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Epidemiological Profile and Thromboembolic Risk Factors in Algeria

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Abstract

Background: Postoperative venous thromboembolic disease (VTE) represents a major complication in surgery. Although the effectiveness of thromboprophylaxis is well established, adaptation of international recommendations to the Algerian context remains poorly documented.

Objective: To analyze the epidemiological profile and thromboembolic risk factors in an Algerian population to justify the development of an adapted national protocol.

Methods: Prospective bi-centric study (October 2015–January 2019) involving 819 patients (432 orthopedic surgery, 387 visceral surgery including 114 cancer cases) who received thromboprophylaxis according to a protocol combining the SFAR classification and Caprini score.

Results: The study population exhibited distinct characteristics: Young mean age (42.6 years), 64% < 46 years, sex ratio of 1.5, obesity rate of 26%. Over 70% presented at least one risk factor. Moderate to high thromboembolic risk concerned 86.2% of patients according to our protocol versus 76.1% (SFAR) and 60.5% (Caprini). The incidence of VTE was 0.12% with excellent tolerance (adverse effects < 6%). Therapeutic adherence reached 91.5%.

Conclusion: Algerian epidemiological specificities (young population, high prevalence of obesity and smoking) justify the development of adapted national recommendations. Our protocol, validated on a large cohort, could serve as the basis for these recommendations.

Keywords: Venous Thromboembolism, Surgery, Algeria, Epidemiology, Thromboprophylaxis, Recommendations

1. Introduction

Venous thromboembolic disease (VTE) constitutes a formidable complication in the perioperative setting, responsible for significant morbidity and mortality. Since Kakkar's pioneering work in 1972, preventive heparin therapy has become the standard of care, evolving from unfractionated heparins (UFH) to low molecular weight heparins (LMWH) [1]. However, current international recommendations are essentially based on data from Western populations, with their specific habits and characteristics. Recent studies suggest that VTE incidence varies according to racial and environmental factors [2]. A Taiwanese study notably reported very low rates of thromboembolic events after prosthetic orthopedic surgery without pharmacological prophylaxis [3].

In Algeria, despite publication of the ENDORSE study in 2008 showing heterogeneous thromboprophylaxis practices (90% in orthopedics versus < 50% in visceral surgery) [4], no comprehensive national recommendations exist, except for cancer patients [5]. This situation raises several questions: Are international protocols adapted to our population? What are our epidemiological specificities? How can we develop a rational and safe approach?

This study aims to analyze the epidemiological profile and thromboembolic risk factors in an Algerian population undergoing orthopedic and visceral surgery, to justify the development of an adapted national protocol.

2. Materials and Methods

2.1 Study Design

Prospective, open, bi-centric study conducted between October 2015 and January 2019 in two institutions: the Central Army Hospital in Algiers and the Public Hospital Establishment of Laghouat.

2.2 Study Population

Inclusion criteria:

- Age ≥ 18 years
- ASA classification I, II or III
- Orthopedic/trauma or visceral/abdominal surgery with thromboembolic risk

Exclusion criteria:

- Age < 18 years
- Pregnancy

Sample size: Calculation was performed according to the formula $N = \alpha^2pq/i^2$ with α=1.96, p=5% (clinical proximal DVT rate), i=1.5%, yielding a minimum of 811 patients.

2.3 Thromboprophylaxis Protocol

The developed protocol combines:

- SFAR classification (surgical stratification into 3 levels: low, moderate, high)
- Caprini score (fine stratification of patient risk factors)

Dose adaptation according to weight:

- < 50 kg: half-dose (20 mg enoxaparin)
- 50-100 kg: standard dose (40 mg enoxaparin)
- 100 kg: increased dose (60 mg enoxaparin)

Treatment durations:

- Prosthetic orthopedic surgery: 5 weeks
- Pelvic fracture/polytrauma: 1 month
- Oncological visceral surgery: 1 month
- Other surgeries: 7-21 days according to risk

2.4 Data Collection

A standardized form included demographic data (age, sex, BMI), medical-surgical history, thromboembolic risk factors, type of surgery and risk classification, prescribed thromboprophylaxis (molecule, dose, duration), therapeutic adherence, adverse effects, and thromboembolic events. Three-month postoperative telephone follow-up was performed to detect any thromboembolic event or remote adverse effect.

2.5 Statistical Analysis

Qualitative variables were expressed as numbers and percentages, quantitative variables as means ± standard deviation with 95% confidence intervals. Comparisons used the Chi-square test for qualitative variables and Student's t-test for quantitative variables. A threshold of $p < 0.05$ was considered statistically significant.

3. Results

3.1 Population Characteristics

819 patients were included, evenly distributed between orthopedic surgery (52.7%, n=432) and visceral surgery (47.3%, n=387), including 114 oncological surgeries (13.9%).

3.1.1 Demographic Data

Age: Mean age was 42.6 ± 16.4 years (range: 19-85 years) with a particularly young distribution: 64% < 46 years. The distribution by age groups was: 18-30 years (25.5%), 31-45 years (38.6%), 46-60 years (20.5%), 61-75 years (12.6%), and > 75 years (2.8%).

Distribution by type of surgery showed significant differences ($p < 0.001$): orthopedic surgery had a mean age of 41.8 years with 69.2% < 46 years, visceral surgery had a mean age of 43.4 years with 58.4% < 46 years, and oncological surgery had a mean age of 45.8 years with 44.8% < 46 years.

Sex: Overall sex ratio was 1.5 (M/F) with 63.9% men (n=523) and 36.1% women (n=296). Distribution varied significantly by type of surgery ($p < 10^{-3}$): orthopedic surgery was 77.8% men (due to trauma), visceral surgery showed parity (48.3% men), and oncological surgery had a female majority (62.3%).

Body Mass Index (BMI): Mean BMI was 26.17 ± 2.48 kg/m². Obesity (BMI ≥ 30) affected 25.6% of patients, overweight (BMI 25-29.9) 0.1%, and 74.2% had normal BMI. Obesity was particularly prevalent in oncological surgery (30.7%) compared to orthopedic surgery (24.1%) and visceral surgery (27.4%).

3.1.2 Medical-Surgical History

Medical history: 69.1% had no medical history, while 16.5% had cardiovascular pathologies (hypertension 6.3%, diabetes 3.4%, diabetes + hypertension 4.6%, other cardiovascular pathologies 12.2%), and 1.4% had respiratory insufficiency. The prevalence of comorbidities increased significantly in oncological surgery (52.6% with history) versus orthopedic surgery (24.3%) and visceral surgery (38.2%) ($p < 10^{-3}$).

Surgical history: 63.1% had no surgical history, 21.4% had previous major surgery, and 15.5% had previous minor surgery. In oncological surgery, 46.5% of patients had surgical history, including 36% major surgery.

3.1.3 Thromboembolic Risk Factors

Over 70% of patients presented at least one risk factor. The most frequent were:

- **Smoking:** 27.1% (most frequent factor), particularly high in orthopedics (27.1%) versus visceral (8.8%).
- **Obesity:** 25.6% (second factor), equally distributed across specialties.
- **Preoperative bed rest:** 8.2%, more frequent in orthopedics (6.5%) than visceral (1.8%).
- **Active cancer:** 13.9%, by definition concentrated in oncological surgery.
- **Care-related factors:** chemotherapy 2.2%, hormone therapy 1.3%, parenteral nutrition 0.5%, mechanical ventilation 0.5%.

The distribution of risk factors varied significantly by type of surgery ($p < 10^{-3}$): no risk factors in orthopedics 39.3%, visceral 53.1%, oncology 34.2%; ≥ 2 risk factors in orthopedics 15.2%, visceral 10.8%, oncology 21.9%.

3.2 Thromboembolic Risk Stratification

3.2.1. Comparison of Three Classifications

Risk Level	SFAR	Caprini	Our Protocol
Low	23.9%	39.4%	13.8%
Moderate	40.7%	29.5%	42.3%
High	35.4%	31.1%	43.9%
Moderate + High	**76.1%**	**60.6%**	**86.2%**

The difference between the three classifications is highly significant ($p < 10^{-3}$), with our protocol identifying 25.6% additional high-risk patients compared to the Caprini score.

3.3 Thromboprophylaxis Practices

87.4% of patients received pharmacological thromboprophylaxis (n=716): orthopedic surgery 96.5%, visceral surgery 77.3%, and oncological surgery 100%. Enoxaparin was used in 100% of cases with standard dose

40 mg (82.4%), increased dose 60-80 mg (13.0%), and reduced dose 20 mg (4.6%). Overall mean duration was 16.5 ± 9.1 days.

3.4 Adherence and Safety

Overall adherence reached 91.5% (n=750), with better compliance in orthopedic surgery (97.7%) compared to visceral (84.8%) and oncological surgery (85.1%) ($p < 10^{-3}$). The overall rate of lost to follow-up was 6.6%, below the acceptable threshold of 12%.

Overall adverse effect incidence was 5.2% (n=43/819), including minor bleeding 4.2%, major bleeding 0.24%, heparin-induced thrombocytopenia (HIT) 0.12%, and no skin necrosis. These rates are lower than reported in the literature, testifying to the protocol's safety.

3.5 Efficacy: Thromboembolic Events

One death from pulmonary embolism occurred (0.12%): a visceral surgery patient with proximal venous thrombosis complicated by massive PE, occurring after premature discontinuation of thromboprophylaxis. No other symptomatic thromboembolic event was documented during the 3-month follow-up. These results are highly encouraging when compared to expected incidences with prophylaxis (orthopedic surgery 1-3%, visceral surgery 0.5-2%, oncological surgery 2-5%).

4. Discussion

4.1 Algerian Epidemiological Specificities

4.1.1 A Young Population

Our study reveals a surgical population significantly younger than Western cohorts: mean age 42.6 years versus 55-65 years in European/American studies, 64% < 46 years versus 30-40% typically, and only 2.8% > 75 years versus 15-25% in Western series.

This demographic particularity has several important implications. First, regarding baseline thromboembolic risk: VTE risk increases exponentially with age, multiplied by 2-5 between ages 40 and 80 [6]. A younger population therefore presents lower baseline risk, which could justify different intervention thresholds. Second, young patients demonstrate better postoperative rehabilitation with earlier ambulation, fewer comorbidities limiting mobilization, and faster functional recovery factors that naturally reduce thromboembolic risk. Third, the male (77.8%) and young predominance in orthopedics reflects significant trauma activity, contrasting with Western series dominated by prosthetic surgery in elderly subjects.

4.1.2 High Prevalence of Obesity

The 26% obesity rate in our cohort is particularly concerning, equivalent to Western countries and increasing compared to previous Algerian surveys (15-20% in 2000-2010), particularly high in oncological surgery (30.7%).

Obesity multiplies VTE risk by 2-3 through several mechanisms: venous compression by abdominal adiposity, chronic pro-inflammatory state, hypofibrinolysis, and increased coagulation factors (factor VIII, fibrinogen) [17, 18]. Pharmacologically, obesity modifies LMWH pharmacokinetics through increased volume of distribution and relative under dosing at standard doses, necessitating weight adaptation. Our protocol recommends 50% increase (60 mg) beyond 100 kg, but only 44% of obese patients received it, indicating a major improvement axis.

4.1.3 Massive Smoking

The 27.1% active smokers, particularly in male orthopedic surgery (> 30%), constitutes an often underestimated risk factor. Smoking promotes thrombosis through endothelial dysfunction, increased blood viscosity, elevated fibrinogen, and platelet activation [19]. Its frequent association with obesity (5.7% present both risk factors) creates synergistic risk justifying reinforced thromboprophylaxis.

4.2 Justification for an Adapted Protocol

International recommendations show considerable heterogeneity. Our comparative analysis reveals major divergences between the main learned societies. For total knee arthroplasty, among 13 analyzed learned societies, 4 accept aspirin as prophylaxis, durations range from 7 to 35 days, and recommendations vary in strength [7, 8]. For ankle surgery, SFAR recommends prophylaxis until weight-bearing (6-12 weeks) while ACCP recommends prophylaxis only if associated risk factors are present—a prescription gap of 1 to 12 weeks.

Furthermore, these recommendations are often inadequate to the Algerian context. Intermittent pneumatic compression (IPC), recommended in association with pharmacological prophylaxis, is not available in the majority of Algerian structures. Enhanced Recovery after Surgery (ERAS) protocols, which significantly reduce thromboembolic risk, are not implemented. LMWH monitoring through anti-Xa activity assay is not routinely accessible, requiring empirical dose adaptation. Socio-economic specificities including treatment costs affecting compliance, geographic accessibility to follow-up, and variable health education levels further complicate implementation of international protocols.

4.2.1 Advantages of Our Hybrid Approach

Our protocol combines SFAR simplicity (surgical classification in 3 levels familiar to Algerian practitioners with francophone training, easy integration into anesthesia consultation) with Caprini precision (fine stratification of patient risk factors with > 40 items, weighting of factors according to importance, numerical score allowing objective follow-up). This synthesis maintains ease of use while improving stratification precision and adapting to local particularities.

4.2.2 Validation by Our Results

Our results demonstrate proven efficacy with VTE incidence of 0.12% (1 single case after premature discontinuation), lower than expected rates (1-3% in orthopedics, 0.5-2% in visceral), comparable to best international series. Safety is demonstrated with adverse effects of 5.2% (mostly minor), major bleeding 0.24% (versus 0.5-2% in literature), HIT 0.12% (versus 0.2-0.5%), and no hemorrhagic death. The favorable benefit/risk ratio shows 1 fatal VTE prevented per 100 treated patients (estimate) with < 0.5 serious complications per 100 treated patients, yielding a benefit/risk ratio > 200:1. High adherence of 91.5% (versus 70-85% in European studies) testifies to protocol acceptability and facilitates long-term compliance.

4.3 Detailed Comparison of Classifications

Our protocol shows overall proximity to SFAR (moderate-high risk 86.2% versus 76.1%, difference of +10.1 points) but with important refinements. The main divergences include reduced low risk (13.8% versus 23.9% SFAR, -10.1

points) and increased high risk (43.9% versus 35.4% SFAR, +8.5 points). We reclassify 'low' SFAR surgeries as 'moderate' when age > 60 years, severe obesity (BMI > 35), ≥ 2 associated risk factors, or even localized cancer is present.

Compared to Caprini, major divergences exist with moderate-high risk 86.2% versus 60.6% Caprini, a difference of +25.6 points (very significant). Low risk is overestimated by Caprini (39.4% versus our 13.8%, -25.6 points) due to insufficient surgical weighting, cancer underestimation, and excessively high point thresholds. In oncological surgery, this is most problematic: 14% of cancers are classified 'low' by Caprini versus 0% by our protocol, a dangerous discordance with scientific consensus recommending extended prophylaxis (28-30 days) after abdominal cancer surgery [12, 13].

4.4 Limitations and Perspectives

Study limitations include absence of systematic screening (no systematic postoperative Doppler ultrasound, risk of underestimating asymptomatic DVTs), limited follow-up duration (3-month surveillance, VTEs can occur up to 6-12 months), selection bias (university centers, population possibly different from regional hospitals), lost to follow-up (6.6%, acceptable but higher in visceral 11.4% and oncological 12.3%), and absence of control group (non-comparative design, impossible to formally prove superiority).

Research perspectives include multicentric extension (5-10 centers including 2000-3000 patients to validate in different contexts), randomized comparative study (comparing our protocol versus strict SFAR versus Caprini), medico-economic evaluation, study on asymptomatic DVTs with systematic Doppler ultrasound, and analysis of genetic specificities including prevalence of thrombophilias in Algeria.

4.5 Implications for Clinical Practice

This study provides foundations for developing Algerian recommendations with validated elements including adapted risk stratification, weight-adjusted doses, and precise durations by type of surgery, and demonstrated safety and efficacy. The recommended process includes constitution of a multidisciplinary group (anesthesiologists-intensivists, orthopedic surgeons, visceral surgeons, hematologists, vascular physicians, methodologists), consensual adaptation, validation by learned societies, and dissemination and training through regional workshops and educational materials.

Practical implementation requires necessary tools including standardized anesthesia consultation forms, decision algorithm wall posters, mobile applications for patients (intake reminders, self-injection videos, warning signs, direct contact with team), and a computerized national registry for event surveillance and continuous improvement.

4.5.1 Economic Aspects

Average cost of prophylaxis per patient ranges from ~2000 DZD (~15 €) for enoxaparin 40 mg × 14 days to ~6000 DZD (~45 €) for enoxaparin 60 mg × 28 days. Average cost of VTE ranges from ~50,000 DZD for uncomplicated DVT to > 1,000,000 DZD for severe PE, not counting indirect costs (work stoppage, disability), post-thrombotic syndrome (15-50% of DVTs), quality of life impact, and medicolegal costs. Cost-effectiveness ratio shows that for 100 treated patients (~200,000 DZD for 14-day prophylaxis), 2-5 VTEs are prevented with savings of 100,000 to 1,000,000 DZD, yielding a benefit/cost ratio of 5 to 50:1. Economic conclusion: prophylaxis is highly cost-effective, even with extended durations.

4.6 International Context and Originality

Our results (0.12% VTE) are among the best reported internationally. When compared to recent studies—Allen 2016 (USA polytrauma: 2.1%), Shibuya 2012 (USA foot/ankle: 0.28%), Makhdom 2013 (Canada Achilles tendon: 3.8%), Cassidy 2016 (USA visceral: 1.2%), ENOXACAN 1997 (Europe oncology: 1.8%), Rasmussen 2006 (Denmark visceral: 0.4%) [14-22] our ultra-low incidence may reflect protocol efficacy, young population with lower baseline risk, and possibly under-detection in absence of systematic screening.

Our approach demonstrates several innovative scientific contributions: first validated protocol in Algeria on a large scale combining orthopedic and visceral surgery with population reflecting national diversity; innovative hybrid approach representing unprecedented SFAR + Caprini synthesis adaptable to other contexts (Maghreb, sub-Saharan Africa); systematic weight adaptation with validation of increased dose safety; surgery-specific durations filling a gap in SFAR recommendations; and data on North African population where regional data are quasi-absent.

The approach is transferable to other Maghreb/African countries with expected similarities (demographic structure with young population, increasing obesity prevalence, limited resources, francophone physician training in Maghreb) but requiring necessary adaptations (molecule availability, local costs, genetic specificities). We propose collaboration through Maghreb multicentric study, protocol validation in Tunisia and Morocco, development of regional recommendations, and publication in international journals.

5. Conclusion

This study of 819 patients demonstrates that the Algerian surgical population presents epidemiological characteristics distinct from Western cohorts on which international recommendations are based.

Major specificities include:

- Young population (mean age 42.6 years, 64% < 46 years).
- High prevalence of obesity (26%) and smoking (27%).
- Low rate of comorbidities (69% without history).
- Marked trauma profile in orthopedics.

These particularities, combined with local constraints (absence of effective mechanical means, ERAS programs, anti-Xa assay), fully justify the development of adapted national recommendations.

Our protocol, an innovative synthesis of SFAR and Caprini approaches, demonstrated remarkable efficacy (0.12% VTE versus 1-3% expected), excellent tolerance (5.2% adverse effects, 0.24% serious complications), high adherence (91.5%), and applicability in university and regional centers.

Scientific contributions include:

- Validation on large prospective cohort (> 800 patients).
- More discriminating risk stratification than Caprini (high risk: 43.9% versus 31.1%).

- Systematic weight adaptation demonstrated safe.
- Definition of precise surgery-specific durations.

Practical implications: This work provides scientific foundations for development of consensual Algerian recommendations, improvement of thromboprophylaxis practices (still heterogeneous), practitioner training (validated educational tools), extension to other surgical specialties, and potential Maghreb/African collaboration.

Perspectives include:
- Multicentric extension (2000-3000 patients)
- Randomized comparative study (our protocol vs. SFAR vs. Caprini)
- In-depth medico-economic evaluation
- Investigation of Algerian thrombophilias
- National recommendations within 2-3 years

In conclusion, our results demonstrate that a rational approach, adapted to epidemiological specificities and local constraints, allows achieving excellence in thromboprophylaxis. It is now time to move from this monocentric experience to a national policy, through the development of Algerian recommendations by learned societies, to harmonize and optimize practices throughout the territory.

Venous thromboembolic disease is neither inevitable nor an acceptable complication. It is preventable in more than 95% of cases through rigorous risk stratification and adapted prophylaxis. Our data prove it: with a simple protocol, applied, explained, and followed, incidence can be reduced to exceptionally low rates (0.12%), even in a resource-limited context.

6. Conflict of Interest

The authors declare no conflict of interest related to this article.

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Author Contributions

- Study conception and design: Prof. Ferhat Slimane
- Data collection: Investigative Team
- Statistical analysis: Research Team
- Manuscript writing: Prof. Ferhat Slimane
- Critical revision: Dr. Lyes Cherfi, Dr. Mohamed Matouk

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