (VTE) was diagnosed at 15 days post-burn in the equation group and 08 days (range 6-10 days) in the non-equation group.

In Eq group, 15 patients had one or more criteria suggestive of VTE and were explored, compared with 22 patients in group 2. In all patients, the suspicion of thromboembolic complication was based on clinical, gasometric and biological criteria. Diagnostic confirmation was based on imaging.

Table 4. Clinical suspicion critera of VTBE

	Group 1 n=15	**Group 2 n=22**
Dyspnea (n)	7	10
Tachycardia (n)	5	4
Lower limb assymmetry (n)	1	4
Chest pain (n)	3	2
shock (n)	0	2

- Hypoxia-hypocapnia was noted in 03/15 patients for group 1 and in 05/22 patients for group 2.
- D-dimer level was 1200 ng/mL on the day of diagnosis in group 1 versus 3400 ng/mL in group 2.

Radiological investigation of VTBE

-Radiological confirmation of thromboembolic complication was based on the feasibility of the examination and patient's condition, and was performed on the same day or with a 24-hour delay (Table 4).

Table 4. Radiological investigation of VTBE

Radiological investigation	**Groupe 1 n=15**	**Groupe 2 n=22**
Thoracic CT angiography	10	15
Phleboscanner of limbs	1	3
Venous lower extremity doppler	1	4

- In group 1, there were:
  - 04 cases of pulmonary embolism confirmed by thoracic angioscan. Three patients did not benefit from radiological exploration, because of severity of state, before death.
  - 4 cases of peripheral thrombosis occuring in patients who had low anti-Xa levels, between 0.1 and 0.14 IU/mL.

-In group 2, there were:

  - 04 cases of pulmonary embolism confirmed by thoracic angioscan,
  - 05 cases of deep vein thrombosis confirmed by radiological explorations (phleboscan or Doppler ultrasound).

Correlation between Enoxaparin dose, total body surface area (TBSA) and weight:

Pearson's correlation showed an association between final Enoxaparin dose with weight (correlation=0.21; p=0.02 (Figure 3)) and with TBSA (correlation=0.25; p=0.009 (Figure 4)).

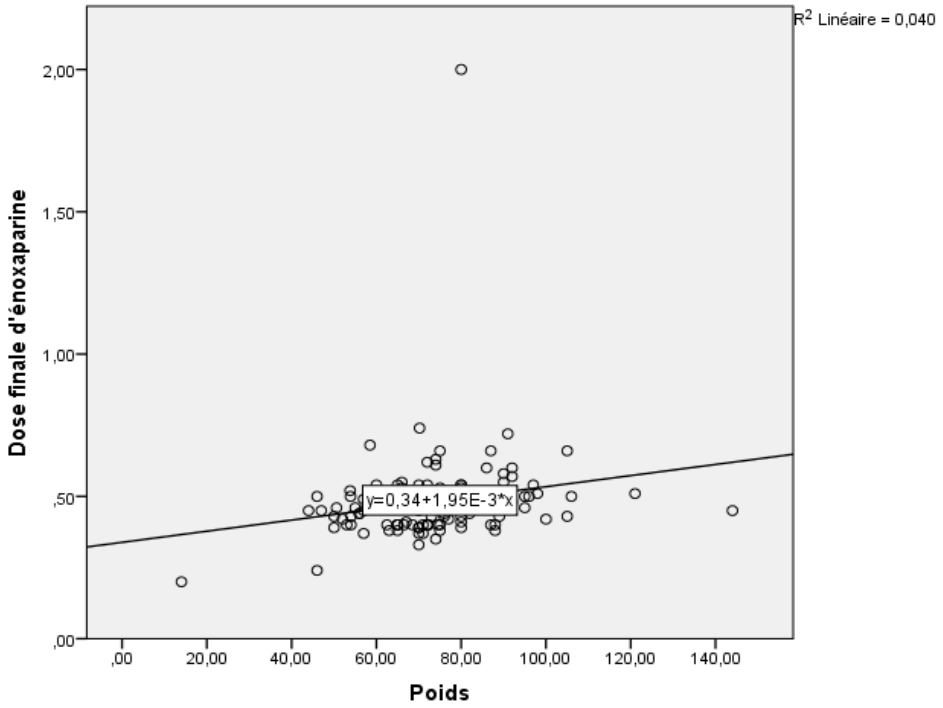

Figure 3: Correlation between dose of Enoxaparine and weight

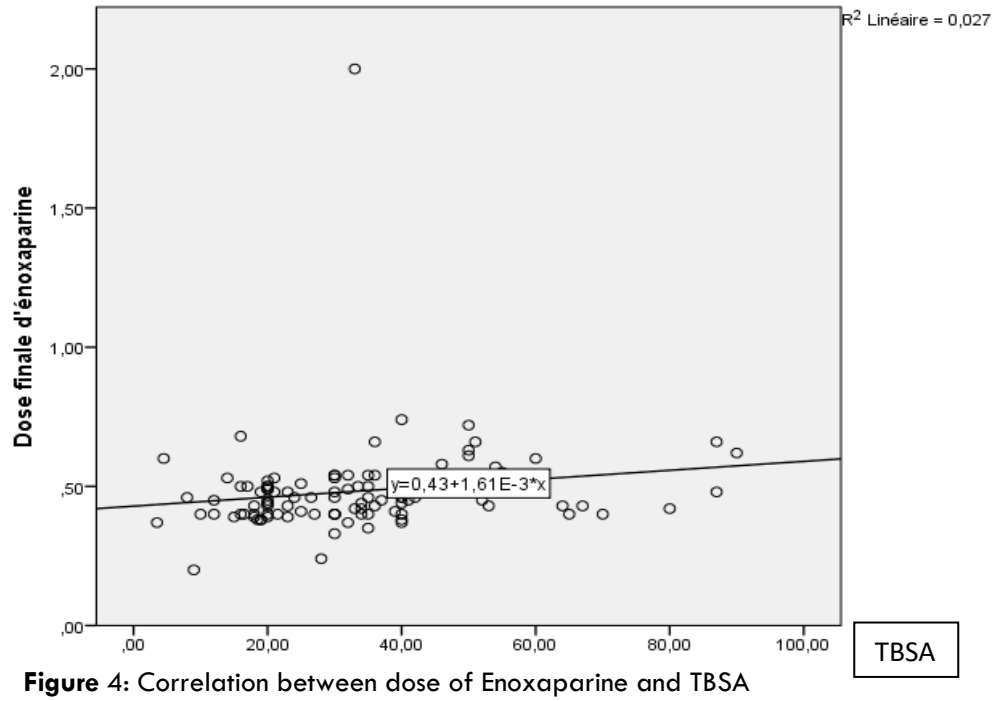

Figure 4: Correlation between dose of Enoxaparine and TBSA

Linear regression showed a relationship between increasing Enoxaparin dose with TBSA and weight (R^2=0.31; p=0.004).

Incidence of thromboembolic complications

The incidence of thromboembolic complications was higher in group 2 (8,3% versus 3,7%; OR=3.25; 95% CI [1.31-8.02],p= 0.001) (Table 5).

Table 5: Incidence of VTBE in 2 groups

	Group 1 n=108	Group 2 n=108	P
Thromboembolic complications, n (%)	4 (3,7)	9 (8,3)	0,001

Discussion

In the literature, the incidence of thromboembolic complication in burns differs from one study to another depending on whether it is retrospective or prospective, the severity of burned patients, and the modalities of prophylaxis. In addition, no study has assessed the efficacy of antithrombotic prophylaxis in burn patient (Table 6).

Table 6: Incidence of thromboembolic complications in the littérature

Study	Patients (n)	Méthode Diagnostique	Incidence of DVT	Type of Prophylaxis
Wahl et al[7]	327	Echographie Lower Extremity Venous	2,4%	Mechanical compression and UFH
Wahl et al[8]	30	Lower Extremity Venous	25%	UHF or mechanical compression
Fecher el al[9]	4102	Lower Extremity Venous	0,25%	UFH
Bushwitz et al[10]	1111	Lower Extremity Venous and phlébography	0,27%	UFH and LMWH

intravenous unfractionated heparin (UFH) / low molecular weight heparin (LMWH)

In the literature, modalities of preventive anticoagulation in burn patients are divergent and the major problem was the effectiveness of standard prophylaxis in preventing thromboembolic complications. In the United States, combined prevention is sometimes adopted, both mechanical and pharmacological with subcutaneous heparin[11]. In France, according to a study published in 2008 by Bertin-Maghit[12], standardization of thromboprophylaxis between different burn treatment centers (BTC), based on a stratification of thromboembolic risk in these patients was adopted. For severe patients with extensive burns exceeding 50% of the total body surface area (TBSA), preventive anticoagulation was either continuous intravenous unfractionated heparin (UFH) or low molecular weight heparin (LMWH). If the thromboembolic risk was low according to the Maghit classification, mechanical compression was used, and if the risk was intermediate, the choice was in favor of low molecular weight heparin (LMWH)[12]. Also, research has shown that inadequate antifactor Xa levels (anti-Xa) in severely burned patients may increase the risk of venous thromboembolic events (VTE). So, our study aims to evaluate the usefulness of an enoxaparin dosing using a previously published equation according to Burn Size and Weight in the prevention of thromboembolic risk. Two anticoagulation modalities in 2 groups of patients, matched in terms of age, sex, severity of burns and risk of thromboembolic complication, were compared. This allowed to achieve target antiXa levels and consequently reduced thromboembolic complications in Equation group compared with No. Equation group, i.e., 3,7% versus 8,3%, respectively (p = 0.001). There were no bleeding complications.

In our study, patients had a TBSA of 30% with a higher incidence of thrombosis than that reported by Pannucci et al[13]: 1.2% in patients with a TBSA of more than 10% versus 2.4% in those with a TBSA of more than 40-50%[13]. Furthermore, in our study, patients in Equation group who had thrombosis had a subprophylactic anti-Xa level at the time of DVT. So, subprophylactic anti-Xa level would be predictive of thromboembolic events. This result was simialr to that published by Cronin et al[4] who reported that the standard dose of enoxaparin (0.3 ml/12H) prescribed in a cohort of 393 burn patients resulted in inadequate for DVT prophylaxis with anti-Xa infra-prophylactic activity in 48.4% of burn patients. In addition, the overall incidence of thrombosis was 4% in the study population, suggesting that adjusting the dose of enoxaparin prophylaxis could reduce DVT rates in burn patients. In a large systematic review including 38 studies, 12 studies reported a

variable incidence of thrombosis ranging from 0.25 to 47.1%. The two largest retrospective studies (enrollment of 33.637 and 36.638 patients, respectively) reported an incidence of thromboembolic events of 0.61% and 0.8% in populations receiving thromboprophylaxis, but the doses were not specified[14]. Although the study by Cronin and al[4] was not powered to show a statistically significant reduction in DVT, it was reported that there were fewer DVTs in the anti-Xa monitoring group (6.6% versus 1.2%). These data suggest that pharmacological prophylaxis strategies are needed to provide high-risk patients with optimal thromboprophylaxis, including personalized initial dosing strategies with additional adjustment of enoxaparin dose based on anti-Xa levels.

Lin et al[15] attempted to evaluate the previously published equation for enoxaparin prophylaxis dosage based on the extent of burns and patient weight. They found that standard enoxaparin dosage of 30 mgQ12Hrs was not sufficient for VTE prophylaxis in burn patients. Initial antiXa levels were less than 0.2 U/mL in 76% of cases. Eighteen percent of patients never reached the target antifactorXa level before enoxaparin was stopped. The median final dose of enoxaparin required to achieve effective antifactorXa levels was 40 mg every 12 hours (range, 20 to 70 mg). They found that the Equation (Eq) group reached the anti-Xa target faster than the Non-Equation group (73% versus 32%; p = 0.002). In this study, no episodes of significant bleeding, thrombocytopenia, or heparin-associated allergy were documented in any of the patients. Also, no patient required additional surgery for graft loss associated with hematomas or had any abnormalities in planned surgical bleeding.

In studies of Lin and al[15,16] and Costantini[17], majority of patients had subtherapeutic anti-Xa levels while on enoxaparin 30 mg twice daily, suggesting inadequate VTE prophylaxis. Also, the number of patients with undetectable anti-Xa levels was also decreased in the Equation group versus the Non-Equation group prior to discontinuation of enoxaparin (3% vs. 29%; P = 0.006)[15].

Cronin and al[6] study's was included 157 patients receiving preventive anticoagulation with enoxaparin (30 mg twice daily). The anti-Xa target (0.2-0.4 IU/mL) was achieved in 51.6% of cases. Patients with low anti-Xa levels were more likely to be men with high BMIs. A similar equivalent result was reported by Mackinzie et al[18] where 42% of obese burn patients did not reach the target plasma anti-Xa peaks (0.2-0.5 IU/mL) under enoxaparin (40 mg twice daily). These patients were more male compared with nonobese ($P < 0.05$) and had increased mean body weight (129 ± 24 kg vs 110 ± 16 kg, $P < 0.05$). These two studies had the merit of confirming the correlation between enoxaparin dose and weight to achieve the anti-Xa target and therefore a potential reduction in TBE complications by adjusting anticoagulation to patient weight.

In burns, drug bioavailability may also be reduced due to altered peripheral perfusion, post-burn edema, and fluid resussitation. Standard doses of enoxaparin prescribed to burn patients yield highly variable anti-Xa levels. Fluid overload is associated with very low plasma anti-Xa levels. Frakalas's series[8] reported anti-Xa infra-prophylactic levels in patients in the acute phase with progressive achievement of distant targets. In addition, the highest level of anti-Xa (0.59U/ml) was reached 106 days post-admission, while the previous level of anti-Xa in this patient was 0.20U/ml at the same dose of 60mg Q12hours. There were no bleeding complications reported in this patient or in the study. The variability of anti-Xa values therefore requires follow-up monitoring of anti-Xa throughout hospitalization in patients with severe burns. Risk of venous thromboembolism in critically ill patients is multifactorial and is increased in the case of obesity[19]. Despite that almost half of the intensive care patients are overweight and a quarter are obese (body mass index [BMI] >30 kg/m2), no specific recommendation exists to date. This is mainly due to the lack of randomized studies in this population. It has been shown that a dosage of 40 mg of enoxaparin does not provide satisfactory anti-Xa activity in obese patients. Some studies have reported a correlation between BMI and anti-Xa, such as that of Iris Frakalas et al[6], which found a Pearson correlation between BMI and the final dose of enoxaparin, with a linear regression confirming a correlation between increasing enoxaparin doses and increasing BMI. Rostas and al[20] were reported that among the risk factors influencing the pharmacokinetics and final dose of enoxaparin to achieve adequate anti-Xa, BMI was significant ($r=0.529$; $p=0.007$). This result was controversial in another study[21] that reported an inverse correlation between anti-Xa levels and BMI in hospitalized ICU patients receiving enoxaparin at a dose of 40 mg per day. David Jiménez et al[22] performed an anti-Xa assay in 112 patients, who received preventive anticoagulation, at a dose of 40mg/d with an anti-Xa assay after the 3rd dose, the patients were divided into 4 groups

according to their BMI. The mean anti-Xa was significantly lower in the group with a higher BMI (for a BMI< 23 kg/m2, the mean anti-Xa was 0.28 versus anti-Xa=0.13 for a BMI > 29.6kg/m2, p<0.001). Only BMI was significantly associated with anti-Xa activity (OR 1.14; 95% CI [1.05-1.24]; p<0.002) after adjustment for age, sex, and creatinine.

In burn patients, complexity of the pathology, multiple invasive therapeutic and monitoring methods lead to a systemic inflammatory response and predispose these patients to the risk of thromboembolic complications[23]. Therefore, we recommend the use of systematic pharmacological preventive anticoagulation associated or not with mechanical preventive measures. This anticoagulation is not standardized for all patients. In addition, taking into account the interindividual variations due to the variations in the weight of the patients and to the increase in the volume of distribution, affecting the protein transport and the glomerular filtration of anticoagulants, dose of anticoagulation prescribed must take into account the body weight of the subject and the extent of burns, as predicted by the equation adopted in our study: Dose of Enoxaparin in mg/12H = 22. 8 + (3.3 × % TBSA/10) + (1.89 × (Weight in kg)/10).

Conclusion: In burns, Enoxaparin dosing equation significantly increased the frequency of obtaining a prophylactic initial anti-Xa level. It was associated with a low incidence of VTE events and resulted in no bleeding complications. Enoxaparin dosing correlates strongly with burn size and patient weight. Thus, a standard dose for all adult acute burn patients is not recommended. In addition, continuous monitoring of anti-Xa activity should be instituted to reach the target range, with a level of 0.2 - 0.4 IU/ml, thus reducing the incidence of thromboembolic complications, a result demonstrated in our study (3,7% in the equation group versus 8,3% in the non-equation group).

References

1. Siah S, El Farouki A. Prévention de la maladie thromboembolique veineuse chez le brûlé. Ann Burns Fire Disasters. Juin 2014;27(2):76-81.
2. Rue LW, Cioffi WG, Rush R, McManus WF, Pruitt BA. Thromboembolic complications in thermally injured patients. World J Surg. 1992 Nov;16(6):1151-4.
3. Mayou BJ, Wee J, Girling M. Deep vein thrombosis in burns. Burns. 1981 Oct;7(6): 438-40.
4. Cronin BJ, Godat LN, Berndtson AE, Pham A, Kolan S, Box K, et al. Anti-Xa guided enoxaparin dose adjustment improves pharmacologic deep venous thrombosis prophylaxis in burn patients. Burns. 2019 Jun;45(4):818-24.
5. Malinoski D, Jafari F, Ewing T, Ardary C, Conniff H, Baje M, et al. Standard prophylactic enoxaparin dosing leads to inadequate anti-Xa levels and increased deep venous thrombosis rates in critically ill trauma and surgical patients. J Trauma. 2010 Apr;68(4):874-80.
6. Faraklas I, Ghanem M, Brown A, Cochran A. Evaluation of an enoxaparin dosing calculator using burn size and weight.J Burn Care Res. 2013 Nov;34(6):621-7.
7. Wahl WL, Brandt MM. Potential risk factors for deep venous thrombosis in burn patients. J Burn Care Rehabil. 2001 Mar;22(2):128-31.
8. Wahl WL, Brandt MM, Ahrns KS, Zajkowski PJ, Proctor MC, Wakefield TW, et al. Venous thrombosis incidence in burn patients: preliminary results of a prospective study. J Burn Care Rehabil. 2002 Mar;23 (2):97-102.
9. Fecher AM, O'Mara MS, Goldfarb IW, Slater H, Garvin R, Birdas TJ, et al. Analysis of deep vein thrombosis in burn patients. Burns. 2004 Sep;30(6):591-3.
10. Bushwitz J, Leclaire A, He J, Mozingo D. Clinically significant venous thromboembolic complications in burn patients receiving unfractionated heparin or enoxaparin as prophylaxis. J Burn Care Res. 2011 Nov;32(6):578-82.
11. Ganau M, Ligarotti GI, Meloni M, Chibbaro S. Efficacy and safety profiles of mechanical and pharmacological thromboprophy -laxis. Ann Transl Med. 2019 Sep;7 Suppl 6:224.
12. Bertin Maghit M, Bargues L, Jaber S, Braye F, Marduel YN. Prévention de la maladie thromboembolique veineuse chez le brûlé. Ann Fr Anesth Reanim. Août2005;24(8):947-50.
13. Pannucci CJ, Osborne NH, Wahl WL. Venous thromboembolism in thermally injured patients: analysis of the national burn repository.J Burn Care Res. 2011 Jan;32(1):6-12.
14. Liu A, Minasian RA, Maniago E, Justin Gillenwater T, Garner WL, Yenikomshian HA. Venous thromboembolism chemoprophylaxis in burn patients: a literature review and single-institution experience. J Burn Care Res. 2021 Feb;42(1):18-22.
15. Lin H, Faraklas I, Saffle J, Cochran A. Enoxaparin dose adjustment is associated with low incidence of venous thromboembo-lic events in acute burn patients. J Trauma. 2011 Dec;71(6):1557-61.
16. Lin H, Faraklas I, Cochran A, Saffle J. Enoxaparin and antifactor Xa levels in acute burn patients. J Burn Care Res. 2011 Jan;32(1):1-5.
17. Costantini TW, Min E, Box K, Tran V, Winfield RD, Fortlage D, et al. Dose adjusting enoxaparin is necessary to achieve adequate venous thromboembolism prophylaxis in trauma patients. J Trauma Acute Care Surg. 2013 Jan;74(1):128-33.
18. McKinzie BP, Nizamani R, Jones S, King B, Williams FN. Single-center experience with venous thromboembolism prophylaxis for obese burn patients. J Burn Care Res. 2021 May;42(3):365-8.
19. Hirsch DR, Ingenito EP, Goldhaber SZ. Prevalence of deep venous thrombosis among patients in medical intensive care. J Am Med Assoc. 1995 Jul;274(4):335-7.
20. Rostas JW, Brevard SB, Ahmed N, Allen J, Thacker D, Replogle WH, et al. Standard dosing of enoxaparin for venous thromboembolism prophylaxis is not sufficient for most patients within a trauma intensive care unit. Am Surg. 2015 Sep;81(9):889-92.
21. Priglinger U, Delle Karth G, Geppert A, Joukhadar C, Berger R, Hülsmann M, et al. Prophylactic anticoagulation with low dose enoxaparin: is the subcutaneous route appropriate in the critically ill? Crit Care Med. 2003 May;31(5):1405-9.
22. Jiménez D, Díaz G, Iglesias A, César J, García Avello A, Martí D, et al. Anti-factor Xa activity of enoxaparin for thromboprophylaxis in nonsurgical patients is dependent on body mass. Arch Bronconeumol. 2008 Dec;44(12):660-3.
23. Harrington DT, Mozingo DW, Cancio L, Bird P, Jordan B, Goodwin CW. Thermally injured patients are at significant risk for thromboembolic complications. J Trauma 2001;50:495.