



A new score assessing the surgical wound of a TKA and its relation with pain, infection and functional outcome

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The aim of this study was to describe a new score to evaluate the clinical aspect of the TKA surgical wound and to correlate it with postoperative pain, infection and functional outcome at 1 year of follow-up. This score, ranging from 0 to 10, assessed 5 parameters ; swelling, haematoma, erythema, blood drainage and blisters. One hundred fifty-nine consecutive TKA were prospectively evaluated. Intra and inter-rate reliability was superior to 0.9. No differences were obtained comparing the aspect of the surgical wound with postoperative pain or functional outcomes. Incidence of deep infection is directly related with an increased score ($p = 0.0025$).

Keywords : total knee arthroplasty ; surgical wound ; functional outcomes ; score ; TKA.

INTRODUCTION

Total Knee Arthroplasty (TKA) is a very common procedure in orthopaedic departments because it is a successful treatment for knee osteoarthritis. Different variables, such as quadriceps strength (11), preoperative range of motion (ROM) (8) or obesity (6,20), have been described as preoperative predictors of long-term TKA outcomes. However, the aspect of the surgical wound in the first days has not been taken into account as a predictor of TKA outcomes.

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Some factors have been correlated with the evolution of wound healing such as tissue perfusion, age or co-morbidities among others (6). Nowadays, the importance of a correct care of the soft tissues during and after surgery is well recognized. In daily practice, surgeons handle a large number of surgical wounds and although the same procedure has been

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followed, their aspect varies considerably. Therefore, physicians closely follow the surgical wound after the operation.

As far as the authors know, no studies in the literature have measured the aspect of a surgical wound and its potential relationship to the outcomes of the performed procedure. Currently, surgical wounds are described based on physician's subjective opinions in the absence of an objective score. Several scores have been described that quantify the cosmetic result of the surgical wound (13,14) and others have tried to assess the scar aspect (1,2,13). However, none of these scores consider objective parameters to describe these surgical wounds. In our department, TKA surgical wounds are first uncovered at 48 hours after the surgery and many variables such as ecchymosis, blood draining or swelling are normally used to describe and analyze their aspect.

Therefore, a study hypothesizing that the aspect of the surgical wound could be related to the different outcomes of TKA was performed. The aims of this study were ; 1) to design an objective score to evaluate the surgical wound aspect 2) to check and compare functional outcome of the TKA at 1 year follow-up with the aspect of the surgical wound at 48 hours after the surgery and 3) to assess the relation between the aspect of the surgical wound with pain in the immediate postoperative period as well as the incidence of TKA infection.

MATERIALS AND METHODS

Study design and population

An observational prospective study was designed including all TKA operated by the same surgical team in the same centre during a recruitment period of 6 months. Osteoarthritis was the diagnosis in all but 7 patients in the sample. In these 7 patients, rheumatic arthritis was the diagnosis. The exclusion criteria were ; 1) significant deformities of the mechanical axis of the leg (varus superior to 20°, valgus superior to 15° or extension deficits superior to 15°), 2) intra or postoperative periprosthetic fractures and 3) major medical complications during the hospital stay such as myocardial infarction, pulmonary thromboembolism or important cognitive disorders.

Preoperative analysis

The preoperative variables considered were ; 1) medical history (diabetes mellitus, rheumatic disease, peripheral vasculopathy or cardiovascular disease) 2) Range of motion (ROM) measured with a manual goniometer 3) mechanical axis measured with the computer system PACS (Picture Archiving and Communication System) and 4) Knee Society Score (KSS).

Surgical procedure

Patients were operated in the same operating room by the same surgical team. All patients received prophylactic antibiotics (cephazoline 2 gr ev. or vancomycin 1 gr ev. in peniciline allergic patients). All patients received intradural anaesthesia and were operated on under tourniquet at a pressure of 350 mmHg with previous exsanguination. An anterior longitudinal approach and parapatellar medial capsulotomy were made in all cases. The prosthetic models used in all cases were : Triathlon® (Stryker, Kalamazoo, MI, USA) or Genutech® (Surgival, Valencia, Spain). Moreover, time under tourniquet and the use of femoral or tibial stems was also registered.

Postoperative analysis

The mean hospital stay was 7 days. All patients received 24 hours postoperative antibiotic prophylaxis and intravenous (IV) analgesia for 48 hours. After that, an oral analgesic protocol was followed. Antithrombotic prophylaxis (bemiparine 3500 IU/24 hours) was maintained for 30 days after surgery. The rehab protocol was initiated at 24 hours after surgery with passive movements of the knee using a CPM machine (Kinetec® Spectra Knee CPM) which progressively increased flexion for the first week to achieve the maximum possible ROM. Patients were allowed weight bearing the second day after the surgery.

Pain was assessed using the "Visual Analog Scale" (VAS) every 8 hours for the first three postoperative days. The mean and the maximum values were considered. The intravenous analgesic protocol consisted of : paracetamol 1 gr/6 hours IV, and dexketoprofen 50 mgr/12 hours IV for the first 48 hours. Subsequently, an oral protocol was set up consisting of paracetamol 1 gr/6hours and ibuprofen 600mgr/6hours. In both cases, 1 mgr/Kgr/hour of morphine subcutaneously divided into 4 doses was scheduled as rescue analgesia.

During the hospital stay, complications related to the surgical wound and the suspicions of wound infection were reported. The patients continued with the rehab protocol over the following 2 weeks.

Surgical Wound Aspect Score (SWAS)

The surgical wound was first uncovered at 48 hours after surgery. At that moment, its aspect was independently evaluated by four physicians from the Knee Unit who followed the "Surgical Wound Aspect Score" (SWAS) system. A picture of both knees was also then taken in order to perform the intra-observer correlation in a posterior assessment of the pictures.

Five parameters were included in this score ; swelling, erythema, ecchymosis, blood drainage and blisters.

The cut-offs of each parameter were established based on the clinical experience of the investigators and the observation of the surgical wound aspect of 40 patients operated for a TKA previous to the beginning of the study.

1. *Swelling*. The diameter of the extended knee was measured in the prepatellar zone of the knee, approximately in the mid third of the wound, with a tape measure set using sterile gauze on the top of the wound. The contra-lateral knee was measured at the same level. After that, the ratio between these measures was calculated. A ratio of less than 1.07 was considered 0 points, a ratio between 1.07 and 1.14 were rated with 1 point and a ratio greater than 1.14 was rated with 2 points.
2. *Erythema*. It was considered 0 points if erythema was absent and 1 point with erythema at the wound edges. If erythema exceeded the wound edges, it was scored with 2 points.
3. *Ecchymosis*. The absence of ecchymosis was scored with 0 points, edges limited ecchymosis scored with 1 point and extended ecchymosis 2 points.
4. *Blood drainage*. The uncovered dressing was the reference to measure this item. If the gauze had no signs of blood drainage it was scored with 0 points, if there were one or two points of blood drainage, it was scored with 1 point. Finally, it was scored with 2 points when more than 2 points of drainage were observed. It was important not to consider the iodine spotting as blood drainage.
5. *Blisters*. The presence and size of blisters was checked. The absence of blisters was scored with 0 points, one or two blisters of less than 2 centimetres scored with 1 point and finally more than two blisters or 1 larger than 2 centimetres with 2 points.

Finally, a score of 0 points (the best) to 10 points (the worst) was obtained by adding the results of these 5 parameters. Examples of different SWAS are shown in figures 1a, 1b and 1c.

Score reliability

Four members of the Knee Unit were involved in the evaluation of the wound aspect to determine intra-rater and inter-rater reliability : two experienced orthopedic knee surgeons (investigators 1 and 2) and two orthopedic residents (investigators 3 and 4).

Inter-rater reliability : the surgical wound was independently measured, using the SWAS, by each investigator at 48 hours after surgery.

Intra-rater reliability ; A picture of both knees of each patient was taken by one of the investigators when the wound was uncovered at 48 hours after surgery. Each picture showed both knees with the uncovered dressing. The pictures of the knees were re-evaluated using the SWAS score one month after the first review.

Follow-up

At the final follow-up (FU), the TKA function was assessed reporting ROM using a manual goniometer and the KSS score. Emphasis was placed on the presence or absence of superficial or deep infection during the first year and the treatment performed. Follow-up was carried out at 1, 3, 6 and 12 months after the surgery.

Statistical analysis

The quantitative variables were described with mean and standard deviation and categorical variables with frequencies and percentages. To assess the relationship between two categorical variables, the Chi-square test or exact Fisher test were used as appropriate. To quantify the degree of association between two quantitative variables, Spearman's correlation coefficient was used. Intra-observer and inter-observer agreement were analyzed using the Intra-class Correlation Coefficient (ICC). P values less than 0.05 were considered statistically significant. Score of the total SWAS and the different items that make up the score were independently correlated with the different variables studied.

The SPSS vs. 15.0 (SPSS Inc, Chicago, Illinois, USA) statistical package was used for the statistical analysis.

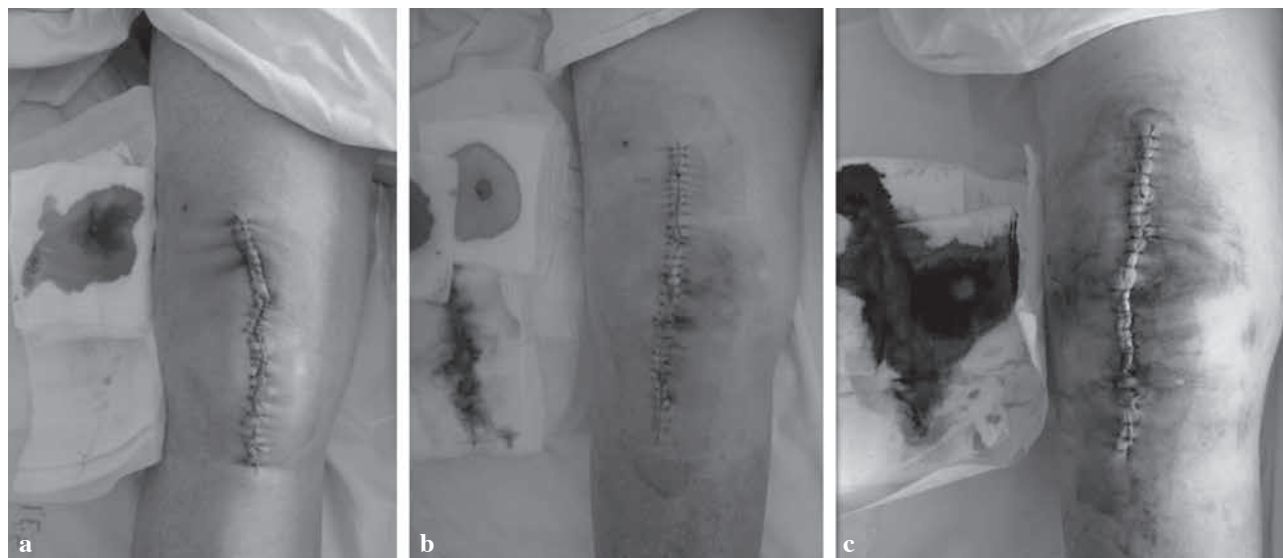


Fig. 1

RESULTS

Descriptive data

A total of 171 knees were initially assessed but twelve were excluded for different reasons: 9 of them had an important deformity of the mechanical axis, 1 case suffered a postoperative fracture and other 2 patients were diagnosed of a major medical complication in the postoperative period. A total of 159 knees were finally assessed, 125 women (78.6%) and 34 (21.4%) men. The mean age was 72.97 years old (SD 7.24) and the mean Body Mass Index (BMI) was 31.20 (SD 5.16). With regard to co-morbidities, 26 patients (16.4%) had type II Diabetes Mellitus, 7 patients (4.4%) had rheumatic diseases, 9 patients (5.7%) had peripheral vasculopathy and 29 patients (18.2%) suffered from central cardiovascular disease requiring antiplatelet or anticoagulation treatment.

The mean preoperative ROM was 107.18° (SD 17.13) and maximal flexion stood at 110.25° (SD 14.35). The mean mechanical axis was 4.49° of varus deviation (SD 6.38). The mean value of the preoperative “KSS knee” score was 48.55 (SD 14.83) points and the mean “KSS function” score were

51.3 (SD 13.88) points. The mean time under tourniquet was 73.91 (SD 13.05) minutes and the use of femoral or tibial stems was required in 8 patients.

Table I shows the score of the different surgical wounds assessed at 48 hours after the surgery. Table II shows the different scores of the different parameters of the surgical wound aspect.

The mean maximum VAS value obtained within this period was 4.71 (SD 2.13) and the mean VAS score was 1.53 (SD 1.89).

Six patients were not available in the last follow-up: two of them due to serious systemic diseases and four of them had gone missing. At 1 year, mean ROM was 104.01° (SD 19.66) and mean maximal flexion was 107.86° (SD 13.05). The mean postoperative “KSS knee” score was 85.82 (SD 12.51) and the mean “KSS functional” score was 80.85 (SD 15.94).

Six patients suffered superficial infection of the surgical wound (Tsukayama IIA) (17) with positive *Staphylococcus aureus* (4 cases) and *Staphylococcus epidermidis* (2 cases) cultures. All of them were resolved with antibiotic treatment based on an antibiogram. These 6 patients had a mean SWAS score of 2.83 points. Three patients suffered deep prosthetic infection at 1 year of follow-up (Tsukayama

Table I. — Description of the different parameters of the SWAS and values assigned

	0	1	2
Tumefaction	< 1.07	1.07 a 1.14	> 1.14
Erythema	No presence	Located at surgical wound edges	Exceeded surgical wound edges
Ecchymosis	No presence	Located in knee and surgical wound	Exceeded knee limits and surgical wound
Blood draining	No presence	Only one or two points	More than two points
Blisters	No presence	1 or 2 blisters ≤ 2 cm	> 2 blisters or 1 blister > 2 cm

Table II. — Number of patients and percentage divided depending on the punctuation of the SWAS

Total Score	N (%)
0	9 (5.7)
1	45 (28.3)
2	40 (35.2)
3	40 (35.2)
4	10 (6.3)
5	9 (5.7)
6	4 (2.5)
7	1 (0.6)
8	1 (0.6)
9	0 (0)
10	0 (0)
Total	159 (100)

IIB) (9). It was caused by *Staphylococcus aureus* in 2 cases and *Staphylococcus hominis* in the remaining case. All were treated with a two-stage TKA exchange. The mean SWAS score in these three patients was 4.66 points ; 5 points in 2 patients and 4 points in the other one. Considering surgical site infection as the addition of both deep and superficial infection, the mean SWAS was 3.44. Patients who did not have a surgical site infection had a mean SWAS score of 2.27.

Intra and inter rater reliability

The ICC was performed to determine intra- and inter-observer reliability. Intra-observer ICCs were ; 0.962, 0.952, 0.938 and 0.961 for observers 1, 2, 3 and 4 respectively. The ICCs to analyse inter-observer reliability were ; 0.942 in the first trial and 0.910 in the second trial one month later.

Preoperative variables : No significant differences were obtained when comparing the SWAS with epidemiologic data [age ($p = 0.491$), gender ($p = 0.325$), BMI ($p = 0.061$)], the different comorbidities studied [diabetes mellitus II ($p = 0.979$), a history of myocardial infarction ($p = 0.759$), rheumatic disease ($p = 0.276$), peripheral vasculopathy and central cardiovascular disease treated with anti-coagulants or antiplatelets ($p = 0.936$)]. No differences were obtained comparing the SWAS with the mechanical axis ($p = 0.559$), the “KSS knee” score ($p = 0.838$), the “KSS function” score ($p = 0.902$), the maximal flexion ($p = 0.457$) or the preoperative ROM ($p = 0.258$).

Intraoperative variables : No differences were obtained comparing SWAS with the intraoperative variables studied (time of tourniquet and need for stems) or the type of arthroplasty used.

Postoperative variables : No differences were obtained comparing the SWAS with the mean VAS score ($p = 0.272$) and the maximum VAS score ($p = 0.565$). No statistical differences were obtained comparing the mean VAS or maximum VAS values with the different items of the SWAS. Furthermore, there were no differences when comparing the SWAS with the different functional parameters ; “KSS knee” ($p = 0.470$), “KSS function” ($p = 0.662$), maximum flexion ($p = 0.657$) or ROM at 1 year of follow-up ($p = 0.759$). No differences were obtained comparing the SWAS with the difference between the preoperative and postoperative variables : differential “KSS knee” ($p = 0.185$), differential “KSS function” ($p = 0.926$), or differential ROM ($p = 0.200$). Only by comparing the total score of the SWAS and the gain in maximal knee flexion, was statistical significance ($p = 0.017$) with a slight negative correlation (correlation coefficient -0.2) obtained.

A statistical significance correlation comparing the total value of the SWAS with the presence of deep infection at 1-year follow-up was obtained ($p = 0.025$). No statistical significance was obtained when the total SWAS was compared with the superficial infections ($p = 0.404$) or the summation of both ($p = 0.064$). Preoperative or intraoperative variables of these 9 patients showed no statistical differences with regard the rest of patients.

DISCUSSION

As far as we know, this is the first score described to assess the aspect of the surgical wound of any orthopaedic procedure. The present investigation confirmed that the aspect of the surgical wound in the immediate postoperative period has no relation with the TKA functional outcomes at 1-year follow-up. Another finding is that this variable is directly related to the incidence of deep infection.

Most of the surgical wounds studied (85%) were scored from 0 to 3 points and the rest of the knees were scored from 4 to 8 (15%) with a mean score of 2.42 points. No case was scored with 9 or 10 points. With the exception of the score of 2 for the erythema item, all the other scores had 7 or more patients (Table II). The unique correlation in the functional outcomes obtained was just a slight difference, with minimal clinical relevance, comparing the wound aspect with the maximal flexion in the KSS score at 1 year of follow-up ($p = 0.017$). In the literature, different variables, such as time of tourniquet (4), wound closure in extension or flexion (15), the correct emplacement of the skin injury (16,18), or the influence of a correct management of the soft tissues (3,5,10), have demonstrated their influence on mid or long-term TKA functional outcomes.

Pain in the immediate postoperative period was another of the variables studied that had no relation to the aspect of the surgical wound when the maximum or mean VAS was assessed. The wounds with a worst aspect are not more painful than those with a better aspect. Different authors have stated that the surgical wound haematoma (7,12) had relationship to pain. In our series, this variable, studied independently, had no relation with the pain (n.s.).

Table III. — Punctuation obtained by the different items of the SWAS

Parameter	Scoring		
	0 (%)	1(%)	2(%)
Swelling	38 (23.9)	92 (57.9)	29 (18.2)
Erythema	151 (95)	8 (5)	0 (0)
Ecchymosis	104 (65.4)	46 (28.9)	9 (5.7)
Blood draining	62 (39)	75 (47.2)	22 (13.8)
Blisters	138 (86.8)	14 (8.8)	7 (4.4)

With regard to the incidence of TKA infection, some studies (3,5,9,10) have related variables such as an incorrect evolution of the surgical wound in the immediate postoperative period, the persistence of wound drainage (19) or haematoma (7,12) to the presence of a TKA infection. In this series, the SWAS in patients who had a surgical site infection was slight higher than those who did not have an infection (3.44 vs 2.27). On the other hand, the SWAS clearly increased (4.66) in those patients who finally had a deep infection. The aforementioned means that surgical wounds scored with 3 points must be closely monitored and those wounds scored with 4 or higher points in the SWAS, had an increased probability of getting a deep TKA infection.

As far as we know, no score or classification system that assesses the aspect of the surgical wound in any orthopaedic procedure has been reported in the literature. The Hollander Wound Evaluation Score (13) or the Manchester Scar Proforma (1,2) have been described to assess the cosmetic appearance of the scar, but not to study the aspect of the wound in the immediate postoperative period and its possible relation with functional outcomes or risk of infection. In this study, a new score to objectively assess the surgical wound has been described. It provides a valuable tool to further analyze different outcomes of any orthopaedic procedure.

The main criticism of the scoring scale presented are in relation to the lack of reliable previous studies to describe this new score. Another criticism of this score is related to the evaluation of the swelling. To obtain this data, it was necessary to compare the swelling of the studied knee with the contra-lateral knee. It might have been more reliable to compare

the same knee in the preoperative and the postoperative period. However, we think the score would not be very practical in the daily routine as measurement in the preoperative period would be need.

In conclusion, a reliable and reproducible score has been defined in order to measure the aspect of the surgical wound in the immediate postoperative period. The surgical wound aspect has no relation to the clinical repercussion on the functional outcomes of the TKA at 1 year follow-up and/or with pain in the immediate postoperative period. Nonetheless, it is directly correlated with the incidence of deep infection.

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