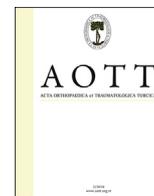




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The assessment of portal-tract healing after knee arthroscopy

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ABSTRACT

Objective: The aim of this study was to analyse the pattern of portal-tract healing, to compare the healing time of anteromedial and anterolateral portal tracts and to assess the impact of portal-tract delayed healing on the post-operative sub-acute and chronic anterior knee tenderness.

Methods: The study included 104 patients (68 males and 36 females; mean age: 49 ± 3.16 years (range: 17–66)) who have undergone knee arthroscopy. Puncture wounds were divided into two groups, (1) anteromedial and (2) anterolateral groups. Each group contained 104 portal-tracts. Healing of portal tracts was evaluated using sequential superficial ultrasonographic examinations. Visual analogue scale (VAS) was used to measure pain related to delayed tract healing and its association with the post-operative sub-acute and chronic anterior knee tenderness.

Results: Anteromedial and anterolateral tracts total healing time average values were 47 days and 28 days respectively. The VAS average values of anteromedial tracts after 2 weeks, one month, three months, six months and one year were 8.2, 6.3, 4, 1.9 and 0.6 respectively, and for the anterolateral tracts 7.4, 5.5, 2.8, 1.2 and 0.2 respectively. A statistical significance was detected between the two groups at the first and third months with P values 0.042 and 0.0035 respectively.

Conclusions: Anteromedial tracts closed later than anterolateral tracts. Both portal-tracts delayed closure is a potential for post-operative sub-acute and chronic anterior knee tenderness after arthroscopic surgery. Four grades of tract healing were recognized. Portal-tract ultrasonography is advised in persistent post-operative sub-acute and chronic anterior knee tenderness.

Level of evidence: Level III, Therapeutic study.

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Introduction

The number of arthroscopic knee procedures have been increased tremendously within the last decade. In knee arthroscopic surgery two classical skin punctures are used to allow surgeon to examine and treat joint lesions. The skin portals (anteromedial and anterolateral) are closed with simple stitches to minimize the probable formation of an iatrogenic dead space, to lower the risk of bleeding and to lower the risk of infection.¹ Many suturing techniques have been introduced to close portal-tracts, however the most commonly used closure techniques are the regular nylon mattress and the simple stitches.² Post-operative

portal-site pain is known to disturb immediate rehabilitation and may seriously affect patient's comfort.³ Ultrasonography (USG) has been used successfully in the diagnosis of many musculoskeletal pathologies, it has been considered as a trustable modality of diagnosis by many orthopaedic surgeons.^{4–7}

Our hypothesis before submitting this study was that, anterolateral portal-tracts heal earlier than anteromedial portal-tracts.

The purpose of this prospective study is three-fold; to assess the pattern of both anteromedial and anterolateral portal-tracts healing process, to compare the time required for complete healing of both anteromedial and anterolateral portal tracts and to document the impact of delayed portal-tract healing on the post-operative sub-acute and chronic knee tenderness.

Patient and methods

169 patients underwent knee arthroscopy for simple therapeutic and diagnostic purposes in the period of January 2013 to

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June 2014. The inclusion criteria of this study were, active mobile patients, patients without chronic diseases that may disturb wound healing process like diabetes mellitus and chronic obstructive lung disease and patients with neither X-ray signs of moderate to advanced knee osteoarthritis nor with knee mechanical axis deviations. Whereas all patients with radiological signs of moderate to advanced knee osteoarthritis, patients required prolonged arthroscopic procedures like ACL reconstruction, meniscus repair, mosaic arthroplasty and patients with certain conditions that may delay wound healing like diabetes mellitus, chronic obstructive lung diseases, coronary heart diseases and cigarette smoking were excluded from the study. 117 patients were remained, 11 of them were missed during the follow-up period and 2 patients developed superficial wound infection, were excluded from the study. The remaining 104 patients were eligible for the final analysis. The average age of the patients involved in this study is 49 ± 3.16 years (range; 17–66), consisted of 36 females and 68 males with an average body mass index (BMI) of 34 ± 4.74 kg/m². All knee arthroscopies were performed by one surgeon. All patients were admitted as day cases. The average follow-up period was 12.4 months. All patients were called for followed up at one week, two weeks, one month, three months, six months and twelve months. The demographic data of the patients and the types of knee arthroscopic procedures of patients involved in this study were explained in (Table 1). The patients were evaluated clinically and radiologically before surgical interventions. Surgical indications for the arthroscopic procedures of the patients involved in the study were explained in detail in (Table 1). The main aim of this study was to assess the healing time required for the most commonly used portal tracts in knee arthroscopic surgery; the anteromedial and the anterolateral portals which have different localizations, and to evaluate the impact of the delayed healing of portal tracts on the post-operative sub-acute and chronic knee tenderness. Portal tracts were divided into two groups according to their localization around the patellar tendon, the anteromedial (group 1) and the anterolateral (group 2). All arthroscopic procedures were carried out using only the classical anteromedial and anterolateral portals. Portal punctures were made oblique, pointing to the intercondylar notch, 1 cm above the joint line and 1 cm away from the patellar tendon. Skin puncture was made with number 11 sharp blade. A blunt 4 mm trocar was used in all procedures. All of operations were performed under regional anaesthesia. A 30-degree 4.0 mm arthroscopic optic was used in all cases. All portals were closed with simple stitches. Hemovac drains were not used and all patients were allowed to mobilize immediately with full-weight bearing when possible after the procedure. Stitch removal was made at the out-clinic after two weeks for all patients. Ultrasonography (USG) has been described by variant studies^{4–6} to be sensitive in detecting superficial soft tissue pathologies. USG has

been used in our study as a diagnostic tool to assess the pattern of portal-tract healing, the period required for tract healing for both portal-tracts and the impact of portal-tract healing grade on post-operative sub-acute and chronic knee tenderness. All portal-tracts were examined by superficial USG by the same radiologist at each follow up.

Two groups of portal tracts (anteromedial and anterolateral), were evaluated during our study period. Each group contains 104 portal-tracts. No additional portals were needed for any case. Throughout the follow-up period from two weeks to one year, the post-operative USG revealed four different grades of tract healing pattern in the knee joint (Fig. 3). Fig. 3D demonstrates grade (0) where the tract is totally open, Fig. 2C demonstrates grade (1) where the tract is partially healed, Fig. 3B demonstrates grade (2) where the tract is healed subtotally, whereas Fig. 3A demonstrates grade (3) a total healing of tract.

Resting tenderness related to portal-tract incomplete healing was evaluated by direct pressure on the puncture wounds. All patients were asked to quantify the tenderness at the portal-tract according to the visual analogue (VAS) scale which is considered as a valid measure of acute pain with a good construct validity.⁸

The Mann–Whitney-U Test was used for statistical evaluation of the collected data. The level of significance was set as $P < 0.05$.

Ultrasonographic examination protocol

The HD 15 pure wave (Ultrasound system, Philips) US apparatus was used for the study, equipped with a 12 L linear transducer, with a frequency of 12 MHz. The patients were in a supine position with legs being straight. USG protocol was mainly focused on the portal-tract area to detect the healing grade of each tract at every follow-up session (Fig. 1). Superficial USG clearly demonstrates the anterior anatomy of the knee joint (Fig. 2).

Results

The average value of the anteromedial portal-tract healing time was 47 ± 92.21 days (range; 15–386), two tracts remained partially opened after 1 year; one of which was with grade 1 and the other was with grade 2. Whereas the average value of the anterolateral portal-tract healing time was 28 ± 65.73 days (range; 15–180). Anterolateral tracts heals earlier than the anteromedial tracts, the difference of tracts healing time was statistically significant with a P value of 0.018.

The averages VAS values of anteromedial tracts after 2 weeks, one month, three months, six months and one year were (8.2 ± 6.44 , 6.3 ± 4.87 , 4 ± 3.26 , 1.9 ± 2.59 , 0.6 ± 2.16) respectively, and (7.4 ± 3.29 , 5.5 ± 4.73 , 2.8 ± 3.14 , 1.2 ± 2.83 , 0.2 ± 1.19) for the anterolateral tracts respectively.

Two weeks after the arthroscopic standard surgical technique, high average values of VAS scores were recorded in both groups with no statistical significance was documented, P value (0.164). However after one and three months of the surgical procedure, minimal drop of the average VAS score values was recorded in both groups. The anteromedial tract group had a greater average VAS score value (6.3) compared to that of the anterolateral tract group (5.5) after one month of the surgical procedure, a statistical significance was detected between the two groups with P value (0.042). After three months the VAS average score value of the anteromedial tract group was (4), which was higher than that of the anterolateral tract group (2.8), a statistical significance was detected between the two groups with P value (0.0035). After six months and one year of the standard surgical technique, an obvious drop of the average VAS score values was noticed in both groups. The average VAS score value of the anteromedial tract group was higher

Table 1
Demographic characteristics of patients who underwent knee arthroscopic procedures and surgical indication for knee arthroscopy.

Data	
Total no. of patients	104
Male (n)	36
Female (n)	68
Average age (y)	49 ± 3.16
Average BMI (kg/m ²)	34 ± 4.74
Indications (n)	
Medial meniscal tear (partial meniscectomy)	71
Medial meniscal tear (total meniscectomy)	3
Lateral meniscal tear (partial meniscectomy)	9
Medial femoral condyle cartilage lesion	11
Lateral femoral condyle cartilage lesion	2
Synovectomy and plica resection	8

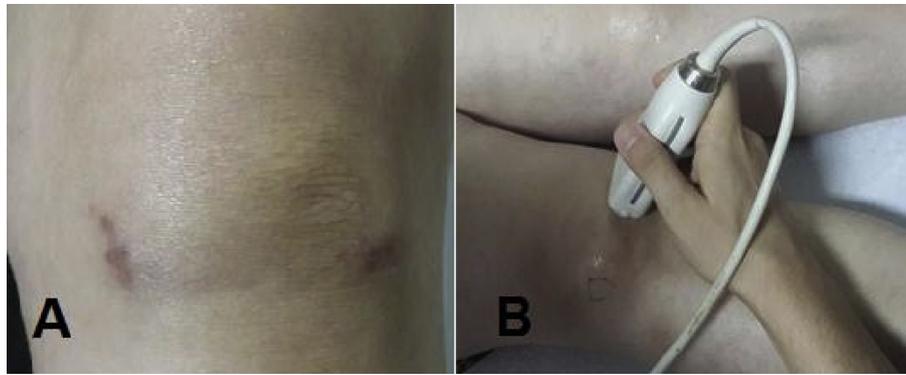


Fig. 1. A. Arthroscopic classical anteromedial and anterolateral portals. B. Ultrasonography examination of portal-tracts for a patient in a supine position with both legs in straight position.

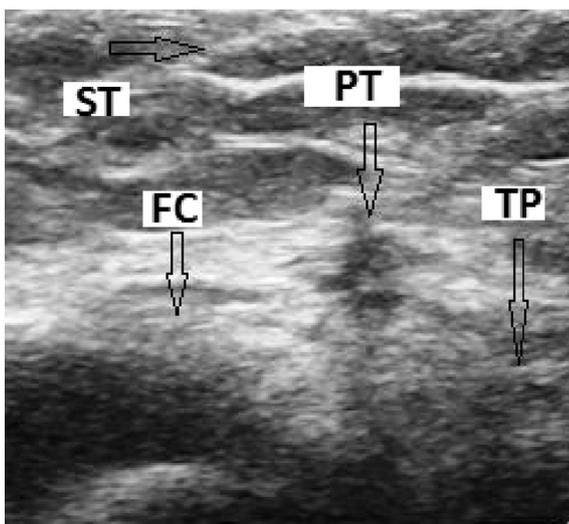


Fig. 2. Ultrasound imaging of a female patient's anteromedial portal-tract, 6 months after arthroscopic procedure, still complaining of an anteromedial knee pain, revealed an incompletely healed tract, grade (2). **ST:** Subcutaneous tissue, **PT:** Portal-tract, **FC:** Medial femoral condyle, **TP:** Tibial plateau.

than that of the anterolateral tract group. However no statistical significance was detected between the two groups (Table 2).

Discussion

The idea of this study emerged from our clinical experience. During follow-up periods of knee arthroscopic surgery patients, we recognized that, some patients complain of a prolonged knee pain and tenderness around the anteromedial portal tract on several occasions. Superficial USG examination revealed a delay in the healing process of the anteromedial portal tract compared to the anterolateral one. The pain was closely associated with the grade of the healing pattern. These findings encouraged us to establish this study to address the healing time required for the most commonly used portals in knee arthroscopy.

Portal-tract pain and hernia have been studied extensively in laparoscopic surgery. It has been defined by Crist and Gadacz as the development of hernia at the cannula insertion site.⁹ However searching the orthopaedic literature did not reveal any well-established work studying the effect of portal-tract delayed healing on the post-operative sub-acute and chronic knee pain.

In this work, using the superficial ultrasonography and the VAS system, we assessed the pattern of portal-tract healing grades and

the impact of each grade on the sub-acute and chronic post-operative knee pain after arthroscopic surgery.

This is the first time to assess the healing pattern of a portal tract via USG tool. In the last few years, the technical development of ultrasound equipment, the advent of new technologies, the development of higher frequency transducers that can be even used for small joints and superficial tissue evaluation and mostly the increased expertise of sonographers have boosted the role of soft tissue ultrasound in assessment of fine and delicate musculo-skeletal superficial and deep pathologies. For that reason USG has become an essential diagnostic method for many rheumatologists and orthopaedic surgeons for diagnosing, monitoring and assessment of remission of many pathological situations that involve joints and the associated periarticular structures. In fact, superficial USG is particularly attractive because of its widespread availability, non-invasiveness, low cost and good reproducibility, as it can be easily repeated during follow-up.^{10,11}

It is well known that, USG is more reliable and sensitive when compared to other diagnostic tools, in both small joints, large joints and superficial soft tissue pathologies.^{12,13} Although magnetic resonance imaging (MRI) is known to be the gold standard modality for diagnosing many knee pathologies, however, several difficulties have been encountered to evaluate the healing pattern through MRI tools, some of them are the cost-effectiveness, the difficulty to obtain at each follow up and the presence of claustrophobia in some patients, makes MRI very difficult to be obtained frequently. USG has the advantage of combining dynamic clinical tests with visualization in real time. Together with its being widely available, it is considered as an ideal first line imaging technique when superficial lesions are suspected.¹⁴

During our periodic USG follow-up examinations, variant portal tracts healing patterns were recognized. In order to facilitate description of the healing process visualized by USG, we proposed a novel four-type grading system. Grade (0) demonstrated a totally open portal-tract, which may last for more than three months in some patients before proceeding to grade (1). It was associated with the highest portal tract tenderness and discomfort score in the VAS system. Grade (1) demonstrated a partial portal tract healing and it was associated with more portal tract tenderness score in the VAS than grade (0). Grade (2) demonstrated a subtotal tract healing and it exhibited less portal tract tenderness and discomfort in the VAS system when compared to grade (0) and grade (1). Grade (3) demonstrated a total portal tract healing and it was associated with the least portal tract tenderness score in the VAS. Grade (3) strangely may last sometimes for more than 12 months in some patient to occur.

It was noticed that, low grades of portal-tract healing is always associated with high average scores of the VAS and more knee

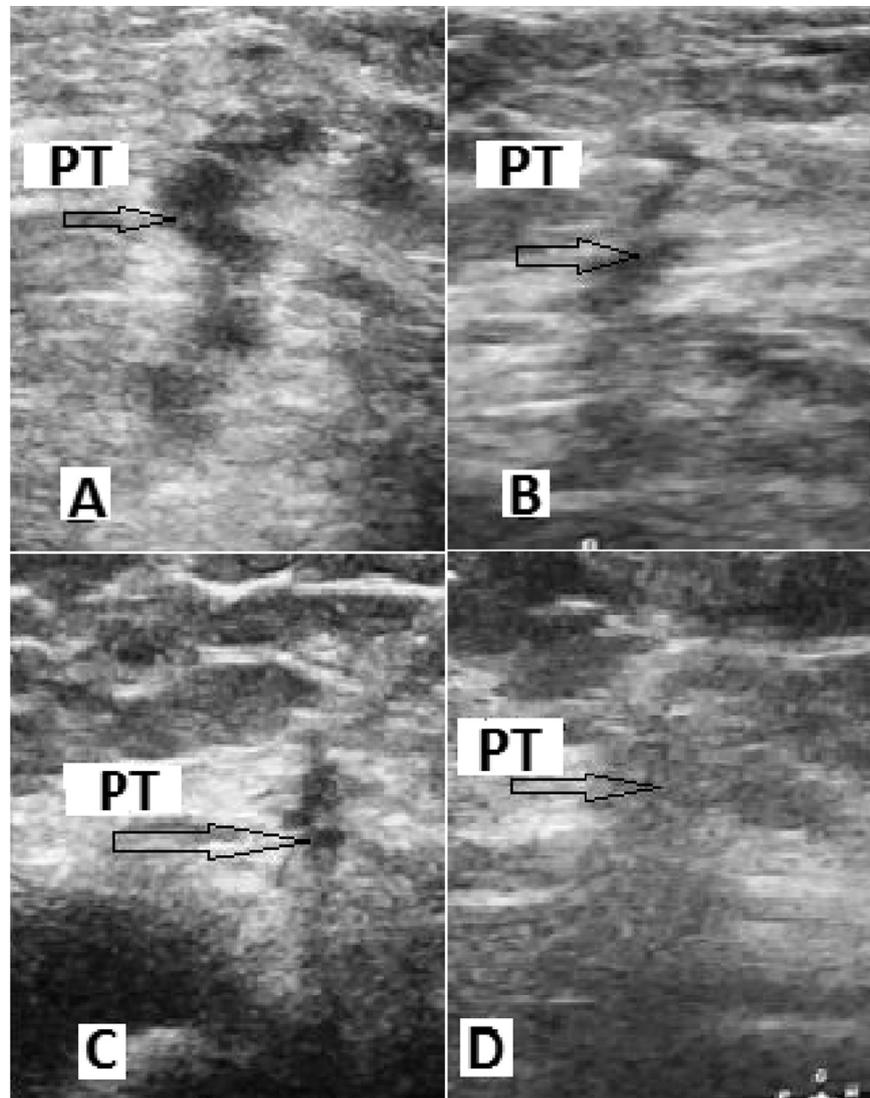


Fig. 3. Ultrasonography grading of portal-tract healing pattern observed during the follow-up period. PT: Portal-tract. A: Grade (0) PT is totally open. B: Grade (1) PT is partially healed. C: Grade (2) PT is subtotally healed. D: Grade (3) PT is totally healed.

Table 2

Comparison between the anteromedial and anterolateral portal-site tract closure time and pain at different time intervals.

	Anteromedial portal-site tract	Anterolateral portal-site tract	P value
Average total closure time (day)	47 ± 92.21 (range; 15–386)	28 ± 65.73 (range; 15–180)	0.018
Average pain measurement (VAS)			
After 2 weeks	8.2 ± 6.44 (range; 6–10)	7.4 ± 3.29 (range; 5–10)	0.164
After 1 month	6.3 ± 4.87 (range; 4–10)	5.5 ± 4.73 (range; 4–8)	0.042
After 3 months	4 ± 3.26 (range; 1–8)	2.8 ± 3.14 (range; 1–6)	0.0035
After 6 months	1.9 ± 2.59 (range; 0–5)	1.2 ± 2.83 (range; 0–3)	0.87
After 1 year	0.6 ± 2.16 (range; 0–4)	0.2 ± 1.19 (range; 0–2)	0.135

discomfort during rehabilitation programs. Delayed portal-tract healing was associated strongly with the persistent sub-acute and chronic post-operative knee tenderness and discomfort in arthroscopic surgery.

This study has highlighted that, there is an obvious statistical difference in terms of wound healing between the anteromedial and anterolateral portal-tracts healing. Anteromedial portal-tracts healed later than anterolateral portal-tracts, also anteromedial portal-tracts recorded higher average scores of the VAS than the anterolateral ones. This variety in portal-tracts healing time is not

well understood but it may be due to the cyclic variation of the intraarticular pressure differences of the two compartments.^{15,16}

Delayed anteromedial tract healing may be associated also with the recurrent instrumentation and manipulation of the anteromedial portal-tract compared to that of the anterolateral one. This condition should be investigated by another study to rule out other conditions which may prevent usual portal tract healing process like synovial fluid extravasation, fat tissue necrosis, capsular or other structures herniation or even a meniscal fragment or debris sequestration through the portal tract. The high standard

deviation values is associated closely with the delay of the healing process happened in both portal tracts especially in the anteromedial portal tracts which exceeded one year in some patients. However excluding the extreme cases from both groups, reduces the standard deviations obviously but doesn't seriously affect the average values of the healing time in both groups.

Many studies compared between different portal-site closure techniques. Sikand M. et al carried out a single blind, randomized trial in which he examined the healing of portal wounds treated by three techniques, they showed that suturing the portals has no additional advantage.⁶

Hussein R. et al investigated two modalities of portal management after knee arthroscopy, the open method and the use of adhesive tape. They concluded that leaving knee arthroscopy wounds open is an acceptable method and doesn't lead to complications when compared to adhesive tape.¹⁷

But none of these studies addressed the impact of portal-tracts delayed healing on the post-operative sub-acute and chronic knee pain and discomfort.

Arthroscopic knee surgery can evoke different levels of pain, as an acute, sub-acute and chronic in nature, which at times can be unbearable and not explained.^{18–20} This study demonstrated that both anteromedial and anterolateral portal-tracts delayed healing are potentials of post-operative sub-acute and chronic knee discomfort in knee arthroscopic surgery. This may help orthopaedic surgeons to add the delayed of portal-tract healing phenomena in the differential diagnosis of the sometimes unexplained post-operative sub-acute and chronic knee discomfort after arthroscopy.

However this study has several weakness, the number of patients involved in this study was small and all the knees were examined in a static straight leg conditions. Further studies should be conducted in a larger patient population. A dynamic real time ultrasound examination of the portal-tract should be performed in different knee flexion angles to record position related changes of the portal-tract.

Conclusion

Anterolateral portal tracts close earlier than anteromedial portal tracts. Anteromedial portal tract total healing may last for a long time, which in term may cause tenderness and discomfort around the anteromedial aspect of the knee joint. Healing process demonstrated four healing patterns. Delayed portal-tract wound healing is strongly associated with the post-operative sub-acute and chronic knee pain after arthroscopic procedures. Ultrasonography is a reliable tool to evaluate tract healing grade. Orthopaedic surgeons and Physiotherapists are advised to ask for portal - tract USG for knee arthroscopic portals in case of persistent sub-acute and chronic knee pain to exclude portal tract delayed healing. Further studies should be conducted on a larger population using the real time dynamic USG protocol to support the tract healing grading system applied in this study.

Ethical approval

Institutional ethical approval was granted by Sifa University Hospital ethics of research committee assigned a reference number 325-83.

Financial support

No financial support was received from any organization regarding this study.

Conflicts of interest

No conflict of interest regarding this work.

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