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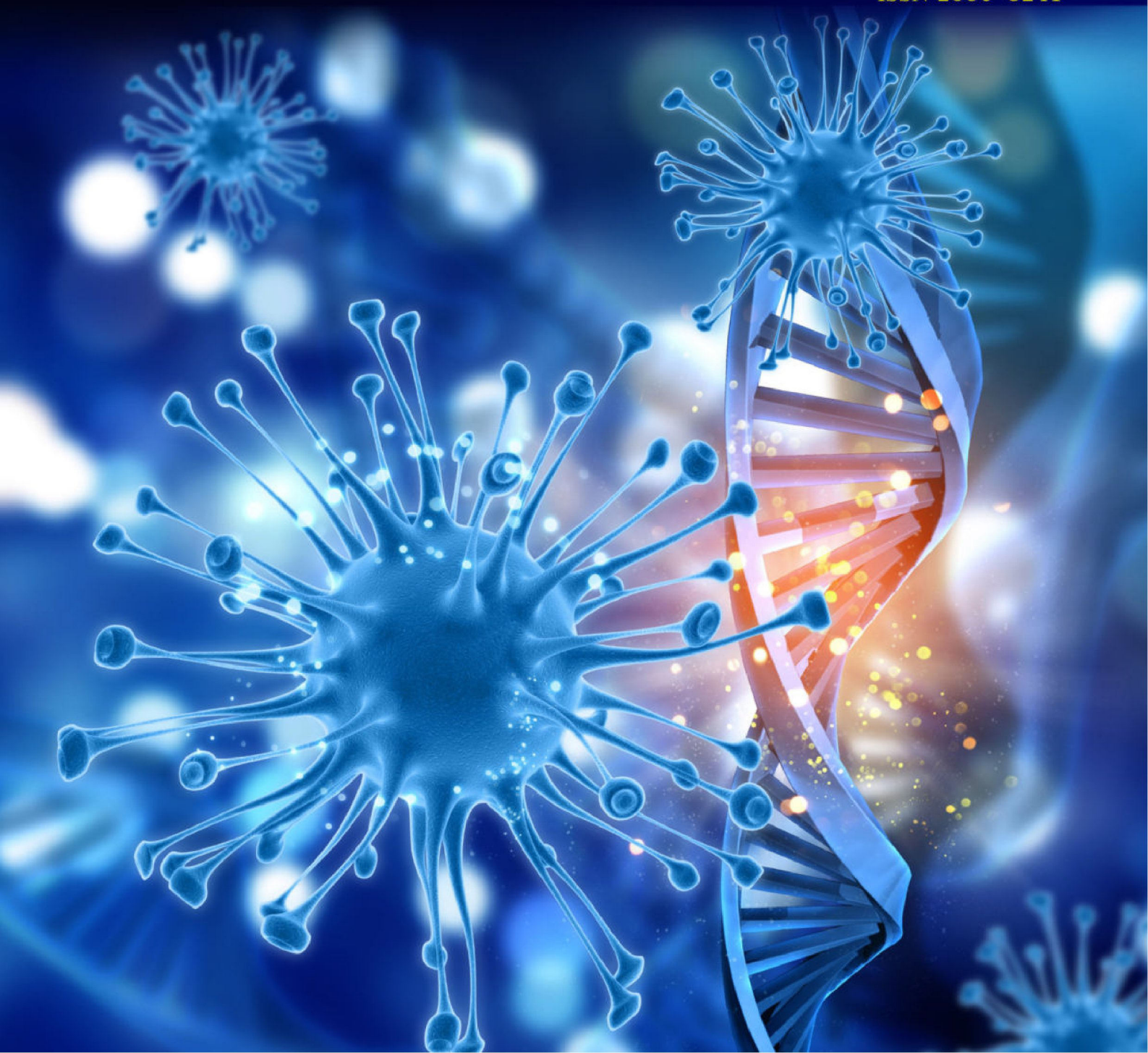

JOURNAL OF
SOUTHEAST ASIAN
MEDICAL RESEARCH

Introduction

The Journal of Southeast Asian Medical Research is a peer-reviewed journal with printing every 6 months. The main goal of this collaboration project is to distribute new knowledge in medical sciences to medical communities and scientists, as well as encouraging scientific collaborations within Southeast Asia and also other nations around the world. The journal publishes original research in the medical sciences: clinical and basic. We welcome original articles from across the world. The editorial board comprise of international experts in various fields of medicine, ranging from internal medicine to a variety of surgeries. The full text of the journal is available online at http://www.jseamed.org

It is our aim to publish the most up-to-date and useful research information in medical sciences. In Southeast Asia, there are some unique problems in health care and diseases, such as tropical diseases, and it is crucial that health professionals can access, share and exchange knowledge promptly. In this region, there is still a gap of knowledge in health sciences that needs to be closed by scientific research, which we are hoping to close after this collaboration project. We hope that the journal will fulfill the objectives and will provide benefit to all, both medical practitioners and researchers alike.

Editorial board

JOURNAL OF SOUTHEAST ASIAN MEDICAL RESEARCH

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ANATOMICAL CONSIDERATION FOR POSTERIOR ATLANTOAXIAL TRANSARTICULAR SCREW FIXATION FROM REFORMATTED TWO-DIMENSIONAL CT IMAGES

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Background: Posterior transarticular C1-C2 fixation by screw is a widely used technique to correct atlantoaxial instability. However, the screw trajectory must be precise because the adjacent vital organs include the spinal cord and vertebral artery in the transverse foramen. Due to the lack of an objective measuring method, clarifying the range of the safe zone of screw trajectory in both the sagittal and coronal planes is important.

Objectives: To clarify the safe zone and ideal trajectory for screw fixation ensuring safety and without violating the transverse foramen and spinal canal.

Methods: Radiographs of the normal upper cervical spine in sagittal and coronal reconstruction CT scans from the entry point of the screw on C2 was performed and the safe zone for the screw path was drawn. The points of screw intersection on the superior articular surface of C2 were measured from the posterior rim of the superior articular surface of C2 then the safe zone of the screw in the coronal plane was drawn in the coronal oblique plane along the screw direction.

Results: Average safe zone in the sagittal plane was 51.6° - 61.2° relative to the superior articular surface of C2 and the safe zone in the coronal view was medially 9.5° and laterally 4.2° relative to the midline of the spinous process. The safe zone and ideal screw trajectory should intersect C2 at 8.03 and 4.5 mm from the posterior rim of the superior articular surface on C2.

Conclusion: The result of this study showed the range of the safe zone of the posterior atlantoaxial screw trajectory that guides to minimize the risk of misdirection and violating the transverse foramen by the screw. The areas on the superior articular surface of C2 intersected by the trajectories making the longest paths are guides to purchase the longest path of bone to achieve more stability and pullout strength.

Keywords : Atlantoaxial, transarticular screw, Cervical Spine

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Background

Posterior transarticular screw fixation was pioneered by Magerl and Seeman in the 1970 s.[1] This surgical technique has been an accepted method to promote immediate rigid fixation for atlantoaxial instability, obviating the need for rigid external bracing.[2]

However, this technique is inherently demanding because the tolerance for error in this region of the spine is low and because small variations are always located in the anatomy of this region. Superior and precise measurement is mandatory to correct the trajectory of the screw and avoid complications of the vital and critical structures in this area such as the vertebral artery and spinal cord.

The limitation of this technique is the lack of an objective method to clarify the direction of this screw. In this study, we used a two dimension 1 mm slice reformatted CT scan to measure the safe zone of the screw trajectory and objectified by measuring the location of point of the screw intersection on the superior surface of C2.

Objectives

1. To clarify the safe zone for screw trajectory in both sagittal and coronal views that are purchased in C1 and do not violate the vertebral foramen.
2. To clarify the ideal screw trajectory and length that creates the longest path to provide the greatest pullout strength for screw fixation.
3. Measuring point of safe and ideal screw transected on C2 superior articular surface to use for objective reference of the screw trajectory.

Study populations

We studied 75 human adult cervical CT scans of both sexes (40 males, 35 females) with a mean age of 53 years from the Radiology Department, Phramongkutklao College of Medicine.

The inclusion criteria were

(1) they no longer present the pathology of the upper cervical spine and

(2) age >20 years and data will be excluded for prior cervical spine fracture or anomaly of the cervical spine.

Measurements

Reformatted one-millimeter slices in 75 samples were reconstructed. The sagittal and coronal oblique reconstruction were made at the standard entry point of the atlantoaxial screw (2 mm superior and medial from the C2 to C3 facet joint)

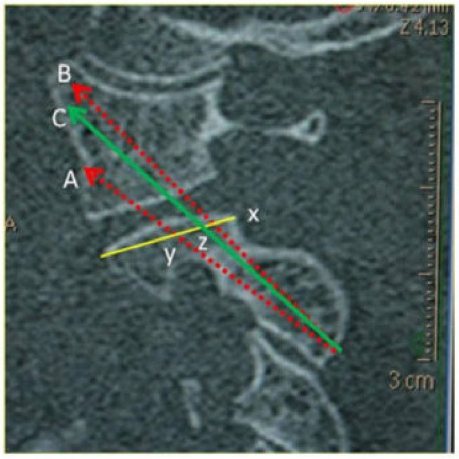

Fig. 1 Sagittal view reconstruction of atlanloaxial complex

From **Fig. 1**: Three of the 3.5 mm screw trajectories were simulated. A and B arrows show the safest caudal and cephalad angle of the screw. The C arrow shows the ideal path of the screw, the safest and longest path to obtain the most pullout strength. The XY distance is a safe zone for the screw trajectory reference on the C2 articular surface. The XZ distance is the point of the ideal screw transected on the C2 articular surface.

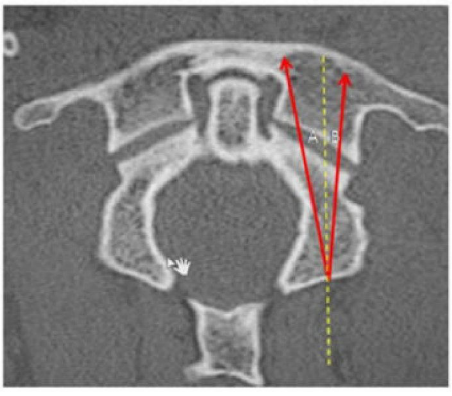

Fig. 2 Coronal view reconstruction of the atlanloaxial complex

From **Fig. 2** coronal oblique reconstruction was performed parallel to the screw trajectory in the sagittal plane. Two 3.5 mm screw trajectory simulations were performed then the safe zone in the coronal view was measured by the angle between the most medial (A) and lateral (B) safe angles of the screw to the midline of the spinous process.

The mean and SD for angle and length was recorded and analyzed on Microsoft Excel 2010 (Microsoft, Chicago, IL, USA). Statistical analysis was performed using IBM SPSS Statistics, version 19.0 (SPSS Inc., Chicago, Il, USA)

Results

The results of the measured angles of the safe zone for the screw trajectory are shown in **Table 1.** The average of safe angle in the sagittal plane was 51.25° to 61.27° from the superior articular surface of C2. The average safe angle in the coronal plane was 9.53° medial and 4.26° lateral to the midline.

Table 1. the measured angles of the safe zone for the screw trajectory

	Sagittal plane*		Coronal plane*	
	Highest	lowest	Medial	lateral
Mean	61.26	51.65	9.53	4.26
SD	5.43	7.03	3.18	3.58

**safe angle for screw trajectory in sagittal and coronal plane*

The result of the screw trajectory on C2 and the average screw lengths were reported in **Table 2.** The point of the screw trajectory that intersected C2 was safe and did not violate the vertebral foramen was 8.03 mm from the posterior of the superior articular surface of C2 and the ideal point of the screw trajectory intersection on C2 that created the longest path of the screw was 2.36 mm

Table 2. the screw trajectory on C2 and the average screw lengths

	Position and Length of screw*		
	Safe	Ideal	length
Mean	8.03	4.5	44.16
SD	2.07	1.08	3.57

** point of screw trajectory intersection C2 and screw length in millimeter*

Discussion

Atlantoaxial transarticular screws were pioneered by Magerl and Seeman in the 1970 s. This technique provides superior biomechanical properties and higher fusion rates and does not require postoperative halo immobilization, but has been reported to be the most dangerous form of fixation. The reported rates of vertebral artery injury range from 4.1% to 8.2% .[3]

Because the vertebral artery runs on the anterolateral side of the lateral margin of the screw when it passes the par interarticularis of C2 [4], the risk of injuring the vertebral artery is predictable by measuring the safe inclination of the screw trajectory reference from the superior articular surface of C2 and the safe zone in the coronal plane is predictable by measuring the medial and lateral deviations from midline that predicted the screw trajectory without violating the spinal canal and purchase in the C1 lateral mass.

From this study the safe zone for the screw trajectory was narrow in both the sagittal and coronal planes. The C2 isthmus has been found to be too narrow to accept a 3.5 mm screw in two of 75 cases. Based on these results, the pre-operative CT angiography with sagittal and coronal reconstructions should be obtained to determine the diameter of the isthmus that will allow the passage of the screw and to create the template of the screw trajectory.

The anatomical reduction of the atlantoaxial joint before screw insertion is very important. I Any amount of subluxation of the safe zone of the screw trajectory will be altered. Madawi et al. reported the malposition of the screw from incomplete reduction in 9 of 14 cases and 5 vertebral artery injuries were associated with incomplete reduction .[5]

From related studies, the anatomical risk of vertebral artery injury of the C2 transarticular screw and C1-2 transarticular screw did not significantly differ.[6,7] The risk of vertebral artery injury is derived from several factors: (1)anatomy of the vertebral artery, [2] malreduction of the C1-2 facet joint, [3] narrowness of the C2 isthmus and [4] improper surgical technique.[3,8,9,10,12] The preoperative plan of the ideal screw trajectory could decrease the risk of vertebral artery injury during surgery.[11]

In this research, we studied the safe zone of the screw trajectory in the sagittal and coronal planes using the reconstructed images from thin section CT scans. Therefore, future studies should apply these results in cadaveric studies and compare the risk of vertebral artery injury with standard techniques as well as the rate of malposition screws among these procedures.

Conclusion

The screw trajectories were studied by measuring the safe inclination in both the sagittal and coronal planes. The result of this study showed the narrow range of the safe zone for screw inclination and some C2 isthmus were too small for a 3.5 screw. A pre-operative evaluation using reconstruction CT scans should be performed to determine that the isthmus is wide enough for screw placement.

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ROTATIONAL MISMATCH OF SELF-ALIGNED TIBIAL COMPONENT IN POSTERIOR-STABILIZED (PS) TOTAL KNEE ARTHROPLASTY

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Background: Rotational alignment of femoral and tibial prosthesis is one of the important factors for outcomes of total knee arthroplasty (TKA). Rotational malalignment may lead to patellar maltracking, anterior knee pain, femoro-tibial flexion instability and premature wear of the polyethylene inlay. Several studies have demonstrated higher revision rates and less favorable clinical results among patients with rotational malalignment. The transepicondylar axis is widely accepted as the best representation of the functional flexion-extension axis of the knee. On the other hand, no comparable agreement exists for tibial rotational alignment.

Objectives: The aim of this study was to determine the accurate rotational alignment of components by posterior cruciate ligament substituting TKA using the center-post self-align technique.

Methods: From January 2007 to May 2009, 54 patients (60 knees) underwent the cemented, posterior cruciate ligament substituting TKA using the center-post self-align technique of the tibial component and performed computer tomography postoperatively. The rotational angle between the femoral and tibial components and the rotational variance from the transepicondylar axis were measured.

Results: The rotational alignment of femoral components were 90% in the neutral group: 48.3% external rotate (mean 1.15°, range 0.1°-4.9°), 48.3% internal rotate (mean 1.53°, range 0.2°-3.8°) and 3.4% were in neutral alignment. The rotation alignment of tibial components were 71.7% in the neutral group: 41.2% external rotate (mean 2.03°, range 0.2°-6.7°), 56.7% internal rotate (mean 2.59°, range 0.3°-6.7°) and 1.67% had neutral alignment. We found no rotational mismatch between femoral and tibial components in this study. All 60 knees had good patellar tracking by no thumb test technique without lateral released procedure.

Conclusion: Femoral component rotations were mostly in the safe zone. Using the center-post self-align technique in posterior cruciate ligament substituting TKA, tibial component rotation was much more varied than the femur. However, all tibial component rotations were in between medial most and medial 1/3 of the tibial tuberble.

Keywords : Rotational, TKA, mismatch, self align, tibial component

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Introduction

The outcomes of total knee arthroplasty (TKA) depend on multiple factors. In addition to the patient-related factors, surgical factors such as mechanical axis restoration, rotational alignment and soft tissue balancing also affect the good long-term results. Transepicondylar axis, widely accepted as the best representation of the functional flexion-extension axis of the knee, has been used as a reference for femoral rotational alignment.[1-5] However, a standard reference for tibial rotational alignment remains controversial. Rotational malalignment may lead to patellar maltracking, anterior knee pain, femoro-tibial flexion instability and premature wear of the polyethylene inlay.[6-10] Several studies have reported higher revision rates and less favorable clinical results among TKA patients with rotational malalignment.[8, 11, 12] Plastic deformation and gross damage to the tibial post are the results of anterior or posterior impingement against the femoral component.[13-15]

Akagi et al.[16] measured the angles between a line perpendicular to the transepicondylar axis and different landmarks on healthy subjects. They reported that an axis from the medial border of the ligamentum patellae to the posterior cruciate ligament has the lowest variability among volunteers. However, because this study was conducted on nonosteoarthritic knees, its application to osteoarthritic knees is questionable.

Other different landmarks have been used for tibial rotational alignment. Currently, two techniques are widely used to determine tibial rotational alignment among TKR patients.[17] The first is anatomical landmarks such as tibial tuberosity, posterior condylar line of the tibia and malleolar axis of ankle and the second is the range of movement (ROM) technique. The ROM technique, in which the knee is moved through a full range of flexion and extension, allows the tibial trial to orientate itself in the best position relative to the femoral component. With this technique, the anterior tibial cortex is marked and the tibial component is then implanted to match this mark.[18] This method is based on the hypothesis that the rotational mismatch between femoral and tibial components should be zero degree when both components are ideally implanted using the range of movement (ROM) technique or center-post self-align technique.

Methods

This study was a prospective study and approved by the Ethics Committee of Phramongkutklao Hospital and Phramongkutklao College of Medicine. Informed consent was obtained from all subjects.

Patients undergoing TKA in Phramongkutklao Hospital from January 2007 to May 2009 were eligible for the study. Inclusion criteria included 1) patients with primary or secondary osteoarthritis of the knee, 2) age more than 55 years, 3) no previous partial or total knee arthroplasty, 4) deformity between 15° of varus and 5° of valgus and 5) no severe instability. Because we used postoperative computerized tomography (CT) to evaluate the outcome, patients who refused postoperative CT were excluded from the study.

Surgical technique

All procedures were performed by a single senior surgeon. Posterior cruciate ligament substituting TKA (PFC Sigma, Depuy, Warsaw, Indiana), fixed bearing tibial component and an all-polyethylene patellar component were implanted in all patients, with surgical self-aligned technique for tibial rotation. A standard midline incision and medial parapatellar approach were performed. The femoral bone cut was created by intramedullary guide and anterior sizing reference with 3-degree external rotation from posterior condylar axis. The tibial bone cut was created by extramedullary guide. The tibial rotational alignment was performed by center-post self-align technique after the femoral component trial was placed. The knee was passively flexed and extended five times, allowing the unsecured tibial trial to seek its own rotation which occurred between the undersurface of the unsecured tibial trial and the cut surface of the proximal tibia. The rotational orientation of the tibial trial determined by the ROM technique was marked on the anterior tibial cortex by electrocautery and patellar tracking was evaluated intra-operatively. **Fig. 1**

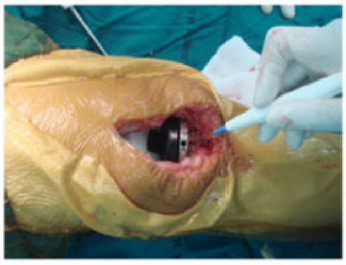

Fig. 1 The mark of tibial component with center-post self-align technique was made by electrocauterization.

Radiographic and CT evaluation

All patients performed a radiographic and CT assessment at five to seven days after surgery to evaluate the leg axis and alignment of the components. The patellar tilt and the displacement of the patella were measured on a Laurin view radiograph. The patellar tracking was defined as neutral when the tilt was within ±10° and displacement less than 5 mm.[19] The CT digital images were evaluated in fully extended position of the knee in the supine position using the software ID, PACS Release 3.6 (Image Devices, Idstein, Germany). The rotational alignment of the femoral component was defined as a line through the edge of both posterior condylars of femoral prostheses. The rotational alignment of the tibial component was defined as a line along the posterior border of the tibial tray. The rotational alignment of the femoral and tibial components were then superimposed and the mismatch between both was measured. The rotational alignment of the patellar component was defined as a line along the surface bone cutting beneath the polyethylene component. All imagination lines were compared with the epicondylar axis line of the femur. **Fig. 2**

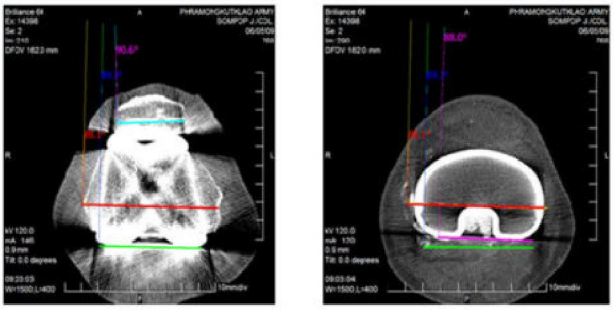

Fig. 2 The computerized tomography images were performed in the fully extended knee, in the supine position and component alignment was measured using digital software.

The femoro-tibial component rotational mismatch was defined as the difference between femoral and tibial components on CT images. True femoro-tibial rotational mismatch was defined as the difference between an ideal position of the femoral component (transepicondylar line) and the tibial component (center-post self-align technique). Our study used 10-degree mismatch as the reference point because the biomechanical study demonstrated an increased tibial cortical strain in the TKA that had femoro-tibial rotational mismatch more than 10 degrees.[20]

Results

Sixty TKAs in 54 patients were included in the study; 11.1% (6 patients) were male and 88.9% (48 patients) were female. Mean age was 69 years (range, 63 to 79 years).

Rotational alignments of the femoral component comprised 48.3% (29 knees) external rotation from transepicondylar axis (mean 1.15°, range 0.1°-4.9 °), 48.3% (29 knees) internal rotation (mean 1.53°, range 0.2°-3.8 °) and 3.4% (2 knees) in neutral alignment.

Rotational alignment of the tibial component comprised 41.2% (25 knees) external rotation from transepicondylar axis (mean 2.03 °, range 0.2°-6.7 °), 56.7% (34 knees) internal rotation (mean 2.59 °, range 0.3°-6.7 °) and only 1 knee (1.67%) was in neutral alignment. All tibial component rotations were between the medial most and medial 1/3 of the tibial tuberble.

Mean rotational mismatch between tibial and femoral components was 2° (range 0.1°-5.8 °). No patients had femoro-tibial mismatch over 10° (range 0.1° -5.8°)

The patellar rotational axis comprised 63.33% (39 knees) external rotation from transepicondylar axis (mean 5.85°, range 0.6°-18.8°) and 36.67% (21 knees) internal rotation (mean 4.12°, range 0.2°-17.2°). **Fig. 3-5**

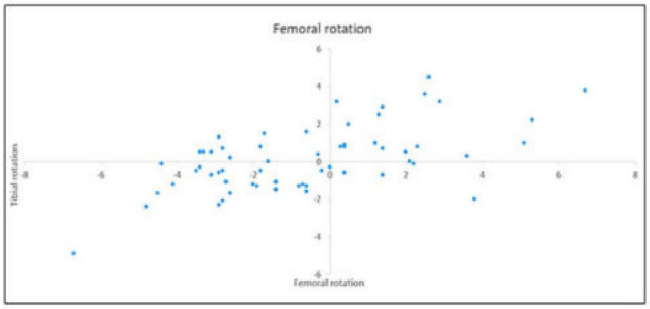

Fig. 3 Alignment characteristics from computer tomography compared between femoral and tibial components

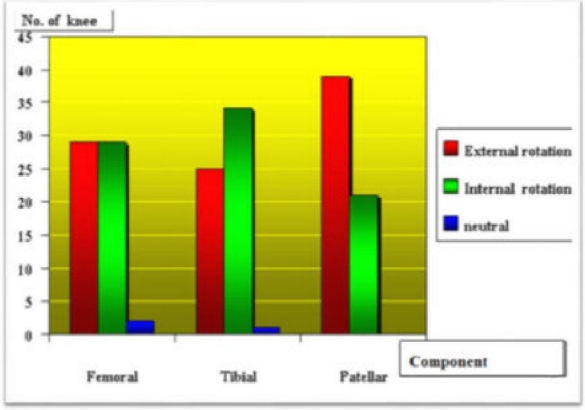

Fig. 4 Rotational alignment characteristics from computer tomography following TKA

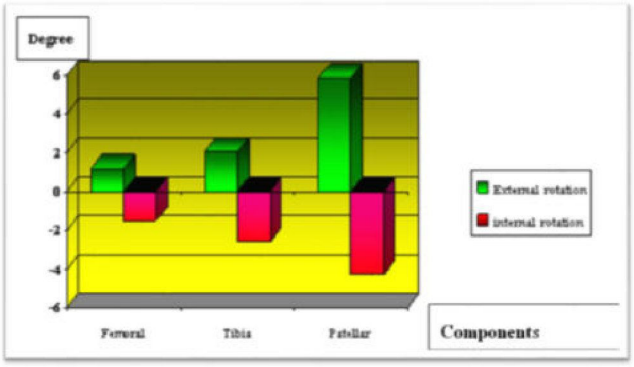

Fig. 5 Mean rotational component from computer tomography following TKA

All 60 TKAs had good patellar tracking by the no thumb test technique without lateral released procedure. Radiographic evaluation of patellar orientation with Laurin film found 90% (54 knees) within normal range (±10° patella tilt and less than 5 mm displacement).

Mean distance between tibial tuberosity and trochea groove (TT-TG) was 5.29 mm (range, 1.0-14.3 mm).

Discussion

The transepicondylar axis has been widely used as a reference for femoral rotational alignment.[1-5] On the other hand, no comparable agreement exists for tibial rotational alignment.

Several studies aligned the tibial component using the landmark of the medial 1/3 of the tibial tuberosity resulting in occasionally excessive external rotation in some cases.[21-23] Eckhoff et al.[23] documented the amount of malrotation between the femoral and tibial components with a contemporary alignment technique. They reported the average external rotation of the tibial component relative to the femoral component associated with the reference of tibial tuberosity was 19° and those rotational mismatches might account for posteromedial polyethylene wear. Uehara et al. [21] demonstrated a tendency to align the tibial component in external rotation relative to the femoral component using computed tomography. He reported rotational mismatch in nearly 50% of the subjects between the axis of medial 1/3 of the tibial tuberosity and the transepicondylar axis for the femur. Another possible cause of the difference was medial torsion of the tibia. Nagamine et al.[24] demonstrated that the foot could be severely rotated internally when the medial 1/3 of the tibial tuberosity was used as a guide for rotational alignment among patients with severe medial torsion of the tibia. In patients from East Asian countries, the medial torsion of the tibia should be taken into account, because it can aggravate rotational mismatch. Tang et al.[25] showed a tendency for the tibial component to be externally rotated when the medial one third of the tibial tuberosity was defined as a rotational landmark. This finding was particularly prominent in Chinese osteoarthritic knees with varus or valgus deformities. The anteroposterior axis of the tibia intersected with the patellar ligament near its medial 10% in healthy Chinese knees, whereas it intersected the medial 20% in varus knees and the medial 30% in valgus knees.

According to the posterior cruciate ligament substituting TKA (PFC Sigma, Depuy, Warsaw, Indiana), the tibial post was designed to engage the femoral cam at approximately 42° of knee flexion and through the endpoint of flexion. Furthermore, the post could accommodate up to 8° of internal or external rotation between the femur and tibia from the neutral axis before impinging against the femoral box. The Sigma posterior-stabilized prosthesis generated little torque through 5° internal and external rotation. An increase in torque then occurred because of box-post impingement, generating peak torques of 17 to 18 N-m at 12° to 14° rotation. Small changes in relative tibio-femoral component rotation can more than double the generated torque. Axial rotation of the knee in vivo can generate substantial torque. Relative tibio-femoral rotational position is an important factor influencing component function and fixation.[26]

Conclusion

We found no femoro-tibial rotational mismatch among patients undergoing posterior-stabilized (PS) total knee arthroplasty with center-post self-align technique. All tibial component rotations were between the medial most and medial 1/3 of the tibial tuberble. This technique can reduce femoro-tibial rotational mismatch with good patella tracking for posterior cruciate ligament substituted TKA. The long term results and functional outcomes should be further investigated.

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ONE-POINT PROXIMAL INJECTION TECHNIQUES FOR DE QUERVAIN'S DISEASE: A CADAVERIC STUDY

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ABSTRACT

Purpose: To investigate the success rate of dye injection in the first extensor compartment of the wrist using the one-point proximal injection technique.

Methods: Thirty-seven wrists from 19 cadavers were included in the study. The skin overlying the first extensor compartment was removed. Methylene blue was injected directly in the first extensor compartment at a point 3 cm proximal to the palpated radial styloid. The first extensor compartment was explored to identify the dispersion of dye. The successful result was determined as diffusion of dye in both subcompartments of the APL and EPB. The anatomical variation of the first extensor compartment and the related structure were also investigated.

Results: A separated compartment was found in 20 of 37 dissected cadaveric wrists. Complete and incomplete septum was presented in 7 wrists and 13 wrists, respectively. The success rate of proximal injection technique in the septum group was 90%.

Conclusions: A higher success rate was observed when compared with the more distal single injection technique reported in a related study. The proximal injection technique may be used as an alternative method for steroid injection among patients with de Quervain's disease.

Keywords : one-point proximal injection techniques, de Quervain's disease, cadaveric study

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Introduction

Stenosing tenosynovitis of the first extensor compartment of the wrist or de Quervain's disease is one of the most common painful conditions found in repetitive hand users. The incident of the condition is predominant among female.[1,2] Friction between the tendons inside the first extensor compartment and its retinaculum seem to be the leading cause of the disease.[3]

Various types of conservative treatment are available, but steroid injection seems to be the most effective method for de Quervain's disease.[4,5] However, presence of septum between the abductor pollicis longus (APL) and extensor pollicis brevis (EPB) inside the first extensor compartment is described as the major risk factor of injection failure **Fig. 1.**[6-10]

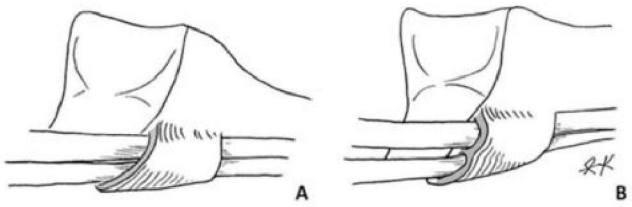


Fig. 1 The first extensor compartment without (A) and with intracompartmental septum (B).

Many studies have emphasized injection in both subcompartments of the APL and EPB can significantly increase the success rate of treatment.[8,11] According to an anatomic study, APL and EPB share a common muscle and vascular supply.[12] Moreover, the synovial sheath of the extensor tendon usually extends from the musculotendinous junction to the tendon insertion.[1]

We believed that these two tendons might have a common or interconnected synovial sheath proximally that allowed the medication to spread in both subcompartments using the one-point injection technique at the proximal portion of the first extensor compartment.

Methods

Nineteen fresh cadavers (6 male and 13 female) from the Department of Anatomy, Mahidol University, were investigated. Any wrist that had deformity, injury or surgical scar in the area of the radial styloid was excluded from our study. The skin overlying the first extensor compartment was removed. A 25-gauge needle was used to inject 2 cc of methylene blue dye, number#151B54, directly between the APL and EPB at a point 3 cm proximal to the palpated radial styloid **Fig. 2**. The needle was inserted at 45 degrees to the radial aspect of the forearm and directed distally.

Then the first extensor compartment was explored to identify the dispersion of dye. In the case with separated compartments, the success result was determined as a diffusion of dye in both subcompartments. The relationship between the first extensor compartment and the superficial radial was investigated.

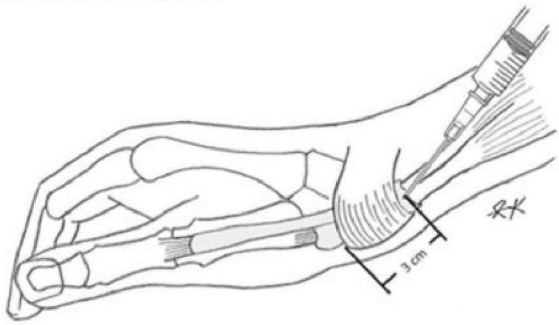
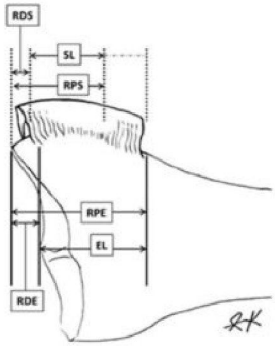


Fig. 2 Proximal injection technique, the needle is placed directly between the abductor pollicis longus and extensor pollicis brevis at the point 3 cm proximal to the palpated radial styloid.

Results

Thirty-seven wrists from 19 cadavers were included in our study. One wrist with arteriovenous shunt in the distal forearm was excluded. The average age was 68.53±9.47 (range 37 to 87) years. The intracompartmental septum was found in 20 of 37 wrists (54%). The septation was complete in 8 wrists (40%) and incomplete in 12 wrists (60%). The details of anatomic findings are presented in **Fig. 3**.



	Mean ± SD (mm)	Range (mm)
EL	25.59 ± 7.3	18-30
RPE	26.45 ± 3.7	18-33
RDE	1.37 ± 1.2	0-4
SL(C)	26.3 ± 4.8	18-30
RPS(C)	26.9 ± 4.8	22-32
RDS(C)	1.25 ± 1.5	0-4
SL(I)	14.0 ± 4.8	7-23
RPS(I)	19.8 ± 5.8	12-30
RDS(I)	5.75 ± 1.8	2-8

Fig. 3 The details of anatomic findings. EL = length of the extensor retinaculum, RPE = distance from the radial styloid to the proximal edge of extensor retinaculum, RDE = distance from the radial styloid to the distal edge of extensor retinaculum, SL = length of septum inside the first dorsal compartments, RPS = distance from the radial styloid to the proximal edge of septum inside the first extensor retinaculum, RDS = distance from the radial styloid to the distal of septum, (C) = complete septation, (I) = incomplete septation

In 20 wrists with intracompartmental septum, the methylene blue dye successfully diffused in both subcompartments in 18 wrists (90%) **Fig. 4**. The dye entered in only the APL subcompartment in 2 wrists (10%), while the complete septation was present in both. Moreover, the distance from the radial styloid to the proximal edge of the extensor retinaculum as well as the septum was 30 mm in one wrist and 32 mm in another.

The mean distance from the radial styloid to the point that the superficial radial nerve crosses the first extensor compartment was 26.59±3.1 mm (range 12 to 44 mm).

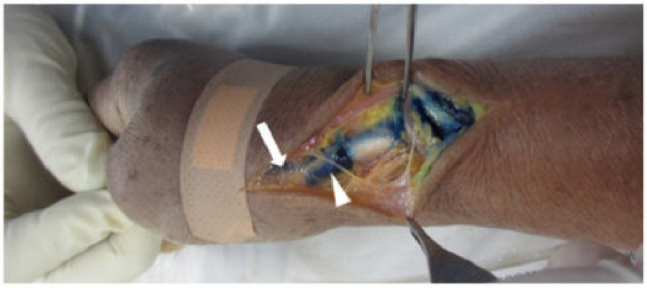


Fig. 4 Diffusion of the dye into both subcompartment, abductor pollicis longus (arrow head) and extensor pollicis brevis (arrow), in the wrist with intracompartmental septum.

Discussion

Among the conservative treatments for de Quervain's disease, corticosteroid seems to be the most effective method with a curative rate of 83 to 93%.[1, 4] Various anatomic studies have investigated the first extensor compartment of the wrist including multiple tendinous slips and variations of insertions of the APL and presence of the intracompartmental septum. Many studies have suggested that the intracompartmental septum is the main cause of failure of corticosteroid injection therapy for de Quervain's disease.[6-10]

In related studies, the presence of intracompartmental septum varied from 32.1 to 77.5%. Among patients with separate compartments, the complete septation was presented in 39 to 71.7% of cases. We found a 54% incidence of intracompartmental septum and a 40% incidence of complete septation documented among patients with separated compartments, and these two values are in those reported ranges.[13-19] The anatomic variation of the first extensor compartment and the septum reported in related studies are summarized in **Table 1**.

Many studies have demonstrated that in the wrist with intracompartmental septum, the one-point injection technique failed to deliver medication in both subcompartments and led to unsuccessful treatment.[8, 9, 11] Many injection techniques have been proposed to ensure that steroid injection can reach both subcomparments.

Table 1. The anatomic variation of the first extensor compartment and the septum reported in previous studies.

References	Operative finding	Cadaveric Study			Length of the first extensor compartment (cm)
	Incidence (%)	Incidence (%)	Type of septum		
			Complete (%)	Incomplete (%)	
Jackson et al (13)	67.5	40	71.7	28.3	
Leslie et al (14)		34			
Gonzalez et al (15)		47			20 (1.1-3.0)
Mahakkanukrauh and Mahakkanukrauh (16)		77.5	39	61	
Shiraishi and Matsumura (17)		44.2	69.7	30.3	
Hazani et al (18)		34.7			21.9±3.7
Motoura et al (19)		32.1	72.2	27.8	
Choi et al (20)	73		63.5*	36.5*	
The present study		54	40	60	25.59 ± 7.3

*operative finding

Regarding the one-point, two-direction technique, the needle is first introduced and injects the medication in the tendon sheath at the level of the radial styloid; then the needle is redirected slightly dorsal aiming to inject the remain medication in a separate subcompartment of the extensor pollicis brevis.[1, 16]

Concerning the two-point technique, the steroid is introduced in a possible subcompartment of the APL and EPB from a different entry point.[8, 9]

Finally, regarding the ultrasound-guide injection technique, many studies have demonstrated that ultrasound can be used to identify the anatomical variation of the first extensor compartment including intracompartmental septum and confirm the corrected location of the needle before injecting corticosteroid in both subcompartments.[10, 20, 21]

Our technique, the one-point proximal injection technique, was based on the anatomic study.

Revol et al. found that the APL and EPB share a common vascular and muscular unit.[12] Wolfe suggested that the synovial sheath of the first extensor compartment usually extends from the musculotendinous junction to the insertion point.[1] Many studies have found that intracompartmental septum is usually confined in the distal portion of the first extensor retinaculum.[13, 14, 16, 20] We hypothesized that some interconnection exists between the synovial sheath of the APL and EPB, proximally.

In a wrist with intracomparmental septum, our success rate of 90% was higher than the one-point injection technique described in related studies. Mirzanli et al. injected acrylic dye int a subcompartment containing APL or EPB from the distal portion of the first extensor compartment in each cadaveric wrist with a separated compartment and found that the dye could enter only one subcompartment.[9]

Zingas et al. injected a mixture of corticosteroid and radiographic dye in the first dorsal compartment among 19 patients. They chose the interval between the APL and EPB at the distal edge of the first extensor compartment retinaculum as the entry point and found that dye diffused in both subcompartments in 5, not in 3 and only one subcompartment among 11 patients: 10 in the APL and 1 in the EPB subcompartment. They believed that small and deeply located subcompartments of the EPB were the cause of failure to place dye in its subcompartment. However, 7 of 11 patients with dye entering only one subcompartment gained relief. They explained the open-ended EPB subcompartment allowed the steroid to flow in from the APL subcompartment.[8]

Injury to the superficial radial nerve should involve the proximal injection technique. In our study, the nerve runs across the first extensor compartment at the point 26.59±3.1 mm (range 12 to 44 mm) proximal to the radial styloid. This finding was comparable to the study of Gurses et al.[22]

Several limitations can be found in our study. First, the sample size was small. The second limitation was lacking a comparison to the standard method. Third, our study was conducted using cadaveric wrists. Thickening of the first extensor retinaculum or narrowing of the compartment in the wrist with de Quervain's disease may have contributed to our failed proximal injection technique. We believe that a further well designed clinical trial study should be performed among patients with de Quervain's disease to confirm the usefulness of our technique.

Conclusion

One-point proximal injection technique can be used as an optional method for injection corticosteroid to treat de Quervain's disease.

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THE EFFECT OF POSITIVE PSYCHOLOGICAL CAPITAL PROGRAM ON RETENTION OF NURSES

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ABSTRACT

Turnover rate of nurses in Thailand has been increasing due to excessive workload, stressful nature of the work and lack of psychological support. Therefore, the researcher has developed interventions to promote positive psychological strengths to improve retention rates among nurses. The purposes of this study were to examine retention of nurses and the effect of the program to develop positive psychological capital among professional nurses. The samples were randomly divided in two groups: experimental and control groups, consisting of 20 nurses each group. The experimental group received the program, including 16-hour class lectures, counseling and activities designed to reinforce the 5 elements of positive psychological capital: self-efficacy, hope, optimism, resilience and hardiness, while the control group did not. The study found that retention intention of nurses in the experimental group was greater than that of the control group with statistical significance.

Keywords : Psychological capital, Retention, Nurses

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Introduction

Nurses play vital roles in providing health services and ensuring patient safety. Nursing practices are based on a holistic approach, covering health promotion, disease prevention, treatment and rehabilitation requiring nursing knowledge, skills and other integrated relevant sciences.[1, 2]

Nurses also need to take responsibility for their duties, morality and ethics to provide nursing services and effectively work with multidisciplinary personnel both from internal and external organizations.[3] Nurses working in the hospitals under the Ministry of Defense, especially in Bangkok including Phramongkutklao Hospital, Bhumibol Adulyadej Hospital and Somdej Phra Pin Klao Hospital have to perform their duties both as professional nurses and military personnel. They have to develop military characteristics and work under military discipline, courtesy and probation, follow the chain of command and strict rules and regulations. Further, nurses have been dealing with heavy workloads and shortage of nurses due to limited funding to produce nurses, causing insufficient production, compared with the demand.[1, 3, 5]

Moreover, shortage of nurses and excessive workload problems cause deteriorated health, work dissatisfaction, stress, anxiety, discouraged feelings, uncertainty with their work and less work commitment.[4, 5] Further, low salary, delayed professional growth and lack of promotional opportunities in the career path has led nurses to leave the organizations they worked for or change their position to nonnursing health professions, which could negatively affect the healthcare system in the Ministry of Defense.

A number of strategies are used to promote work satisfaction such as improved working environment, increased work freedom and use of the participatory approach. However, psychological concepts are gaining great attention among academics focusing on organizational behaviors.[5, 6, 7] Apart from external motivation, positive psychological capital is an internal motivation that can be used to motivate nurses to remain in the healthcare system as long as possible, reduce the resignation rate and lower the number of professionals leaving or changing their workplace.[8, 9] Once positive psychological capital among personnel in an organization has been developed, nurses, who are significant healthcare providers in developing an organization, would be able to perform their duties with maximum potential, enthusiasm, organizational attachment, contributing to working happiness and passion and better retention in nursing career.[10, 11] Thus, the researcher was interested in examining the effect of positive psychological capital on retention of nurses by strengthening psychological capability.[12, 13, 14] and enhancing organizational attachment and working happiness.[15] The research findings could also be used for nursing administrators to reinforce desirable working outcomes among nurses to improve retention and reduce turnover rates among nursing professionals, important workforce mechanisms driving the healthcare system throughout the country. This would contribute to better quality of life, working happiness and quality of care among the nurses[16], which in turn would benefit professional nurses themselves, the Ministry of Defense and the nation in the future.

Materials and Methods

The research hypothesis was retention of nurses in the experiment group will improve after completing the program and scores will be greater than in the control group. In this study, purposive sampling was used to select 40 professional nurses in Phramongkutklao Hospital, Somdej Phra Pin Klao Hospital and Phumibol Adulayadej Hospital. Then the subjects were randomly selected to the experimental and control groups consisting of 20 nurses each group.[6] The studied variables consisted of self-efficacy, hope, optimism, resilience and hardiness. The treatment variable was the positive psychological capital program and the dependent variable was the retention of nurses. For data collection, the researcher started with sending a consent letter to the directors of the studied hospitals to ask for permission to collect data. The Retention of Nurses Questionnaire was piloted with 30 nurses who were not the study subjects at Phramongkutklao Hospital.

The experimental group received the psychological capital program, whereas the control group did not. The program was provided to 20 nurses in the experimental group for 2 days (16 hours), while the control group did not receive any intervention. After implementing the program, the researcher asked both experimental and control group nurses to answer the Positive Psychological Capital Questionnaire again at postintervention and 2-week follow-up to provide sufficient time for those participating in the program to apply what they learned to their nursing practice and examine the sustainability of positive psychological

The research was conducted under consideration of human rights and dignity, justice and rightness. After the research project was approved by the Institutional Review Board (IRB) Committee of the Army Medical Department, the researcher formally informed the director of the hospitals about the research objectives and asked for permission to collect the data. The subjects' rights were strictly protected using both verbal and written information. The consent form was signed by nurses participating in this study. They were informed that denial or discontinuing participation in this research would not affect them in any circumstances.

Data analysis

Descriptive statistics including percentage, maximum, minimum, mean and standard deviations of the scores in the Positive Psychological Capital Questionnaire were used to analyze the data. Content validity of the Retention of Nurses Questionnaire was performed using Index of Item-Objective congruence (IOC) by three experts totest validity between items and definitions specified. Discrimination index for each item of the Retention of Nurses Questionnaire was analyzed using Pearson' Product Moment Correlation. The reliability of the Retention of Nurses Questionnaire was analyzed using Cronbach's alpha coefficient and the means of retention of nurses at experimental, post-experimental and follow-up phases were compared using F-test statistics from Two-way Repeated ANOVA Measurement.

Results

Most samples were aged 25 to 30 years (22.9%), were female (92.6%) and only 7.4% mere male. The majority of them were single (58.2%), 37.7% were married and the rest (4.1%) were divorced, separated or widowed, respectively. In terms of education, 89% obtained a bachelor's degree and the remaining 11% had a Master's degree. Means and standard deviations of each aspect and the overall retention of nurse scores are presented in **Table 1**. The average overall retention of nurses was high at 3.89 and the SD was 0.52 with maximum psychological aspect (X=4.08, SD = 0.60). **Table 2**. shows that the average retention of nurses in the experimental group was higher than in the control group after completing the program and at follow-up with significance at .01 level.

Table 1. Means and standard deviations of each aspect and the overall retention of nurse scores

Retention of nurse	$\bar{X}$	SD	Level
1. Psychological aspect	4.08	0.60	High
2. Nurses' retention aspect	3.85	0.62	High
3. Norm aspect	3.76	0.43	High
Overall	3.89	0.52	High

Table 2. Comparison between experimental and control groups in retention of nurses

Measurement phases	Average		B	SE	t
	Experimental group	Control group			
Pre-experimental	2.76	2.80	-.042	.145	-.342
Postexperimental	3.89	2.97	-.452	.134	1.432
Follow-up	4.15	8.98	-.775	.146	3.656

* $p < .01$

Discussion

According to the research findings, the levels of positive psychological capital of nurses under the Ministry of Defense in the experimental group after receiving the program and at follow-up period were higher than in the control group which did not receive the program. The result was consistent with a study of Luthans et al. (2007)[7] which found that the level of positive psychological capital in the experimental group increased after the program, contributing to better working performance.[14, 16] The result can be explained in that this program was based on positive psychological concepts, positive organizational behaviors and group discussion. It developed individuals' psychological conditions linked to nursing practices. The guidelines to improve each component of the program included developing self-efficacy by promoting beliefs and confidence in one's own ability to obtain achievement to enhance their perception of success in the nursing profession.[17, 18] and developing hope, which is the process of setting goals and plans to achieve them. This leads to great commitment and determination to reach the set goals, developing optimism by creating positive expectations and reasoning to build up positive thinking toward achievement, developing resilience by improving and changing perceptions of the thinking process, emotions and behaviors to realize the value and abilities to return to the right track for success when facing challenges or barriers. Further, the program develops hardiness by improving working dedication and focusing on relaxation and stress management, contributing to greater retention among nurses. With these positive psychological assets, nurses would develop desirable thoughts and abilities to effectively plan and manage their work, believe in their ability to accomplish their goals, never easily give up to any challenges or difficulties and rapidly recover when facing any barrier, leading to greater working performance and success.[18, 19] The Retention of Nurses Questionnaire can also be used for nursing personnel in other organizations. According to the research findings, positive psychological capital is dynamic and motivating as shown by the increased level postintervention period when compared with the control group. Therefore, the program should be provided for nurses to reinforce desirable thoughts, emotions and behaviors to prepare them well prepared for their nursing practices and challenging missions. However, studying and understanding the related concepts, theories and techniques used by psychological experts is highly recommended before applying the program to ensure best outcomes. The hospitals under the Ministry of Defense should consider positive psychological capital an important factor to develop nurses' psychological strengths and potential to prepare them for nursing practices. These psychological assets can push these hospitals forward to be leading organizations in improving nursing personnel' quality of work as specified by the Thai Nursing Council for optimal effectiveness and competitive advantages of the organizations. Thus, policies focusing on positive psychological capital development should be in place in addition to economic, human and social capital.[20]

Recommendations for further research

Many interesting dimensions and gaps of positive psychological capital and its development can be further studied such as other variables that can be explored including working happiness of professional nurses, effect of the positive psychological capital program on nurses in different contexts and settings such as other hospitals under the Ministry of Defense, government hospitals, hospitals of the Ministry of Public Health and private hospitals are recommended. The level of retention of nurses should be continuously followed up at one, three and six months after the program to evaluate sustainability of the program's effectiveness. Furthermore, qualitative data should be explored to gain more insights regarding this issue.

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INTEROBSERVER AGREEMENT OF PI-RADS SCORE VERSION 2 FOR PROSTATE CANCER

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Objective: To assess the interobserver agreement with the use of the Prostate Imaging Reporting and Data System (PI-RADS), version 2.0 to detect prostate cancer using multiparametric magnetic resonance (MR) imaging in a tissue diagnosis patient population.

Materials and Methods: Fifty-six lesions in 37 patients with elevated prostate-specific antigen levels who underwent transrectal ultrasound (TRUS)-guided biopsy or prostatectomy with multiparametric MR imaging of prostate suspicious lesions detected using multiparametric MR imaging were scored by 4 readers of varying experience who were blinded to pathologic results using the newly revised PI-RADS and the scoring system version 2. Inter-observer agreement was evaluated using the Intra-Interclass Correlation Coefficient (ICC).

Results: Inter-observer agreement of 4 observers using the PI-RADS, v2 for prostate cancer produced an intermediate to good agreement beyond chance; ICC = 0.736, (95% CI: 0.565, 0.851). Concerning all observers, the most correlated PI-RADS assessment was between observers 1 and 2, r = 0.758 (p<0.001).

Conclusion: PI-RADS score, version 2 showed intermediate to good agreement in readers of varying experience.

Keywords : Prostate cancer, Prostate MRI, PI-RADS, version 2, Gleason score

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Introduction

Prostate cancer is the second most frequently diagnosed cancer worldwide (13.6 % of all diagnosed cancers) and the third most lethal cancer in men in the developed world.[1] The detection rate of prostate cancer is only around 25% when based on elevated prostate-specific antigen (PSA) and digital rectal examination. Prostate MRI has become an increasingly common adjunctive procedure used to detect prostate cancer. Clinical applications of prostate MRI have expanded to include, not only locoregional staging, but also tumor detection, localization (registration against an anatomical reference), characterization, risk stratification, surveillance, assessment of suspected recurrence and image guidance for biopsy, surgery, focal therapy and radiation therapy.

The procedure of choice is multiparametric MRI (mp MRI), a combination of high-resolution T2-weighted (T2W) morphological sequences and the multiparametric techniques of diffusion-weighted MRI (DWI), dynamic contrast-enhanced MRI (DCE-MRI) and proton MR spectroscopy (^{1}H-MRS). Previously, no uniform recommendations existed in the form of guidelines to implement and standardize communication of findings. The European Society of Urogenital Radiology (ESUR) in 2012 established clinical guidelines to acquire, interpret, and report mp MRI of the prostate to facilitate a greater level of standardization and consistency. These recommendations, popularly referred to as Prostate Imaging Reporting and Data System (PI-RADS),[2] were based on literature evidence and consensus expert opinion and were modeled on similar efforts in mammography (BI-RADS),[3] leading to the transformation of breast cancer care. A number of studies have subsequently validated PI-RADS in certain research and clinical settings; however, experience has highlighted some limitations, in part due to technical improvements and also changes in clinical practice.[4-18] A joint steering committee formed by the American College of Radiology (ACR), ESUR and the nonprofit organization AdMeTech Foundation, have recently attempted to update and improve on the original proposals. PI-RADS version 2 (v2) was officially launched at RSNA 2014, and is now available online.[19] Research has shown substantial inter-observer variability in the interpretation of prostate MRI as a result of heterogeneous reader experience.

The purpose of this study was to assess the inter-observer agreement of the PI-RADS score using histology obtained from TRUS biopsy or pathological results from prostatectomy as the reference standard.

Materials and Methods

Patient cohort

This retrospective study was approved by the Institutional Review Board and required neither patient approval nor informed consent to review patients' images and medical records. However, written informed consent was obtained from all patients for TRUS biopsy or prostatectomy before each procedure according to our hospital's regular policy. A total of 37 patients with increased prostate-specific antigen (PSA) levels (above 4 ng/ml) were retrospectively recruited and enrolled in a research database from April 1, 2013 - December 31, 2014. Inclusion criteria were patients who had biopsy proven prostate cancer and undergone mp MRI without endorectal coil to detectprostate cancer, including high-resolution, triplanar T2-weighted anatomic imaging, diffusion-weighted imaging (DWI), proton MR spectroscopy (1H-MRS) and DCE- MRI at 3 Tesla (3T) in KCMH before surgery. Exclusion criteria included patients who had incomplete pathological data, image distortion caused by hip prostheses or patient motion too severe for readers to interpret and short interval between MRI and biopsy (less than 4 weeks).

MR imaging

All imaging studies were performed using a thirty-two-channel cardiac coil parallel imaging (sensitivity-encoding [SENSE]; Philips Medical Systems, Best, the Netherlands) technique with a 3-T magnet (Achieva; Philips Medical Systems) without the use of an endorectal coil and prior bowel preparation. Hyoscine butylbromide (Buscopan; Boehringer Ingelheim, Ingelheim, Germany) (20 mg) was injected intravascularly immediately before beginning the MR imaging examination to reduce peristalsis. T2-weighted turbo spin-echo images were acquired in three orthogonal planes (transverse, sagittal, and coronal). T2WI scan parameters were as follows: repetition time (TR)/ echo time (TE), 2740/58 msec; slice thickness, 3 mm; interslice gap, 0 mm; field of view (FOV), 1.4 cm; number of signals acquired (NSA), 3 and sensitivity encoding (SENSE) factor, 2.

Axial T1-weighted turbo field echo sequences (6-mm slice thickness; FOV, 3.8 cm) were acquired to detect biopsy artifacts and assess lymph nodes. Diffusion-weighted MR images were acquired in the transverse plane using the single-shot echo planar imaging (EPI) technique with parallel imaging and fat suppression (spectral attenuation inversion recovery). Scan parameters were as follows: TR/TE, 2130-2582/63-76; slice thickness, 3 mm; interslice gap, 0 mm; FOV, 20 cm; SENSE factor 2; and NSA, 3. The frequency direction was anteroposterior to decrease motion or susceptibility artifacts over the prostate. Diffusion-encoding gradients were applied as 4 b values from 500-1500 s/mm^2 (500, 1000, 1200 and 1500 s/mm^2) along the three orthogonal directions of motion-probing gradients. The b values were varied by changing the amplitude of the diffusion gradient with all timing parameters fixed. The ADC maps were automatically constructed on a pixel-by-pixel basis (for b values of 0 and for each b value from 500-1500 s/mm^2). The DWI acquisition time was less than 10 minutes.

Scoring system

The ESUR guidelines endorse a division of the prostate gland in 39 regions.[19] All lesions are rated on a score from the three MRI sequences (T2WI, DWI, DCE-MRI) according to PI-RADS v2. [19] To evaluate T2-weighted data sets, the location of the lesion either in the peripheral or the central zone has to be considered **Table 1-5**.

Table 1. PI-RADS v2. Assessment Categories

PI-RADS 1	Very low (clinically significant cancer is highly unlikely to be present)
PI-RADS 2	Low (clinically significant cancer is unlikely to be present)
PI-RADS 3	Intermediate (the presence of clinically significant cancer is equivocal)
PI-RADS 4	High (clinically significant cancer is likely to be present)
PI-RADS 5	Very high (clinically significant cancer is highly likely to be present)

Table 2. Peripheral zone (PZ) and Transitional zone (TZ)
Peripheral zone (PZ)

DWI	T2W	DCE	PI-RADS
1	any*	any	1
2	any	any	2
3	any	negative / positive	3 / 4
4	any	any	4
5	any	any	5

Transitional zone (TZ)

T2W	DWI	DCE	PI-RADS
1	any	any	1
2	any	any	2
3	≤ 4 / 5	any / any	3 / 4
4	any	any	4
5	any	any	5

*any indicates 1-5

Table 3. PI-RADS assessment for T2W at Peripheral zone (PZ) and Transitional zone (TZ)

Score	Peripheral zone (PZ)
1	Uniform hyperintense signal intensity (normal)
2	Linear or wedge-shaped hypointensity or diffuse mild hypointensity, usually indistinct margin
3	Heterogeneous signal intensity or non-circumscribed, rounded, moderate hypointensity (Includes others that do not qualify as 2, 4, or 5)
4	Circumscribed, homogenous moderate hypo intensefocus/mass confined to prostate and <1.5 cm in greatest dimension
5	Same as 4 but ≥1.5 cm in greatest dimension or definite extraprostatic extension/invasive behavior

Score	Transition zone (TZ)
1	Homogeneous intermediate signal intensity (normal)
2	Circumscribed hypointense or heterogeneous encapsulated nodule(s) (BPH)
3	Heterogeneous signal intensity with obscured margins. Includes others that do not qualify as 2, 4 or 5
4	Lenticular or noncircumscribed, homogeneous, moderately hypo- intense, and <1.5 cm in greatest dimension
5	Same as 4, but ≥1.5 cm in greatest dimension or definite extraprostatic extension/invasive behavior

Table 4. PI-RADS assessment for DWI and ADC

Score	Peripheral zone (PZ) or Transition zone (TZ)
1	No abnormality (i.e., normal) on ADC and high b-value DWI
2	Indistinct hypointense on ADC
3	Focal mildly/moderately hypointense on ADC and iso intense/mildly hyperintense on high b-value DWI
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; < 1.5 cm in greatest dimension
5	Same as 4 but ≥1.5 cm in greatest dimension or definite extraprostatic extension/invasive behavior

Table 5. PI-RADS assessment for DCE

Score	Peripheral zone (PZ) or Transition zone (TZ)
negative	No early enhancement, or diffuse enhancement not corresponding to a focal finding on T2W and/or DWI or focal enhancement corresponding to a lesion demonstrating features of BPH on T2WI
positive	Focal, and; earlier than or contemporaneously with enhancement of adjacent normal prostatic tissues, and; corresponds to suspicious finding on T2W and/or DWI

Scoring

Lesions (n=37) were retrospectively evaluated by four blinded readers {K.S., C.L., N.C. and P.B. with 8 years' (abdominal radiologist), 1 year 6 months' (second year fellowship training in advanced body imaging), 6 month's (first year fellowship training in advanced body imaging) of experience and no-self interpretation of mp MRI of the prostate (third year radiology resident), respectively} comprising the different MRI sequences (T2WI, DWI, DCE-MRI). Third year radiology resident was required to attend lectures for about 3 months given by an abdominal radiologist with 8 years' of experience in interpreting mp MRI of the prostate. Scoring was performed according to the ESUR guidelines (PI-RADS v2). All readers evaluated each lesion separately and were blinded with respect to the patients' clinical data and the histology of the corresponding TRUS biopsy or pathological result. All lesions were marked by a circle on the PACS workstation before starting the study evaluation **Fig. 1, 2**. Lesion documentation used the segmentation model 39-regions; 36 for the prostate, two for seminal vesicles and one for the external urethral sphincter.[19] **Fig. 3**

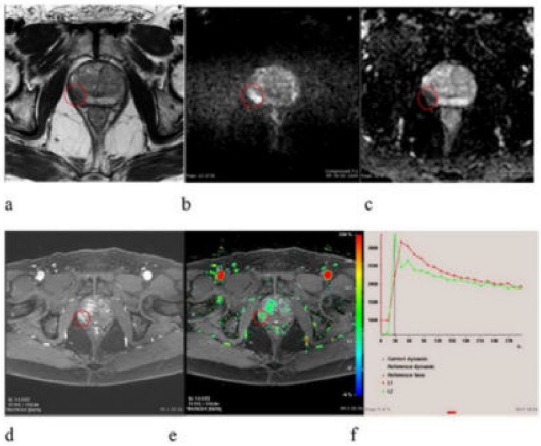

Fig. 1 Example of prostate MRI evaluation of an Axial T2WI with a 1.3 cm circumscribed lesion located in the right posterolateral aspect of PZ at midgland level (marked with a circle); b, c corresponding apparent diffusion coefficient (ADC) map showing a reduced signal and diffusion-weighted imaging (DWI) on high b value (1,500 s/mm^2); d, e, f related dynamic contrast enhanced (DCE)-MRI with steep initial slope of contrast media uptake followed by a quick washout (type 3 curve).

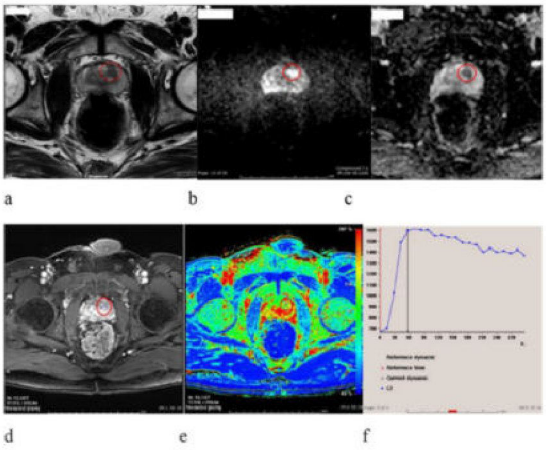

Fig. 2 Example of prostate MRI evaluation of an Axial T2WI with a 0.8-cm circumscribed lesion located in the left anterior aspect of TZ at midgland level (marked with a circle); b, c corresponding apparent diffusion coefficient (ADC) map showing a reduced signal and diffusion-weighted imaging (DWI) on high b value (1,500 s/mm^2); d, e, f related dynamic contrast enhanced (DCE)-MRI with steep initial slope of contrast media uptake followed by a quick washout (type 3 curve).

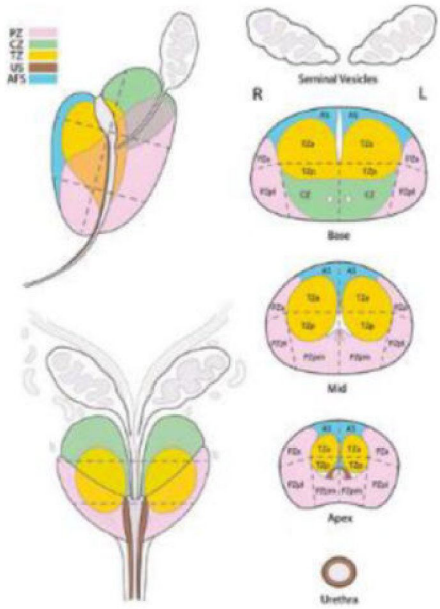

Fig. 3 The segmentation model 39-regions; 36 for the prostate, two for seminal vesicles and one for the external urethral sphincter.

Statistical analysis

Pearson's correlation test was performed for inter-observer correlation. The Intra-Interclass Correlation Coefficient (ICC) was calculated for 1) inter-observer agreement of PI-RADS

score for prostate cancer, 2) agreement between location of tumor (TZ only, PZ only, both TZ and PZ) and low grade lesion (Gleason score < 7) with moderate to high grade lesion (Gleason score ≥7) and 3) agreement between moderate to high grade lesion (Gleason score ≥7) and PI-RADS score. The Chi-square test and ANOVA test were used to determine association between Gleason score (<7 and ≥7) and location of tumor (transitional zone and/or peripheral zone). We performed all calculations with SPSS statistics, 20.0, SPSS (IBM, Corp. Armonk, NY). Statistical significance was defined at a p value below 0.05.

Results

Demographic data

Thirty-seven patients were confirmed histopathologically to have prostate adenocarcinoma. The mean age of all patients was 65.24 ± 6.62 years (median 65 years) and mean PSA value was 17.8 ± 25.33 ng/ml (median 8.25 ng/ml) **Table 6.**

Table 6. Mean, SD and median of age and PSA of the study population.

	Valid N	Mean ± SD	Median [Min, Max]
Age (years)	37	65.24 ± 6.62	65 [51, 77]
PSA (ng/ml)	28	17.8 ± 25.33	8.25 [2, 103.7]

Gleason score and MR imaging

No significant relationship was found between incidence of location of tumor in TZ only, PZ only, both TZ and PZ (overall 56 lesions) and Gleason score <7 and ≥7 (p-value = 0.710) **Table 7.**

Table 7. Incidence of location of tumor in TZ only, PZ only, both TZ and PZ (overall 56 lesions) and Gleason score < 7 and ≥ 7.

Zone	Gleason <7 (n=27)	Gleason ≥ 7 (n=29)	p-value
TZ only	4 (14.8%)	6 (20.7%)	0.710
PZ only	22 (81.5%)	21 (72.4%)	
Both TZ and PZ	1 (3.7%)	2 (6.9%)	

Inter-observer agreement

Inter-observer agreement of four observers using the PI-RADS v2 for prostate cancer was in intermediate to good agreement, ICC = 0.736, (95% CI: 0.565, 0.851). The most correlated PI-RADS assessment was found between observers 1 and 2, $r = 0.758$ (p <0.001) followed by observers 1 and 3, $r = 0.579$(p <0.001) **Table 8.**

Table 8. Correlation and p-value of four observers

PI-RADS score	Observer 1		Observer 2		Observer 3		Observer 4	
	r	p-value	r	p-value	r	p-value	r	p-value
Observer 2	0.758	<0.001	-	-	0.499	0.002	0.476	0.003
Observer 3	0.579	<0.001	0.499	0.002	-	-	0.390	0.017
Observer 4	0.431	0.008	0.476	0.003	0.390	0.017	-	-

In the subgroup, excellent agreement was found among four observers, ICC = 0.972, (95% CI: 0.915, 0.995) between location of tumor (TZ only, PZ only, both TZ and PZ) and low grade to high grade lesion (Gleason score <7 and ≥7) **Table 9.**

Table 9. Inter-observer agreement between location of tumor in each zone of prostate gland and Gleason score < 7 and ≥ 7 using intra-Interclass Correlation Coefficient (ICC) = 0.972, (95% CI: 0.915, 0.995).

Observer	TZ (lesions)		PZ (lesions)		TZ and PZ (lesions)		benign (lesions)
	Gleason<7	Gleason≥7	Gleason<7	Gleason≥7	Gleason<7	Gleason≥7	
1	2	6	17	21	1	2	7
2	2	6	16	21	2	2	7
3	1	4	15	23	1	2	10
4	2	10	14	21	1	1	7

Excellent agreement was found among four observers, ICC = 0.903, (95% CI: 0.575, 0.997) between moderate to high grade lesion (Gleason score ≥7) in TZ only and given PI-RADS score of all observers **Table 10.**

Table 10. Inter-observer agreement between moderate to high grade lesion (Gleason score ≥ 7) in TZ only and PZ only and PI-RADS score using intra-Interclass Correlation Coefficient (ICC) = 0.903, (95% CI: 0.575, 0.997) and ICC = 0.542, (95% CI: 0.009, 0.982) respectively.

Observer	Gleason score ≥ 7 at TZ (lesions)			Gleason score ≥ 7 at PZ (lesions)		
PI-RADS	3	4	5	3	4	5
1	1	1	4	0	7	13
2	1	1	4	0	9	13
3	1	0	3	0	6	15
4	0	5	3	0	2	10

Intermediate to good agreement was found among four observers, ICC = 0.542, (95% CI: 0.009, 0.982) between moderate to high grade lesion (Gleason score ≥7) in PZ only and given PI-RADS score of all observers **Table 10.**

Discussion

The findings of our study revealed that the new version of PI-RADS v2 provided intermediate to good inter-observer agreement among readers of varying experience as well as excellent agreement among four observers, ICC = 0.972, (95% CI: 0.915, 0.995) between location of tumor (TZ only, PZ only, both TZ and PZ) and low grade to high grade lesion (Gleason score <7 and ≥7). In 2013, the Rosenkrantz et al.[18] showed that the inter-observer reproducibility for the original PI-RADS was moderate (concordance correlation coefficient, 0.47) among readers of varying experience, similar to the results of our study. Our study showed the most significantly correlated PI-RADS assessment between observers 1 and 2 followed by observers 1 and 3. Observer 1 was the most experienced followed by observers 2, 3 and 4. A slight difference was found between the result (including location of tumor and given PI-RADS score) of observer 4 who was least experienced and the results of more experienced observers. Our results suggest that experience is necessary for further improving the detection of prostate cancer by MRI imaging and can lead to a fairly high level of accuracy. MR is gaining acceptance as the most accurate imaging investigation to locally assess prostate cancer. The improved performance of MR imaging within the last several years has probably been due mainly to advances in MR technology. Understanding imaging criteria and experience in image interpretation are also growing. In 2010, Akin et al.[20] showed that dedicated interactive training sessions conducted by expert radiologists who provided weekly interactive tutorials with individualized feedback incorporating pathologic results of previously interpreted studies significantly improved accuracy in detecting tumors and extracapsular extensions among radiology fellows. In a similar fashion, Leeuwenburgh et al.[21] showed the efficacy of a tutorial that provided direct feedback to radiologists after interpreting each case to improve performance in diagnosing acute appendicitis. To our knowledge, the lesion revealed Gleason score ≥7 defined as moderate to high grade lesion. Our study showed excellent inter-observer agreement, ICC = 0.903, (95% CI: 0.575, 0.997) and intermediate to good inter-observer agreement, ICC = 0.542, (95% CI: 0.009, 0.982) between moderate to high grade lesions in TZ only and in PZ only, respectively. In 2013, Schimmöller el al.[4] evaluated the original PI-RADS from 2012 and showed higher accuracy in the PZ than in the TZ. In our study, the results for the two zones were comparable. This might have indicated better performance for detecting tumors in the TZ with the revised edition and generally increased awareness of anterior lesions in the TZ. However, the size of tumor is important, as larger tumors can be more easily detected in TZ. No significant relationship was found between incidence of location of tumor and low to high grade lesion (Gleason score <7 and ≥7). This might be due to our small sample size.

Our study had limitations. First, because our study was retrospective, selection and verification biases may have occurred. Moreover, because readers interpreted the MR imaging data with the knowledge that the patients had prostate cancer, a potential bias might have been readers considering equivocal lesions as prostate cancer; thereby, increasing the sensitivity. Second, because our study included patients who underwent radical prostatectomy, a selection bias might have been that only patients with less aggressive and more localized prostate cancer were involved. Finally, the correlation between imaging and histologic examination on a section-by-section basis has inherent limitations because the angle of the histologic slices may differ from that at MR imaging and the prostate usually shrinks during fixation.

Conclusion

PI-RADS are an important standardization tool for reporting multiparametric MR imaging results. However, the results of this study were intermediate to good inter-observer agreement for readers of varying experience showing like the first version of PI-RADS. The inter-observer agreement may be increased by additional divisions of PI-RADS atlas and diminished variation in the acquisition, interpretation and reporting of prostate mp MRI examinations.

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