

THE EFFECT OF A TOURNIQUET ON INTRAOPERATIVE SOFT TISSUE BALANCE IN COMPUTER-ASSISTED SURGERY IN TOTAL KNEE ARTHROPLASTY

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Abstract

Background: Achieving appropriate soft tissue balancing and accurate alignment is an essential procedure in total knee arthroplasty (TKA). Gap balancing affects the final knee kinematics and inadequate correction of soft tissue imbalances is considered an important factor for early TKA failure. During TKA, tourniquets are widely used to provide clear visualization of the tissue. The aim of the present study was to evaluate the effect of a tourniquet on intraoperative soft tissue balance in computer-assisted surgery (CAS) in TKA.

Methods: In this prospective cohort study, patients aged between 50 and 75 years were scheduled for primary CAS TKA due to osteoarthritis. Thirty knees operated by TKA using a navigation-assisted system (KICK system, DuPuy) were evaluated regarding soft tissue tension and compared between the tourniquet released and the tourniquet inflated in full extension (0°) and at 90° knee flexion.

Results: In total, 30 consecutive patients undergoing CAS TKA met the inclusion criteria. Differences were not significant in terms of soft tissue tension in knee full extension medial side ($p=0.616$), knee, full extension lateral side ($p=0.780$), 90° knee flexion medial side ($p=0.573$) and 90° knee flexion lateral side ($p=0.163$).

Conclusion: Our preliminary results showed that tourniquet application during CAS TKA did not significantly affect the soft tissue balance.

Keywords : Tourniquet, Intraoperative soft tissue balance, Computer-assisted surgery, Total knee arthroplasty

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Introduction

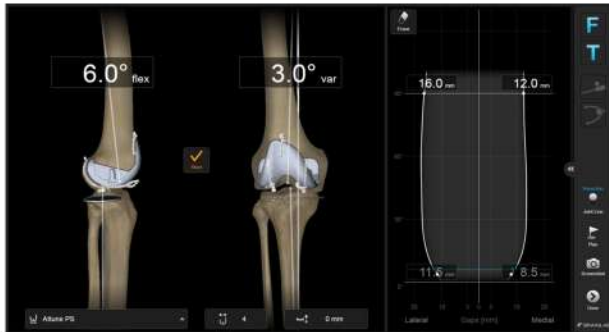
Achieving appropriate soft tissue balance and accurate alignment is an essential procedure in total knee arthroplasty (TKA).⁽¹⁻³⁾ Gap balance affects the final knee kinematics, and inadequate correction of soft tissue imbalances is considered an important factor for early TKA failure. The navigation systems are known to provide excellent restoration of the mechanical axis and precise component positioning, which also improves the accuracy of the balancing procedure by more objective and quantitative measures of flexion and extension gaps.^(4,5) The Joint Stability Graph in the navigation system provides the capacity to assess joint stability and manage gap balancing in TKA. This system continuously calculates the resulting joint gaps based on the maximum knee joint mobility and 3D implant geometries. During TKA, tourniquets are widely used to provide clear visualization of the tissue. One advantage of tourniquet use is reduced intraoperative blood loss.^(6,7) When surgeons use the tourniquet in performing TKA, they assess and adjust the soft tissue tension to achieve the balance of soft tissue both of the flexion and extension gaps. However, after finishing the surgery, the surgeons disconnect the tourniquet and let the patients move their knee via soft tissue tension without the tourniquet condition. When the author performed TKA with the navigation system, some differences in soft tissue tension measurement between the inflated tourniquet and deflated tourniquet were observed. Any significant difference in terms of the soft tissue tension measurement when using the tourniquet has yet to be investigated. The aim of the present study was to evaluate the effect of a tourniquet on intra-operative soft tissue balance comparing between with and without tourniquet using a navigation system.

Methods

This study was approved by the institutional review board, the Royal Thai Army Medical Department. Consent to participate in this research was obtained from all patients. Thirty consecutive patients (20 women and 10 men), treated from August 2016 to August 2017, were included in this prospective cohort study. Patients were eligible for inclusion when they were scheduled for primary computer-assisted surgery (CAS) TKA due to osteo-arthritis, age between 50

and 75 years. Exclusion criteria comprised severe cardiac complaints, severe pulmonary disorders, Body Mass Index (BMI) >35 or severe coagulation disorder. Thirty knees operated by TKA using a navigation-assisted system (KICK system, DuPuy, Warsaw, Ind.) evaluated soft tissue tension and compared between tourniquet released and the tourniquet inflated in full extension (0°) and at 90° knee flexion. The medial parapatellar approach was used in all cases. The first pin was placed, and the distance measured using the 2-Pin X-Press Bone Fixator to place the second pin. The two pins (3 mm) were fixed in the tibia. A drill guide was used on the pins to avoid any disruption to the soft tissue. The 2-Pin X-Press Bone Fixator was placed on the pins and secured firmly in place with the locking screw. The two holes were made on the array block point distally, with the notch towards the patient. The pin position was marked on the femur and a stab incision was made through the soft tissue using a scalpel. Using the 2-Pin X-Press Bone Fixator, the pins were drilled in the bone bicortically. The 2-Pin X-Press Bone Fixator was used with 4 mm pins. The final position was adjusted to ensure a clear line of sight between the array and the camera. Tightening of the array was performed using an adjustment screw. The surgeon started registration of the femoral head center by rotating the leg in the hip joint in a circular manner. The landmarks of the femur and the tibia were registered by pointer. For the femur these comprised the distal mechanical axis point, epicondylar axis, Whiteside's line, medial condyle lateral condyle, anterior reference point while the tibia comprised the proximal mechanical axis point, tibia anterior-posterior direction, medial plateau, lateral plateau and malleoli. After the tourniquet was released the surgeon moved the leg from full extension to full flexion to create the joint stability graph. The joint stability graph showed two curves for the medial and the lateral gap between the femur and tibia implants over the leg's flexion range. The data from the joint stability graph were collected (full extension: medial and lateral side, flexion 90 degree: medial and lateral side). Next, the tourniquet was inflated and the surgeon moved the leg from full extension to full flexion then collected the data from the joint stability graph. Statistical analysis was performed using the paired *t*-test to compare the soft tissue tension between inflated tourniquet

and released tourniquet in knee extension 0 degrees (medial side and lateral side) and knee flexion 90 degrees (medial side and lateral side). The level of significance was set at $p < 0.05$.



Picture 1. Joint stability graph

Results

In total, 30 consecutive patients undergoing CAS TKA met the inclusion criteria. The mean age of patients was 69.7 ± 5.5 years (range 58-81 years) and mean BMI of the patients was 25.0 ± 2.4 kg/m² (range 18.9-30.1 kg/m²). Differences were noted but without significance between the with and without tourniquet groups in terms of soft tissue tension i.e., in knee full extension medial side 4.40 ± 3.2 vs. 4.48 ± 3.35 ($p=0.616$), knee full extension lateral side 10.33 ± 2.25 vs. 10.27 ± 2.46 ($p=0.780$), 90° knee flexion medial side 5.28 ± 3.63 vs. 5.22 ± 3.60 ($p=0.573$) and 90° knee flexion lateral side 8.37 ± 4.12 vs. 8.67 ± 4.60 ($p=0.163$).

Table 1. Effect on knee extension with and without tourniquet

	without tourniquet Mean±SD	with tourniquet Mean±SD	t	df	p-value
Extension					
Medial	4.40±3.24	4.48±3.35	-0.507	29	0.616
Lateral	10.33±2.25	10.27±2.46	0.281	29	0.780
Flexion					
Medial	5.28±3.63	5.22±3.60	0.571	29	0.573
Lateral	8.37±4.12	8.67±4.60	-1.430	29	0.163

Paired t-test

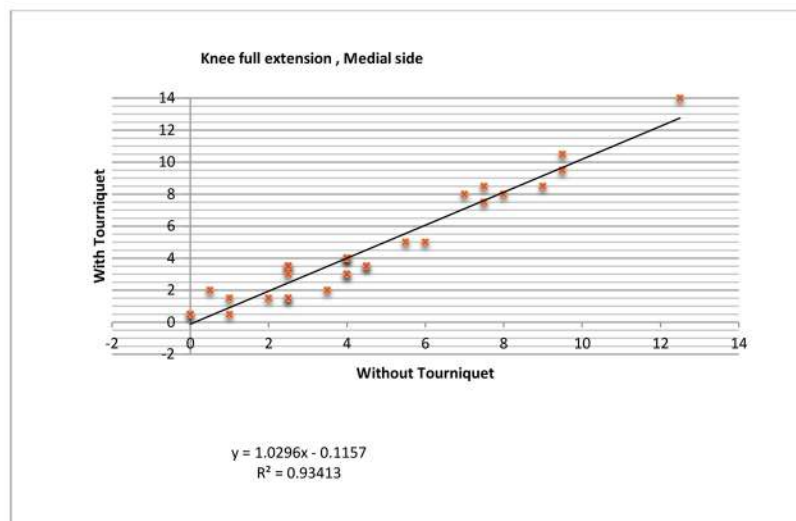


Fig 1. Soft tissue tension in knee full extension with and without tourniquet, medial side

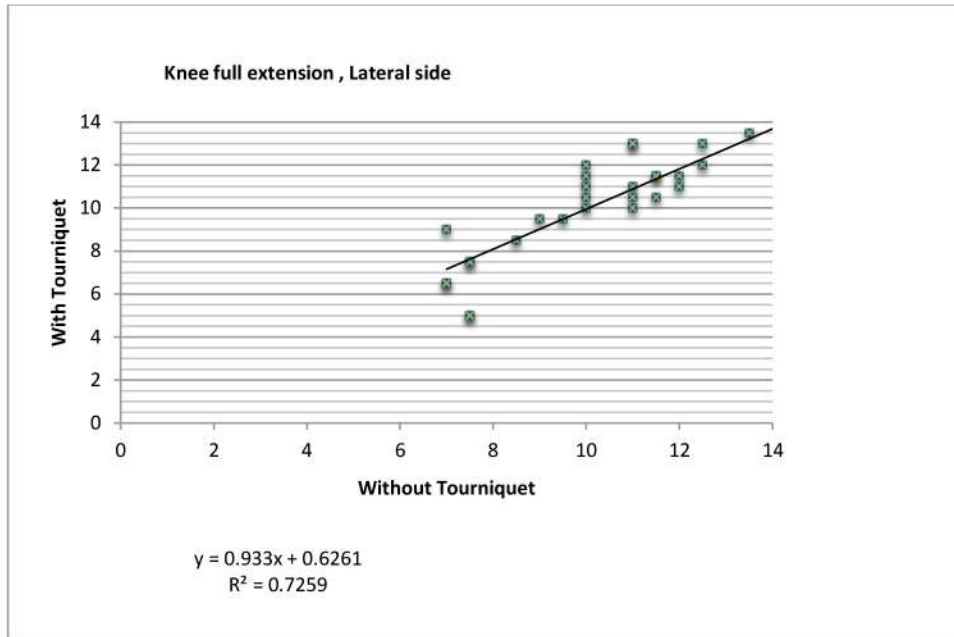


Fig 2. Soft tissue tension in knee full extension with and without tourniquet, lateral side

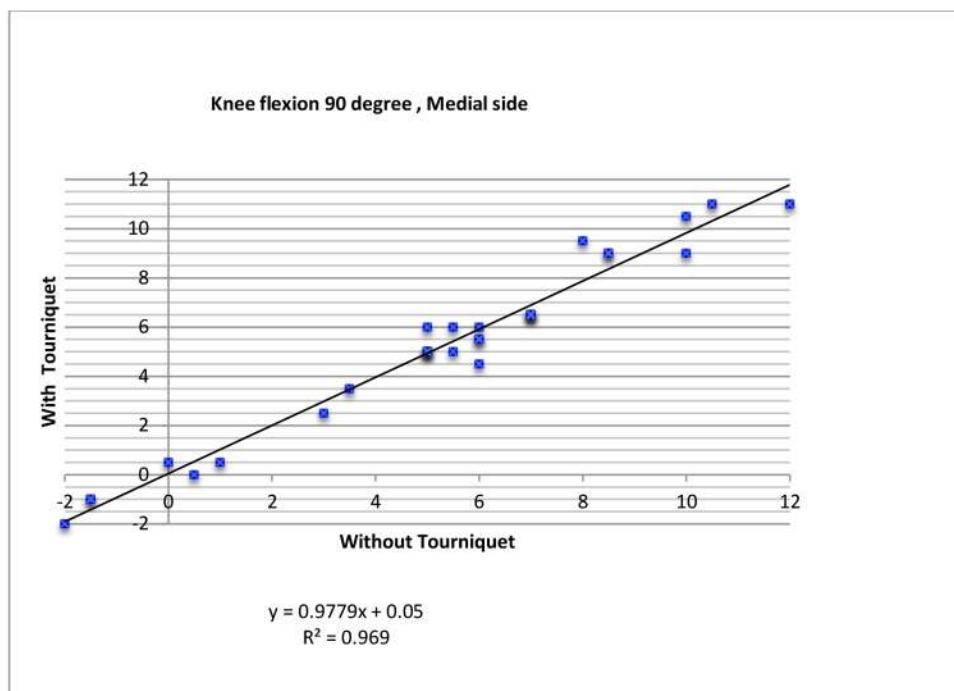


Fig 3. Soft tissue tension with and without tourniquet in knee flexion 90 degree, medial side

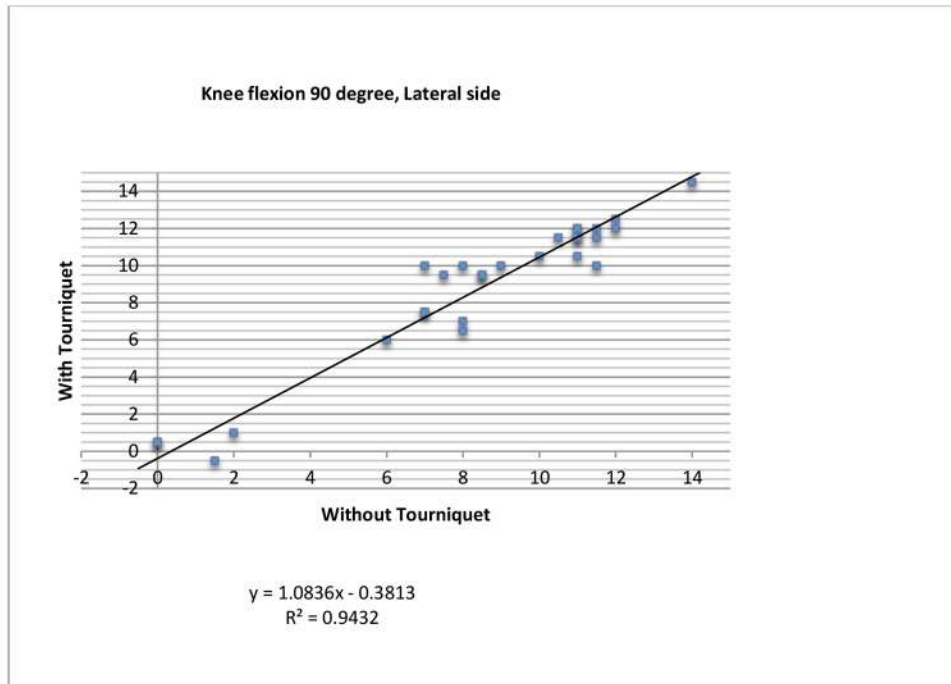


Fig 4. Soft tissue tension with and without tourniquet in knee flexion 90 degree, lateral side

Discussion

Successful outcomes of TKA depend on accurate implant position, restoration of limb alignment and optimal gap balancing.⁽⁸⁾ Malpositioning of the femoral or tibial component can lead to early loosening, increased polyethylene wear and poor patellar tracking.⁽⁹⁾ Gap balancing affects the final knee kinematics, and inadequate correction of soft tissue imbalances is considered an important factor for early TKA failure.^(10,11) The soft tissue imbalance may be present in the form of instability, deformity, contracture or a combination of these elements. The importance of obtaining proper soft tissue balance at the time of TKA is well recognized,⁽¹²⁾ and numerous techniques have been described to correct imbalances, including varus and valgus deformities, flexion contractures, recurvatum and bone deficiencies.^(12,13)

As the incidence of TKA continues to increase, it becomes important to develop techniques to improve outcomes while simultaneously minimizing the incidence of revision. A common difficulty associated with manually performed TKAs is obtaining accurate intra-operative soft tissue balancing, an aspect of this procedure that surgeons traditionally address through their feel and experience. This remains so despite the availability of several devices designed to assist in this regard, including tensors,⁽¹⁴⁻¹⁷⁾

spacers⁽¹⁷⁾ and electric instruments.⁽¹⁸⁻²¹⁾ Regarding navigation systems, the joint stability graph shows two curves for the medial and the lateral gap between the femur and tibia implants over the leg's flexion range and show a number after measuring the soft tissue tension simultaneously. Because the soft tissue tension is measurable, it should not be manipulated by any other factors. The effect of the tourniquet when inflated during surgery is the suspected factor and proved by the results in this proposal.

This is the first study to evaluate the relationship between tourniquet use and the possible influences on soft tissue tension measurement using a navigation system. From the results, tourniquet application during CAS TKA did not significantly affect the soft tissue tension measurement.

However, limitations of this study should be noted. First of all, the sample size was relatively small. Larger series are needed to confirm the effect of the tourniquet on intra-operative soft tissue tension measurement. Second, the author created the joint stability graph using bone to bone contact, i.e., distal femur and proximal tibia, instead of using an injoint spreader to avoid creating any error in the data resulting from the movement of an injoint spreader. It could be better if a stable injoint spreader was used to compare the soft tissue tension.

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