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Saphenous nerve injury during hamstring tendons harvest: Does the incision matter? A systematic review

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Abstract
Purpose Infrapatellar branch of saphenous nerve injury is a common complication following hamstring graft harvest during anterior cruciate ligament reconstruction. The direction of skin incision performed at proximal tibial metaphysis may affect the rate of iatrogenic nerve damage. Aim of the present systematic review was to evaluate evidence that would substantiate the adoption of one incision over another for hamstring graft harvesting.
Methods The available literature was systematically screened searching studies dealing with iatrogenic injury to the saphenous nerve after anterior cruciate ligament reconstruction using hamstring tendons. A search was performed using the keywords "Saphenous" and "Infrapatellar branch" in combination with "Anterior cruciate ligament", "arthroscopy" and "hamstrings", supplying no limits regard the publication year. Coleman methodological score was performed in all the retained articles.
Results Five articles matched the inclusion criteria. There were two randomized controlled trials, one prospective comparative study and two retrospective comparative series. Poor methodological quality was found overall. A vertical incision was found to significantly affect the presence of hypoesthesia and the extent of the area of sensory loss in three articles; no difference was registered in one, and a trend towards a lower rate of iatrogenic nerve damage using an oblique incision was found in the remaining one, without any statistical significance.
Conclusion Although the low methodological quality of the analysed studies does not permit to draw definitive conclusions, the anatomical course of the nerve along with the results obtained in the available studies seems to suggest lower rate of neurological impairment adopting an oblique incision. This kind of incision may therefore be preferred in the routine clinical practice.
Level of evidence Systematic review, Level II.

Keywords Saphenous nerve injury · Hamstring tendons harvest · Complications · ACL reconstruction

Introduction

Anterior cruciate ligament (ACL) reconstruction with hamstrings is a well-established technique, that showed to be a safe and effective alternative to patellar tendon autograft with comparable clinical outcomes associated with a lower rate of anterior knee pain [1, 4, 11, 17, 24]. Despite the above-mentioned lower harvest site morbidity, iatrogenic injury to the terminal branches of saphenous nerve after hamstring removal still remains cause of concern [19].

This iatrogenic damage may cause mild problems including hypoesthesia, dysaesthesia, painful neuroma and reflex sympathetic dystrophy. Furthermore, anterior knee pain and kneeling pain have been directly related to damage of some of saphenous nerve branches [7].

The two branches of the saphenous nerve that may be at risk following ACL surgery are represented by the sartorial terminal branch (sartorial terminal branch) and by the infrapatellar branch (infrapatellar branch). The saphenous nerve divides in its two terminal branches exiting the

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adductor canal. The sartorial terminal branch takes a vertical course as it travels down the medial knee behind the sartorius before becoming subcutaneous by piercing the fascia between the sartorius and gracilis tendons. It then continues distally to govern sensation of the medial aspect of the leg and ankle. The infrapatellar branch travels anteriorly to supply the anteromedial and the antero-lateral aspects of the knee along with offshoots from the anterior and lateral femoral cutaneous nerves [2, 9, 19, 23] (Fig. 1).

Recent studies have stressed that the previous reported rate of injuries of the sartorial terminal branch following ACL reconstruction may be underestimated. Particularly, Sanders et al. reported on a population of 164 patients and sartorial terminal branch isolated injuries accounted for 23 % in their series, while infrapatellar branch and sartorial terminal branch associated lesions were found in 32 % of cases. The iatrogenic damage of sartorial terminal branch is thought to be related to the passage of the stripper during the harvesting of the gracilis tendon due to the strict proximity between the tendon itself and the nerve branch even when the knee is placed in a figure of four positions [19].

Conversely, infrapatellar branch lesions have been more frequently reported with a rate ranging from 12 to 84 % in several case series [6, 10, 12, 20].

The lesion seems to be directly related to the surgical approach adopted to harvest the hamstring tendons, in fact, in the area of incision, the infrapatellar branch passes with an oblique course [19]. For this reason, many authors postulated that an horizontal or oblique incision should permit to spare the infrapatellar branch being parallel to the nerve branches course [12, 13, 16].

Aim of the present study is to systematically review the current literature in order to assess the eventual superiority of one surgical approach over the others for hamstring tendons harvest in limiting the neurological impairment related to infrapatellar branch injury.

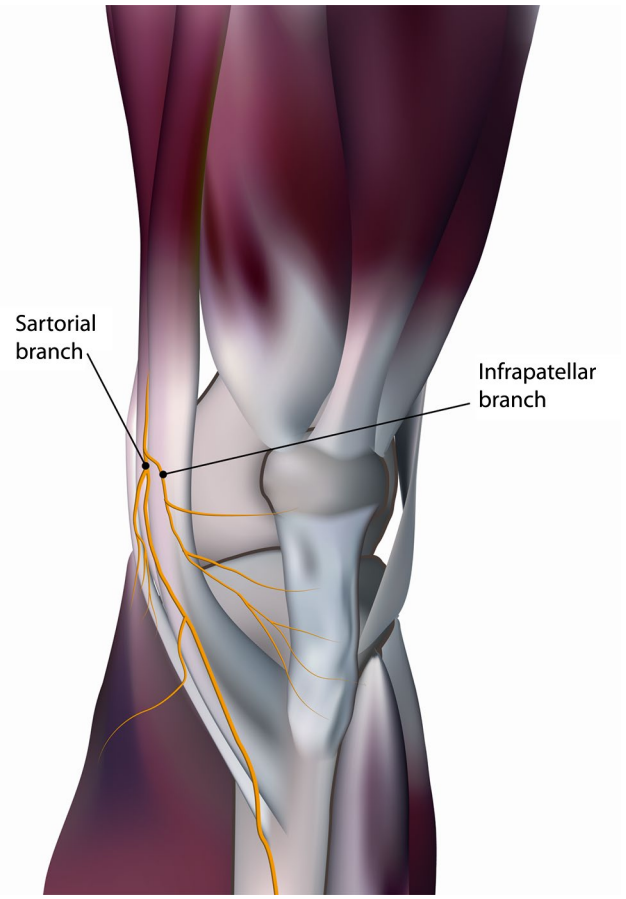

Fig. 1 Schematic illustration showing the course of the two end branches of the saphenous nerve

Materials and methods

The available literature was systematically screened searching papers dealing with iatrogenic injury to the saphenous nerve after anterior cruciate ligament reconstruction using hamstring tendons. The terms "Saphenous" and "Infrapatellar branch" were used in combination with "Anterior cruciate ligament", "arthroscopy" and "hamstrings", supplying no limits regarding the publication year.

PubMed (http://www.ncbi.nlm.nih.gov/sites/entrez/), Ovid (http://www.ovid.com/), Cochrane Reviews (http://www.cochrane.org/reviews/), and Google Scholar were all accessed on December 1, 2015. Only publications in English were considered. Case reports, technical notes, instructional course, literature reviews, biomechanical and/or in vitro studies were all excluded, as well as case series (level IV studies). From a total number of 181 papers, 176 papers not matching the inclusion criteria were excluded after abstract evaluation by two authors (AR and MD). When abstract was not available, the title was used to judge the relevance of the papers in relation to the topic of investigation. In any case of doubt, the senior author (CF) made the final decision. The 5 retained articles were obtained in a full text version, and after cross referencing no further studies were included.

None of the papers were excluded after full text evaluations thus leaving five studies available for the review [12, 13, 16, 18, 21].

The methodological quality of the five articles was assessed by two authors (MD and AR) using the modified Coleman methodology score [5]. Even in this case, any disagreement was solved by the senior Author (CF).

Results

The five retained articles involved two randomized controlled trials (RCT) [18, 21], one prospective comparative study [12] and two retrospective comparative series [13, 16]. In all these series, patients underwent single-bundle ACL reconstruction using four-strand hamstring tendons. Two types of incisions were investigated in all except one study [18], in which three different incisions were compared. Although no demographic differences were found between the study groups, the poor overall methodological quality of the selected papers as assessed according to the modified CMS must be highlighted (Table 1). Inclusion criteria were exhaustively described in two papers [18, 21]. Among the RCT, the randomization technique was specified only in one [18]. Power analysis and sample size calculation were lacking in all studies.

Outcomes assessed and follow-up are summarized in Table 2. A wide variability was found with regard to the time of clinical evaluation; however, in the majority of the papers, an objective evaluation at least 6 months post-operatively was performed. Besides, subjective clinical assessment questionnaires were used just in three articles [12, 18, 21].

Neurological injuries were detected as the presence and the extent of the area of sensory loss in three articles [12, 13, 18]; nonetheless, different strategies have been implemented to perform measurement (see Table 2). The difference between the early (12 days post-operatively) and late (12 months post-operatively) area of sensory loss was mentioned just in one study [12].

Darestani et al. [21] assessed neurological impairment by means of an electrophysiological study, whereas in the paper by Papastergiou et al. [16]. The parameter used was

Table 1 Principal methodological features of the assessed articles

Author	Type of study	Study groups (type of incision/no pts)	L. E.[a]	Demographics	Modified CMS[b]
Sabat et al.	Randomized controlled trial	Vertical (38pts) Horizontal (37pts) Oblique (37pts)	I	No difference	73
Darestani et al.	Randomized controlled trial	Vertical (30pts) Oblique (30pts)	II	No difference	57
Kiærgard et al.	Prospective comparative	Vertical (25pts) Oblique (25pts)	III	No difference	64
Luo et al.	Retrospective comparative	Vertical (35pts) Oblique (25pts)	III	No difference	34
Papastergiou et al.	Retrospective comparative	Vertical (116pts) Horizontal (114pts)	III	No difference	34

Although baseline comparability between study groups was ensured, the poor overall methodological quality of the selected papers must be highlighted

[a] Level of evidence

[b] Coleman methodology score

Table 2 Modes of clinical examinations among the retained articles

Author	Timing of clinical examination	Clinical scores	Neurological assessment
Sabat et al.	6 weeks/6 months	IKDC 2000	Area of sensory loss (pin prick test)
Darestani et al.	12 months	Lysholm Satisfaction (VAS)	Altered sensation in respect to the controlateral leg Electrophysiological study
Kiærgard et al.	12 days, 12 months	Lysholm	Area of sensory loss (light finger touch)
Luo et al.	14 months	N.A.[a]	Area of sensory loss (patient's self marking)
Papastergiou et al.	At least 1 month	N.A.[a]	Any sensory disturbance (present or not)

A wide variability was found with regard to the time of clinical evaluation

[a] Not available

Table 3 Neurological assessment

Author	Study groups (type of incision/no pts)	Incidence of IPBSN[a] damage	Area of sensory loss Mean (range) (cm^2)
Sabat et al.	Vertical (38 pts) Horizontal (37 pts) Oblique (37 pts)	Vertical 29 pts (76 %)[c] Horizontal 13 pts (35 %)[c] Oblique 12 pts (32 %)[c]	Vertical 44.6 ± 24.4[c] Horizontal 22.7 ± 14.3[c] Oblique 14.4 ± 9.5 [c]
Darestani et al.	Vertical (30 pts) Oblique (30 pts)	Vertical 10 pts (33 %) Oblique 4 pts (13 %)	N.A.[b]
Kiærgard et al.	Vertical (25 pts) Oblique (25 pts)	Vertical 21 pts (84 %)[d] Oblique 21 pts (84 %)[d]	Vertical 21 pts 35.6 (0–68)[d] Oblique 21 pts 29.3 (0–65)[d]
Luo et al.	Vertical (35 pts) Oblique (25 pts)	Vertical 23 pts (65.7 %) Oblique 6 pts (24 %)	Vertical 48.0±75.3 Oblique 8.4±19.4
Papastergiou et al.	Vertical (116 pts) Horizontal (114 pts)	Vertical 46pts (40 %) Horizontal 17 pts (18 %)	N.A.[b]

Different measurement strategies have been implemented. In the studies by Sabat et al. and Kiærgard et al., the later assessment was accounted for

[a] Infrapatellar branch of the saphenous nerve

[b] Not available

[c] Results at 6 months

[d] Results at 12 months

the presence of a sensory disturbance or not during objective clinical examination.

The infrapatellar branch nerve was investigated alone in all but one paper [18], in which the sartorial terminal branch was investigated too.

A vertical incision was found to significantly affect the presence of hypoesthesia and the extent of the area of sensory loss in three articles [13, 16, 18]. In contrast, no difference in terms of neurological impairment was registered by Kiærgard et al. [12]. A trend towards a lower iatrogenic damage to the infrapatellar branch using an oblique incision was found by Darestani et al. [21], without any statistical significance. The only paper investigating on the effect of surgical incision on the iatrogenic damage to the sartorial terminal branch [18] found no difference between vertical, oblique or transverse incision (Table 3). Whenever available, length of incision did not differ significantly between the study groups (Table 4).

Subjective evaluation tools revealed no difference in clinical outcomes between different incisions [12, 18, 21].

Table 4 Incision length did not differ significantly between the study groups

Author	Study groups (type of incision/ no pts)	Incision length (cm)	*P* value
Sabat et al.	Vertical (38pts) Horizontal (37pts) Oblique (37pts)	Vertical 4.1±0.4 Horizontal 4.0±0.6 Oblique 3.8±0.6	ns
Darestani et al.	Vertical (30pts) Oblique (30pts)	N.A.[a]	N.A.[a]
Kiærgard et al.	Vertical (25pts) Oblique (25pts)	Vertical 4.8 (3.7–6.0) Oblique 4.5 (3.5–5.9)	ns
Luo et al.	Vertical (35pts) Oblique (25pts)	Vertical 3.3±0.8 Oblique 3.4±0.9	ns
Papastergiou et al.	Vertical (116pts) Horizontal (114pts)	N.A.[a]	N.A.[a]

[a] Not available

Discussion

The main finding of the present study is that the current available literature does not permit to state the superiority of one incision over the other, for hamstring tendons harvest, in reducing iatrogenic lesion rate of the infrapatellar branch of saphenous nerve.

Infrapatellar branch lesions represent the most common complication following hamstring harvest in ACL surgery. These lesions reported in several studies range from 12 to 84 % with an hypoesthetic area measured as 25–53.2 cm^2 [6, 10, 12, 20].

Although the clinical ramification associated with these lesions is usually low, some patients complain about discomfort during kneeling which impairs their daily living activities. Besides, medico-legal implications of such neurological injuries cannot be underrated.

Many strategies aimed to reduce the rate of this complication have been described in the literature. Some authors postulated that nerve exploration should be effective in

reducing neurological impairment in the infrapatellar branch distribution territory. In particular, Mirzatolooei et al. [14] in a prospective descriptive study evaluated 98 out of 120 patients with ACL reconstruction operated by the transfix method at 2 weeks and 6 months post-surgery. In 44 patients, at least one nerve was located and saved. The rate of hypoesthesia in this group of patients was 20.5 %. In 54 patients, the authors were unable to locate the nerve. The rate of hypoesthesia in this group was 72 %, which was statistically significant ($P < 0.005$). In our opinion, routinely surgical nerve exploration seems to be excessive, principally considering the recorded higher rate of ineffectiveness of this approach.

The most effective method aimed to reduce infrapatellar branch damaging according to several authors is represented by the adoption of an oblique or horizontal orientation of the incision for pes anserinus tendon harvest [12, 13, 16].

Boon et al. [3] in their cadaveric study identified a safe area and an incision angle of 51.68 degrees (right knee) and 52.58 degrees (left knee) for harvesting the tendons with the knee in flexion. Conversely, Mochizuki et al. [15] in a similar study stated that the complicated anatomical variations of the nerve branches preclude their absolute avoidance in any surgical incision, clearly excluding the possibility to find a completely safe zone. The same findings were reported by Walshaw et al. [22]. The authors dissected 25 knees following the route of the infrapatellar branch, finding out a huge variation in the infrapatellar branch pathways between all the knees that were dissected and either between contralateral knees in the same cadaver. Based on their dissections, they identified 5 major courses of the infrapatellar branch in relation to the sartorius muscle. Among these, the most common was represented by posterior pathway (running at the posterior-inferior level of the muscle) which was present in the 57 % of the cases. They concluded that the posterior path is the most prone to damage during nerve harvesting due to its relationship with PES anserinus tendons.

Aim of the present study was to systematically review the literature in order to assess evidences able to substantiate the adoption of one incision above the others in terms of reducing neurological impairment related to infrapatellar branch lesions.

After an accurate review of the literature, five studies proved to deal with the selected topic matching the inclusion criteria. Although three studies stated that the adoption of a vertical incision is related to a statistically significant higher rate of damaging infrapatellar branch [13, 16, 18] with respect to oblique incision placed on the route of the PES tendon, there is insufficient evidence to support in a definitive manner one particular incision over the others.

The main limitation of this review is represented by the high numbers of methodological flaws present in the retained articles. This is testified by the low mean values achieved by the 5 analysed papers regarding the Coleman methodological score with an average value of 52.4 ranging from 34 to 73 (Table 1). In particular, no power analysis to calculate the sample size was performed in neither of the study. Secondarily, different outcomes were employed between the evaluated studies to detect neurological deficits making it impossible to pool the results in a meta-analysis. In addition, evaluations were performed at different length of follow-up and only one study [12] registered the difference between the early (12 days post-operatively) and late (12 months post-operatively) area of sensory loss. Finally, records about failed or difficult hamstrings harvesting in relation to different incisions were lacking in the retained articles, and this impairs the significance of our study. Well-designed randomized clinical trials with adequate population and objective measurement tool to detect neurological disturbances seem therefore to be required to definitively sustain one incision over the others.

An interesting option to minimize the neurological impairment related to infrapatellar branch may be represented by the minimally invasive harvest of the hamstring tendons from a small postero-medial incision at the level of the popliteal fossa. The only report regarding this type of harvest is represented by a study by Franz et al. [8] that reported encouraging results in their comparative randomized clinical trial over 100 patients. In detail, the authors observed that the posterior harvest is safe and permits to harvest tendons of an adequate length thus avoiding, in a significative manner, the onset of lower leg sensory disturbances with respect to traditional harvest at the level of the proximal tibial metaphysis.

Conclusion

In conclusion, the low methodological quality of the studies dealing with the evaluated topic does not permit to draw definitive conclusions on the best incision to harvest hamstring tendons. Despite this finding, the anatomical course of the infrapatellar branch along with the results obtained in the available studies seems to suggest lower rate of neurological impairment adopting an oblique incision. This kind of incision may therefore be preferred in the routine clinical practice.

Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

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