

## Knee Pain Associated with Rupture of Tensor Vastus Intermedius, a Newly Discovered Muscle: A Case Report

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### Abstract

**Introduction:** Muscle strains within the quadriceps muscle group are common and occur mostly in the rectus femoris. We report a case of an isolated rupture of the tensor vastus intermedius (TVI); a muscle that has recently been described. It belongs to the quadriceps muscle group and is closely related to the vastus lateralis and vastus intermedius.

**Case presentation:** A healthy 62-year old woman presented with a history of a sudden onset of left knee and thigh pain after stumbling and preventing a near fall. Rupture of the aponeurotic tendon of the TVI was diagnosed by magnetic resonance imaging (MRI). Conservative treatment was successful. Four months after injury the patient returned to her pre-injury level of activity. MRI evaluation five months post-injury revealed full resorption of the muscular haematoma and a healed TVI aponeurosis with scar tissue formation.

**Conclusion:** Due to its anatomic appearance, lesions to the TVI may be overlooked. The isolated rupture of the TVI in the present case further supports the recent finding, that the TVI is a distinct anatomical structure independent of the adjacent vasti.

**Keywords:** Muscle strains; Magnetic resonance imaging; Rehabilitation; Knee pain; Ligamentous injury; Muscle injury; Haemorrhage

### Introduction

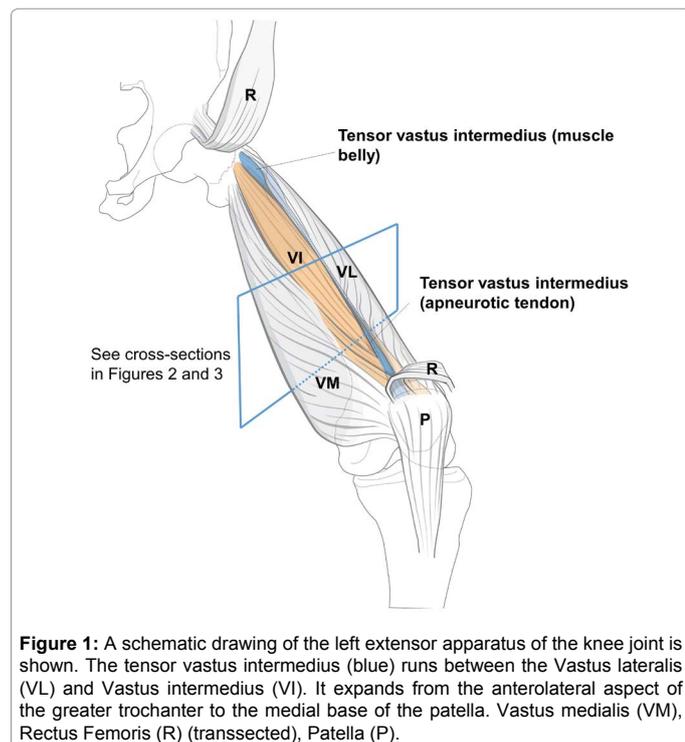
Muscle strains of the quadriceps muscle group are common, and occur mostly in the rectus femoris [1]. They usually manifest as a result of a rapid eccentric contraction [2] such as sprinting or kicking [1]. The injuries are usually non disruptive to the tissue integrity and typically resolve with conservative management [3]. It has been shown that the primary function of the quadriceps femoris group is eccentric deceleration in the early stance phase of gait. Although the rectus

femoris has the highest incidence, other muscles of the quadriceps are injured in isolation [1,4,5]. The tensor vastus intermedius (TVI) has recently been described as an additional component of the extensor apparatus of the knee joint, located between the vastus lateralis and vastus intermedius muscles. It originates from the anterolateral aspect of the greater trochanter and combines distally into a variable broad, flat tendon or aponeurosis merging into the quadriceps tendon (Figure 1) [6,7]. We present a case of TVI rupture including the MRI findings.

### Case Presentation

A 62-year old, slightly obese female (BMI 31) patient presented to the orthopaedic clinic with a history of left knee and thigh pain after a stumble. She lost balance, but managed to stabilise her body with her left leg in a flexed knee position. She then experienced a sharp knee pain accompanied by a “crunching sound” in the lateral thigh. On physical examination, there was no joint effusion or ligamentous injury. The lateral quadriceps femoris muscle from its mid portion down was swollen and tender. No muscle defect was palpable. Passive knee flexion and resisted extension was painful. Passive flexion was 40 degrees with full passive extension. There was no extension lag. Straight leg raise was painful and difficult. There was no history of prior knee problems.

Anterior-posterior and lateral radiographs of the knee were normal. MR imaging demonstrated a rupture of the “intermuscular septum” between vastus intermedius and vastus lateralis. This correlates to the



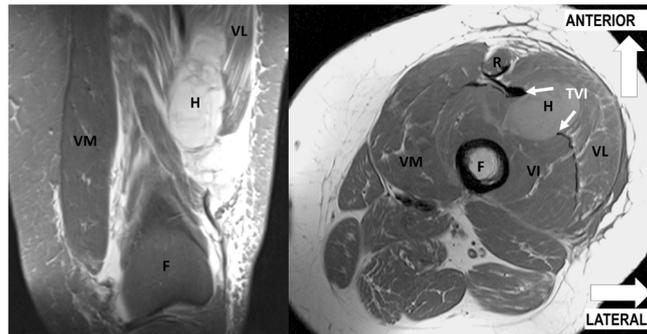
**Figure 1:** A schematic drawing of the left extensor apparatus of the knee joint is shown. The tensor vastus intermedius (blue) runs between the Vastus lateralis (VL) and Vastus intermedius (VI). It expands from the anterolateral aspect of the greater trochanter to the medial base of the patella. Vastus medialis (VM), Rectus Femoris (R) (transsected), Patella (P).

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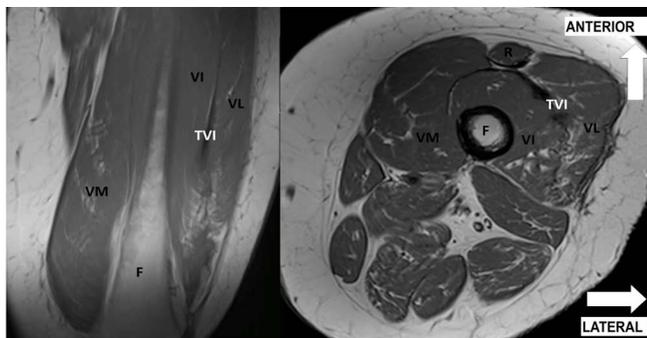
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**Figure 2:** The T1-weighted cross-section (right) and the corresponding T2-weighted coronal plane (left) MR images demonstrate a rupture (discontinuity) of the aponeurotic tendon of the tensor Vastus intermedius (white arrows). See also Figure 1. Edema and Haematoma (H) is present in the adjacent Vastus intermedius (VI) and Vastus lateralis (VL). Vastus medialis (VM), Rectus femoris (R), Femur (F).



**Figure 3:** The T1-weighted cross-section (right) and the corresponding coronal plane MR images (of the same thigh) five months post-injury demonstrate full resorption of the muscular haematoma and healed tensor Vastus intermedius (TVI) aponeurosis with scar formation. The adjacent Vastus lateralis (VL) and Vastus intermedius (VI) show minor atrophic changes. Vastus medialis (VM), Rectus femoris (R), Femur (F).

aponeurotic tendon of the TVI (Figure 1) [6]. There was a moderately high signal, centred about the ruptured aponeurotic tendon of the TVI with discontinuity at the muscle-tendon junction, best seen on axial T2-weighted images. Extended edema and haematoma was present in the adjacent vastus intermedius and lateralis muscles (Figure 2).

Treatment included compression bandage of the knee joint and thigh, ice application, rest and elevation for the first three days. Muscle relaxant and non-steroidal anti-inflammatory drugs were given to reduce the pain and avoid the development of myositis ossificans. After the acute phase the patient started with isometric exercises and active stretching of the muscle within pain limits. The patient was able to walk with crutches after two days and continued so for the next six weeks. After twelve weeks the patient had regained full pain-free range of motion and after four months, she returned to her pre-injury level of activity.

MRI evaluation five months post-injury revealed full resorption of the muscular haematoma and a healed TVI aponeurosis with scar tissue formation. There were minor atrophic changes of the adjacent vastus lateralis and intermedius (Figure 3). Two and a half years post-injury the patient remained asymptomatic during daily activities. However, after walks of more than one hour she occasionally experienced increased fatigue in her left quadriceps muscle accompanied by a mild pain in the area, where the TVI muscle injury occurred. Downhill walking increased this phenomenon.

## Discussion

Muscle injuries most often occur with excessive eccentric muscle contractions [2]. Biarticular muscles and muscles with a higher content

of type II fibres are more susceptible to injury [8]. Laboratory studies show that partial and complete tear injuries exhibit disruption of muscle fibers near the muscle-tendon junction [2]. The hamstrings, followed by the quadriceps and gastrocnemius muscles, are the most commonly affected muscles [9]. The biarticular rectus femoris is the most commonly injured quadriceps muscle. Cross et al. followed forty professional football players over three years. During this time 25 clinical quadriceps injuries occurred, with only seven involving the vasti muscles (6 vastus intermedius, 1 vastus lateralis and 0 vastus medialis) [1]. There are very few cases of vastus muscle strain injuries reported in the literature [1,4,5,10] and because most of these injuries had no routine MRI, it is unknown what kind of vastus strain occurred.

The present report presents a case of an isolated TVI strain. The existence of this muscle has only recently been reported as a component of the lateral part of the extensor apparatus of the knee joint [6,7]. The TVI originates from the anterolateral aspect of the greater trochanter and combines distally into a variable broad, flat tendon or aponeurosis (Figure 1). Traditionally, the TVI has been attributed to the VL. Henle reported of a multi-layered vastus lateralis with different directions of their muscle fibres [11,12]. Williams found that the lower anterior edge of the vastus externus consists of two tendinous laminae, which can very easily be split into two layers [11]. Gegenbaur described intermuscular membrane (“membrana intermuscularis”) belonging to the VL that expands from the middle third of the femur to the lateral femoral condyle [12]. Such an intermuscular membrane has also been illustrated on cross-section in the textbook of Poirier [13]. Testut also mentioned a variation of the VL where a superficial and deep lamination (lamina profunda and lamina superficialis) could be distinguished [14]. These early findings have been confirmed by

investigations of Willan who noted that the vastus lateralis includes a fleshy lamella in 36% of thighs and that the tendinous continuation contributed to the quadriceps tendon [15].

The appearance of the TVI has also been documented sonographically in forty knees of twenty subjects (ten males and ten females). The tendinous portion of the TVI was consistently located in the fascial plane between the VL and VI at the proximal aspect of the distal third of the anterolateral thigh [7].

Owing to the course of the TVI from the antero-lateral aspect of the greater trochanter to the medial patella (Figure 1), this muscle appears to be significant in terms of controlling the motion of the patella in addition to its extensor function of the knee joint. It has been hypothesized that the fibres of the TVI aponeurosis that enter the middle layer of the quadriceps tendon from the oblique lateral aspect, counteract the forces of the medial components of the quadriceps muscle group. The TVI aponeurosis, which is in close contact with the vastus intermedius over a long distance, exerts tension on the vastus intermedius and tightens it medially [6,7]. Similar to the other components of the extensor apparatus, the TVI acts as much to power knee extension as to prevent knee flexion. The strain mechanism of the TVI caused by an eccentric action in the present case emphasizes its function to decelerate flexion of the knee joint.

It is understood that the causes of muscle injuries are often multifactorial [2,9]. Use of systemic or local steroids, statins or fluoroquinolones as well as disorders such as renal insufficiency, hyperparathyroidism, rheumatoid arthritis, obesity, gout and systemic lupus erythematosus may predispose to ruptures. Besides repetitive loading during sport activity, other factors such as fatigue, inflexibility, poor coordination and intrinsic tightness, age, poor flexibility, lack of warm-up and muscle temperature may all contribute to muscle overload [2,9,16-23]. Except for obesity, our patient exhibited no other comorbidity or medical condition that would have promoted this uncommon injury to the TVI. Most probably there were age-related factors, increased BMI combined with the severe eccentric overload during the stumble that led to the muscle injury in the present case.

MRI is the imaging technique of choice for evaluating acute musculotendinous injuries [1] and is useful when swelling or other soft-tissue abnormalities obscure the physical examination. MRI is most sensitive in evaluating the appearance of muscle haematomas and the healing process. In our patient, MRI revealed the isolated rupture of the TVI aponeurosis (at first glance corresponding to the intermuscular septum between the vastus intermedius and vastus lateralis) that caused a large haematoma and consecutive signal changes in the adjacent vastus lateralis and vastus intermedius muscles. Because the TVI (lying between the vastus lateralis and the vastus intermedius) has been given little attention so far, any damage to its structure has not been recognized to date. Cross et al. observed straining of the vastus lateralis muscle in one case (out of 25 acute quadriceps muscle strains) and noticed straining of the adjacent intermuscular septum [1]. Anatomically, the aponeurosis of the TVI runs adjacent to the descending branch of the lateral circumflex femoral artery [6]. Therefore, rupture to the TVI might also cause a rupture of the adjacent vessels and result in haemorrhage. The aponeurosis of the TVI inserts through the intermediate layer of the quadriceps tendon on the medial base of the patella [6]. This explains radiating pain to the knee joint in the present case.

## Conclusion

This is the first reported case of a rupture of the TVI. Because of

its anatomic appearance and relationship to the vastus lateralis and intermedius muscles, lesions to the TVI have been attributed to injuries of the latter. The isolated rupture of the TVI in the present case further supports the recent finding, that the TVI is a distinct anatomical structure independent of the adjacent vasti. Further research is needed to establish its exact function and clinical relevance.

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