The Pellegrini-Stieda lesion of the knee

The Pellegrini–Stieda Lesion of the Knee: An Anatomical and Radiological Review

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J Knee Surg 2019;32:637–641.

Abstract

The Pellegrini–Stieda lesion is a calcification on the medial side of the knee. The origin of this tissue is controversial. The purpose of our study is to investigate the origin of the Pellegrini–Stieda lesion using conventional radiography as to recreate the circumstances in which Pellegrini and Stieda had to study this pathology. Six nonpaired fresh-frozen cadaveric knees were used. A surgical approach to the medial side of the knee was performed using the layered approach. The origin of the gastrocnemius muscle (GM) ($n = 3$) or the superficial medial collateral ligament (sMCL) ($n = 3$) were marked with a radio-opaque fluid. X-ray analysis was performed by measuring the distance from the proximal part of the marking to the medial tibial plateau, multilayer views, and comparison to the original X-rays by Pellegrini–Stieda. Two out of three markings in both the GM and sMCL group were matched with the correct structure. The images were digitally processed so that the osseous structures became partly transparent. After overlaying the images, we found a random distribution of the markings. The Stieda/GM group had no overlap of the markings at all. Compared with the original images from the publications by Pellegrini and Stieda, no comparable position could be found between the original lesions and the markings in our specimens. Conventional X-ray of the knee could not reproduce a distinction between the sMCL and GM as origins for the Pellegrini–Stieda lesion as suggested by Pellegrini and Stieda.

Keywords
- Pellegrini–Stieda
- radiologic study
- cadaver study

The Pellegrini–Stieda (PS) lesion is often interpreted as a calcification of the origin of the medial collateral ligament (MCL) of the knee.[1–4] The PS lesion is usually treated conservatively. In selective cases, with symptomatic instability or persistent pain, surgery may be indicated.[5] The origin of this lesion is reported to be either traumatic or due to repetitive microtrauma to the MCL.[3,6,7] However, involvement of other surrounding anatomic structures has also been suggested.[8–11] Analysis of the original publications by Stieda and Pellegrini reveals the that they had already made a distinction between anatomical

received
December 12, 2017
accepted after revision
May 26, 2018
published online
July 10, 2018

DOI https://doi.org/10.1055/s-0038-1666867.
ISSN 1538-8506.

structures for the lesion.[12,13] Pellegrini described the origin of the MCL of the knee as the location of the calcification.[13–15]

In contract, Stieda reported the calcification to be located in the medial part of the origin of the gastrocnemius medial head muscle (GM).[12]

Therefore, the PS lesion might not entail one entity but represent a spectrum of traumatic lesions resulting in an ossification on the medial side of the distal femur.

The purpose of this study is to investigate the possibility of multiple origins—and therefore multiple causes of the PS lesion—by investigating the structures pointed out by Stieda and Pellegrini using their same conventional radiography technique. The choice to use only conventional radiography is to recreate the circumstances in which these pioneers of our profession performed their work.

Materials and Methods

Six nonpaired cadaver legs were used (5 left and 1 right knees). No marked deformities or previous history of trauma or surgery were present.

A medial approach of the knee and the structures under investigation was performed by means of dissecting the skin and subcutaneous fatty tissue by two experienced knee surgeons. The origin of the superficial MCL (sMCL) and gastrocnemius tubercle (origin of the medial head of the GM)[16] were exposed. The exact location was established in a standardized fashion. First, the adductor magnus tendon was identified and traced distally, revealing the adductor tubercle. Starting from the adductor tubercle, the medial epicondyle was identified by proceeding 12.6 mm distally and 8.3 mm anteriorly. From the epicondyle, the origin of the sMCL was identified by proceeding 4.8 mm posteriorly and 3.2 mm proximally from the epicondyle. The medial gastrocnemius tubercle was identified by following the medial head of the gastrocnemius[16,17] (►**Fig. 1**). After identification, all structures were marked with pins.

The knees were randomly assigned to either the sMCL ($n = 3$) or GM ($n = 3$) group. A region of 1 cm was marked around the origin of the sMCL of the knee or a region of 1 cm from the origin of the medial head of the GM in the distal direction, depending on the assigned group. The sMCL group was to become the "Pellegrini" group and the GM the "Stieda" group.

The cadaveric knee was placed on a regular X-ray table in an anteroposterior (AP) fashion and the allocated structure (sMCL or medial head of the GM) injected with undiluted barium sulfate suspension (Micropaque 1,000 g/L barium sulfate, Guerbet, Paris, France) (►**Fig. 2**). The region was infiltrated with as much fluid as possible, leading to an average maximal fluid mass of 1 to 1.5 mL. If the structure was not sufficiently visible for analysis on the radiological image, additional fluid was administered. The radiologic source was on the anterior side of the knee and the receiver cassette placed underneath the knee in a drawer specifically designed for this cassette.

Only the AP direction was used or comparison with the original X-rays in the historical publications by Pellegrini and Stieda.

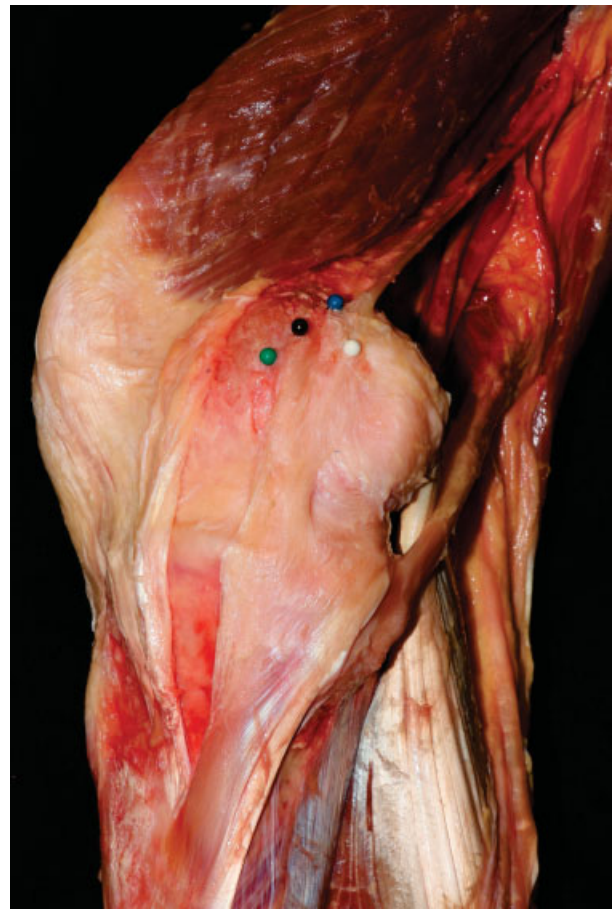

Fig. 1 Medial aspect of the knee, marked are the adductor tubercle (blue), medial epicondyle (green), superficial medial collateral ligament (sMCL) insertion (black), and the medial gastrocnemius tubercle (white).

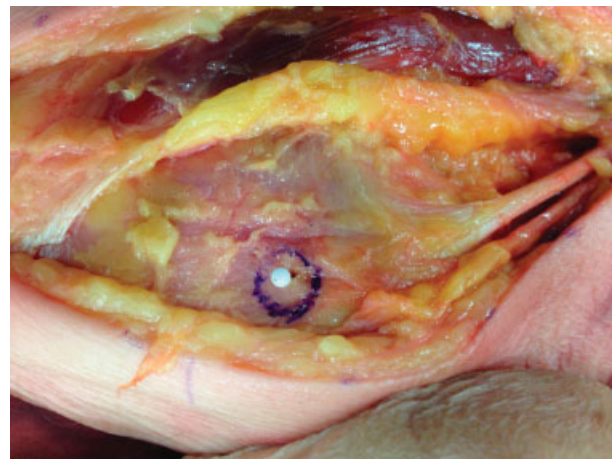

Fig. 2 Approximate area of barium sulfate infusion, marked with a blue surgical pen.

Comparison of Specimens

The radiological images were digitally analyzed and compared with the original X-rays/image of the cases described by Pellegrini and Stieda.[12,15] The images were blinded to the analyzer.

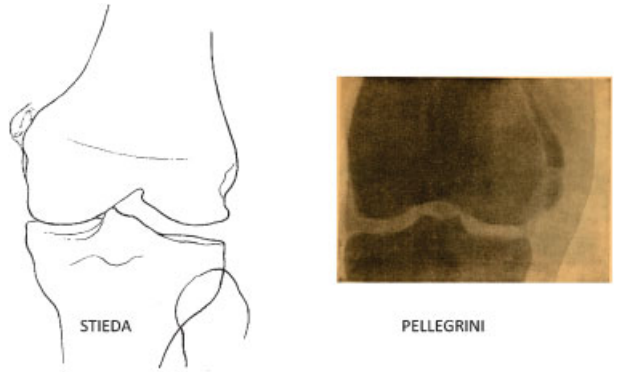

Fig. 3 Original images reproduced with permission from the key publications by Stieda[12] and Pellegrini.[13]

For reason of better reproducibility, the distance between the most proximal part of the contrast-marked region to the medial tibial plateau was determined. The proximal part was chosen as to decrease the risk of wrong measurements because of (unwanted) extravasation into the marked structure or surroundings. It creates a fairly straight line that can easily be measured. This way two groups were formed based on the measured distances. The cadaveric knees that were marked were compared with the original Pellegrini and Stieda X-rays. The observer only knew that in three knees the sMCL (Pellegrini) was marked and that in three other knees the GM (Stieda) was marked. Based on comparability to the original images, the observer allocated each cadaveric knee to either the sMCL or the GM group.

Afterwards, it was revealed which structure was marked in each cadaveric knee.

By digitally coloring the structures in the X-rays, both the groups where the GM was marked and the group where the sMCL was marked could be compared by layering these on top of each other and comparing the distribution of the sulfate suspension (►**Fig. 3**). Anatomical landmarks (top of the fibula, the notch, and the lateral and medial condyle) were used for overlap of the images.

Comparison of Specimens with the Original Images by Pellegrini and Stieda

The measuring method as described in the former paragraph was also applied to the original images. In the case of the original Pellegrini image, there are two visible calcifications. The most proximal part of the distal calcification as seen on the X-ray was used (►**Fig. 4**).

In the original images of Pellegrini and Stieda, we measured the distance from the proximal part of the lesion to the medial tibial plateau. This way they could be compared with the cadaveric knees. It was established whether there was a comparability of these distances, since the groups are too small to measure correlation.

Results

Comparison of Specimens

The results of the measurements are presented in ►**Table 1**. There was a match in 66% of the knees (2 out of 3) in each group. This meant that 2 out of 3 knees with a marked sMCL were put in the sMCL group and one in the GM group. The average distance in the group thought to contain sMCL marked knees was 33.2 mm (range, 30.2–39.0). In the group though to contain GM marked knees the average measured distance was 44.0 mm (range, 35.9–51.3).

The results from overlying the images are shown in ►**Fig. 3**. A relative equal distribution in the Pellegrini group and a more diverse distribution in the Stieda group

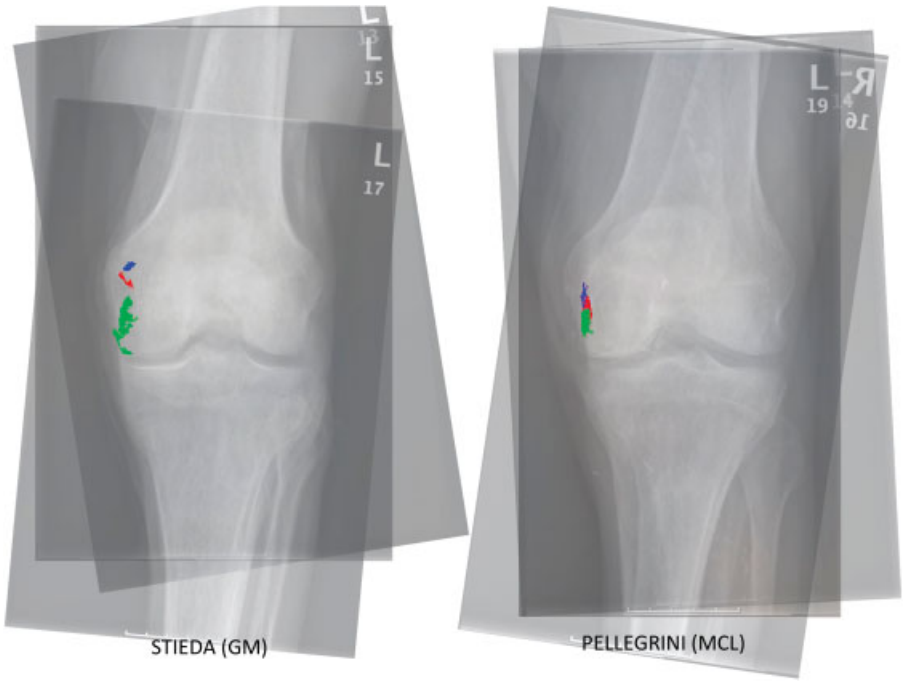

Fig. 4 Overlays of colored images, three samples each.

Table 1 Distances measured from top of marking to the medial tibial plateau and assigned group

Specimen	Distance measured (mm)	Assigned group	Actual group
Pellegrini	39.4	N/A	MCL
Stieda	53.6	N/A	GM
I	51.3	**GM**	**GM**
II	30.2	**sMCL**	**sMCL**
III	39.0	**sMCL**	**sMCL**
IV	35.9	GM	sMCL
V	44.7	**GM**	**GM**
VI	30.4	sMCL	GM

Abbreviations: GM, gastrocnemius muscle; sMCL, superficial medial collateral ligament.
Note: Matches are given in bold.

was found. Since there appeared to be no overlap in the GM/Stieda group, quantification of this distribution was not considered reliable.

Comparison of Specimens with the Original Images

The overlays were optically compared with the original images (►**Fig. 4**). The original lesions were found to start more proximal (Stieda) or distal (Pellegrini) than in the specimens of this study. There was poor similarity of the marked structure in specimens with the calcification in the original images.

Discussion

Conventional X-ray of the knee could not reproduce the historic distinction between the sMCL and GM as origins for the PS lesion as suggested by Pellegrini and Stieda. Their precise descriptions are as follows:

Pellegrini stated: "*Surgery on 30th April 1905: we opened the ossification and the tumor is visible that it began from the epicondyle, which adheres and goes down along the tibial collateral ligament of the knee. With the chisel blows are given on the top of the tumor adherent to the epicondyle, removing even a thin layer of bone of the femur, then with the scissor we cut the distal end of the tibial collateral ligament keeping a certain distance from the end of ossification.*"[13] Stieda stated: "*Thus it concerns in the described preparation without a doubt a rupture of the upper part of the internal epicondyle and we may well suppose also in our clinically observed cases the analogue injury, especially since the position of the shadow in the X-ray fits more with a tearing of the muscle insertion (upper portion of the internal epicondyle) than with a tear of the insertion of the inner sideband (lower portion of the internal epicondyle). Furthermore it is an interesting question, whether the projection comes off by direct force or because of muscle pull.*"[12]

There are some limitations to this study. The first is the limited number of studied specimens. A larger amount could have given more reliable results. The method of injection has not been validated. However, in performing the technique, the region of interest as marked could be infiltrated without visible excess extravasation outside of this region. If there was extravasation into the marked structure, the method of measuring from the origin of the structure should minimize the effect on the results. Furthermore, it might be questionable whether the exact X-ray setup was used in this study compared with the past technique by Stieda and Pellegrini. This is due to the evolving technique since the first X-rays as well as due to the lack of detailed information of the X-ray settings and technique used in their historic publications. It might be argued that specific location of the origins of the femoral sMCL and GM insertions can more easily be reproduced by additional X-ray views or different imaging techniques such as magnetic resonance imaging (MRI). Considering the aim of this study to investigate the reproducibility of two possible anatomic lesions for a radiographic PS lesion as suggested by Stieda and Pellegrini, in this study we chose to limit this to a comparable radiographic technique as presented in their historical publications. Addition of MRI would have given more accurate imaging but by method of dissection and identification of the structures the question was not whether the right structure was injected but whether the resulting image was comparable to the originals presented by Stieda and Pellegrini.

Although the location of the origin of sMCL and GM is reported to be very reproducible anatomically,[16,17] this study showed that marking either the sMCL or GM origin did not result in reproducible imaging by the radiography technique of their historical publications.[12,13] By using conventional radiography, it is not possible to distinguish reliably different structures where the calcification might have originated. This may be attributed to the fact that the structures in the cadaver specimens were not injured. Secondary to the mechanism of injury in PS lesions, swelling or hematoma may displace the injured ligament or tendon and subsequently the calcification that can be viewed on X-ray. This notion was also raised by other authors. Mendes et al performed MRIs of the PS lesion and divided them into four types.[8] Although these four types are distinct in their radiological appearance, no definitive anatomical origin could be related to each type, which confirms the findings of this study. They also found that the MCL could be partially torn or even normal with the PS lesion. As such, one might postulate that the contrast injections without detaching the sMCL of GM insertions on the femur in this study should be able to replicate the findings by Pellegrini and Stieda. In another MRI study, McAnally et al hypothesized that periosteal stripping could be the cause of the PS lesion on the medial side of the knee.[18] This would mean no specific structure might give rise to a PS lesion as well, which was not investigated in this study.

The debate on the origin of the PS lesion remains lively. Recent studies suggest other possible origins of the PS lesion, such as the adductor magnus muscle or the medial patellofemoral ligament, in additional to the sMCL.[8,10] Both Niitsu et al and Wang and Shapiro found the lesion to be located in the MCL upon surgery, but the latter authors reported it to be located in the deep MCL while the former authors reported it to be located in the sMCL.[19,20] Other authors did not find

lesions to be related to any structure upon surgical removal, adding more confusion to the origin of the PS lesion.[21,22]

MRI or surgery may be the most reliable way of establishing the origin of the calcification on the medial side of the knee. Since clinical relevance is low and surgery not always warranted in cases with asymptomatic lesions, MRI seems to be the most promising method of further research into the origin of the PS lesion. In this study, the proximal part of the anatomic contrast marking was deemed to be a reliable location as proximal margin for measurement in relation to the medial tibial plateau on the AP X-ray. The structure originates proximally and is directed distally in both the sMCL and the GM. When comparing the distances measured in this manner, no clear comparability of the distances measured in the specimens belonging to either the sMCL or GM group could be found. The groups were too small to establish a correlation.

Conclusion

Conventional X-ray of the knee could not reproduce a distinction between the sMCL and GM as origins for the PS lesion as suggested by Pellegrini and Stieda.

Conflict of Interest
None declared.

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