



# Ultrasound Point-of-care in Soleus Muscle Flap Reconstruction

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## Abstract

**Introduction:** Point-of-care ultrasound has been successfully used in intensive care medicine, trauma surgery and anesthesia. The soleus muscle is indicated for the reconstruction of wounds with bone exposure in the middle and lower thirds of the leg. The objective of this study is to verify the evidence of the application of point-of-care ultrasound in the soleus muscle flap planning reconstruction.

**Method:** A study was conducted by searching the Pubmed/Medline, SciELO and LILACS databases, applying the descriptors ultrasound, surgical flaps, perforator flap, myocutaneous flap and plastic surgery.

**Results:** In the reconstruction with the soleus muscle flap, the application of point-of-care ultrasound consisted of the use of the acoustic window concepts with the visualization of the limits of the soleus muscle and adjacent anatomical structures, such as the Achilles tendon and the flexor hallucis longus muscle.

**Conclusion:** The evidences of the application of point-of-care ultrasound in the reconstructions of the lower limbs, using the soleus muscle flap, allowed the visualization of the soleus muscle and the adjacent anatomical structures, such as the Achilles tendon and the tendon of the flexor hallucis longus muscle, important anatomical reference points during the preparation of the soleus muscle flap. Ultrasound is a great non-invasive resource to assist in creating the soleus muscle flap.

**Keywords:** Ultrasonography, Surgical flaps, Perforator flap, Myocutaneous flap, Surgery, Plastic

## Introduction

The soleus muscle is of great importance in the reconstructive surgery of the lower limbs,<sup>1,2</sup> since it enables the repair of wounds<sup>3,4</sup> of traumatic, vascular and infectious origins, which determine the loss of cutaneous substance, being directly caused by trauma, or by surgical debridement of the areas of skin necrosis.

The use of imaging using point-of-care ultrasound<sup>5</sup> has shown great interest in intensive care medicine, anesthesia and in trauma surgery, enabling early diagnosis of pneumothorax, pleural effusion, and aiding peripheral anesthetic blocks, particularly in the lower limbs.<sup>6-8</sup>

The purpose of this study is to verify the evidence of the application of point-of-care ultrasound in the soleus muscle flap

planning to reconstruction of wounds with cutaneous loss and bone exposure in the middle third or lower third of the leg.

## Method

The study consisted of searching for evidence related to the use of point-of-care ultrasound in lower limb reconstruction surgery, using the soleus muscle flap, through searches in PubMed, SciELO and LILACS databases, applying the descriptors ultrasonography, surgical flaps, perforator flap, myocutaneous flap and plastic surgery (surgery, plastic) combined with the boolean logical operators AND or OR.

An advanced search was performed and was limited to words present in the title and abstract. All stages of the systematic review were conducted by two reviewers, independently and blinded.

Quick Response Code:



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**Received:** 04 July, 2024

**Published:** 10 July, 2024

**Citation:** Rui Lopes Filho, Lucas Carvalho Lopes, Ana Beatriz Viana Pedrosa, Luiza Amarante Rabelo. Ultrasound Point-of-care in Soleus Muscle Flap Reconstruction: Research Article. *Surg Int Open Acc J.* 2024;2(1):1-4. DOI: [10.53902/SIOAJ.2024.02.000505](https://doi.org/10.53902/SIOAJ.2024.02.000505)

Articles related to the descriptors were included. Duplicate articles and those that were not directly related to the proposed study were excluded.

## Results

In the reconstruction with the soleus muscle flap, the application of point-of-care ultrasound consisted of the use of acoustic window concepts with the visualization of the limits of the soleus muscle

and adjacent anatomical structures, such as the Achilles tendon and the flexor hallucis longus muscle Figure 1.

The scientific articles found in the literature presented the reconstructions using the soleus muscle flap with a proximal pedicle or a distal pedicle Chart 1. However, no articles were found application of point-of-care ultrasound in the soleus muscle flap planning to reconstruction.

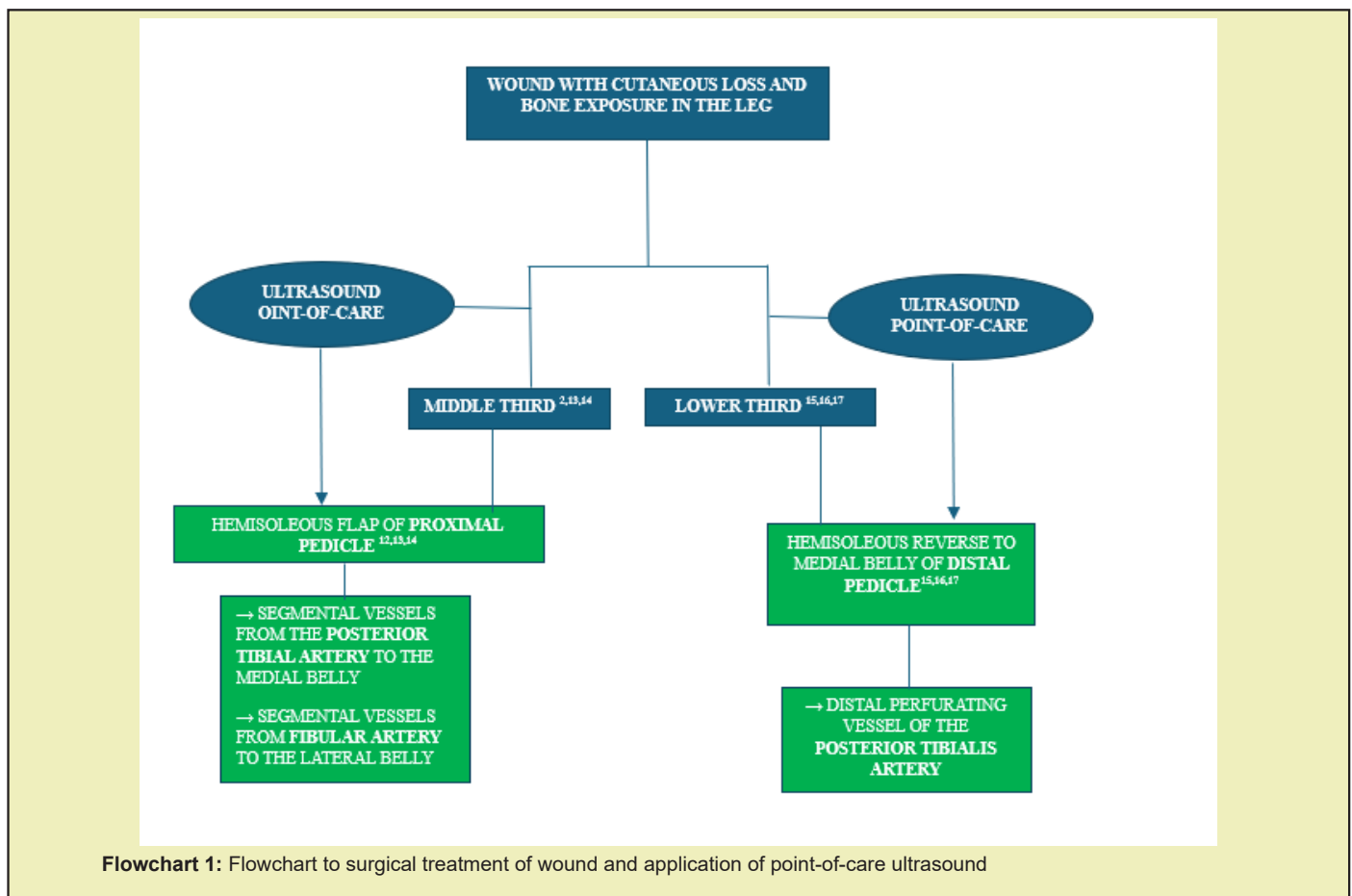


**Figure 1:** Ultrasound image of the soleus muscle (Soleus), Achilles tendon (Achilles) and flexor hallucis longus muscle (Flexor Hallucis Longus)

Autor	Tipo de Estudo Número de pacientes	Técnica Cirúrgica Tipo de Retalho Utilizado	Ano da Publicação	Localização da Ferida
Schmidt	Retrospective 33 patients	Hemioleus muscle flap of distal pedicle	2017	Middle and lower third of the leg
Houdek	Case Report 1 patient	Reverse medial hemioleus muscle flap	2016	Lower third of the leg
Pu	Retrospective 8 patients	Reverse medial hemioleus muscle flap	2006	Lower third of the leg
Ahmad	Retrospective 40 patients	Hemisóleo muscle flap	2013	Lower member
Ata-ul-Haq	Retrospective 10 patients	Hemioleus muscle flap	2009	Middle third of the tibia
Schmidt	Relato de caso 1 patient	Hemioleus muscle flap of proximal pedicle	2016	Middle third of the leg
Bhagat	Retrospective 14 patients	Hemioleus muscle flap	2023	Lower third of the leg
Tobin	Retrospective 33 patients	Retalhos de hemisóleo lateral e medial de base proximal e distal; mantem a inervação do retalho hemisóleo e a flexão plantar	1985	Middle and lower third of the leg
Bacelar	Retrospective 18 patients	Soleus muscle flap	2011	Middle third of the leg
Matos	Case report 1 patient	Hemioleus muscle flap of distal pedicle	2019	Middle third of the leg
Canton	Retrospective 8 patients	Medial hemioleus muscle flap. Maintains flap innervation and plantar flexion	2018	Exhibitions of syntesis and tibia material

The soleus muscle flap using as hemisoleus of proximal pedicle was vascularized by segmental branches of posterior tibial artery to the medial belly of soleus muscle and was vascularized by segmental branches of fibular artery, When the lateral belly soleus

muscle was used, while the medial belly hemisoleus muscle of distal pedicle was vascularized by perforant distal vessel of tibial posterior artery Flowchart 1.



## Discussion

The soleus muscle is located deep in the posterior region of the leg, and originates in the upper third of the fibula, in the upper and middle parts of the tibia, inserting itself together with the gastrocnemius muscle into the calcaneus bone through the Achilles tendo.<sup>9</sup> The soleus muscle flap was used by Tobin in 1985 as a medial hemisoleus flap or a lateral hemisoleus flap, respectively, with a proximal vascular pedicle or a distal vascular pedicle for the use of a medial hemisoleus flap or a lateral hemisoleus flap, for wound reconstructions in topographies of the middle and lower third of the leg.<sup>10</sup>

It is a muscle flap classified as type II, in the classification of muscle flaps described by Mathes and Nahai, which considers the number of vascular pedicles responsible for the blood supply of the flaps. The type II flap has a dominant vascular pedicle and smaller pedicles, and only the smaller pedicles can be sectioned.<sup>11</sup> The vascularization of the soleus muscle comes from branches of the posterior tibial, fibular and popliteal arteries, and the topography of the flap rotation point is located 10 to 12cm below the knee, and

is indicated for the repair of injuries in the middle third and upper portion of the distal third of the leg.<sup>9-11</sup>

The use of the soleus muscle flap is recommended for wound reconstruction with loss of cutaneous substance and bone exposure in the middle third of the leg,<sup>12-14</sup> as a lateral hemisoleus flap for vascularization through the segmental arterial branches of the posterior tibial artery or as a medial belly hemisoleus flap for vascularization from the segmental arterial branches of the fibular artery. The reverse hemisoleus flap of the medial muscle belly with dist arterial pedicle is indicated for the repair of wounds with bone exposure and sometimes exposure of orthopedic synthesis material located in the lower third of the leg.<sup>15-17</sup>

The application of point-of-care ultrasound<sup>5-8</sup> is currently growing rapidly, with emphasis on the areas of intensive care medicine 6, trauma surgery and anesthesia.<sup>7</sup> In intensive care medicine, it enables the diagnosis of cardiac alterations during cardiogenic shock; in the trauma surgery, early detection of pneumothorax, and in anesthesia, it helps to block the location of nerves during peripheral nerve blocks.

In the point-of-care ultrasound image,<sup>6-8</sup> in order to obtain a better correlation with the operative technique of making the soleus muscle flap, the soleus muscle should be scanned in the long axis, in an area sufficient to allow inspecting the fibers of the soleus muscle, with the more superficial Achilles tendon and the tendon of the flexor longus muscle of the hallux deeper to the soleus muscle fibers.

The ultrasonographic aspect of the soleus muscle demonstrates a muscular structure with fascicles arranged at an angle to the direction in which the tendon moves, inserted on one side of the aponeurosis, characterizing a unipennate muscle that is distally incorporated into the Achilles tendon. Ultrasound is a great non-invasive resource to assist in creating the soleus muscle flap.

In the end, it can be stated that point-of-care ultrasound is a great non-invasive resource to assist in creating the soleus muscle flap and that the evidences of the application of point-of-care ultrasound in the reconstructions of the lower limbs, using the soleus muscle flap, were to allow the visualization of the soleus muscle and the adjacent anatomical structures, such as the Achilles tendon and the tendon of the flexor hallucis longus muscle, important anatomical reference points during the preparation of the soleus muscle flap.

### Conclusion

The evidences of the application of point-of-care ultrasound in the reconstructions of the lower limbs, using the soleus muscle flap, were to allow the visualization of the soleus muscle and the adjacent anatomical structures, such as the Achilles tendon and the tendon of the flexor hallucis longus muscle, important anatomical reference points during the preparation of the soleus muscle flap. Ultrasound is a great non-invasive resource to assist in creating the soleus muscle flap.

### Acknowledgments

None.

### Funding

This Research Article received no external funding.

### Conflicts of Interest

Regarding the publication of this article, the authors declare that they have no conflicts of interest.

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