**The influence of ultrasound in the choice of surgical technique to repair inguinal hernia: a prospective multicentric cohort study**

Authorship line: PT Surg\*

 \*Full list of PubMed citable authors available in Appendix 1

**Corresponding author:**

Mafalda Sampaio-Alves

sampaioalvesm@gmail.com

ORCID ID: 0000-0002-1214-8470

**Trial Registration Number:** Clinicaltrials.gov (NCT04328597)

**Keywords:** Inguinal hernia, Surgical technique, Ultrasound, Diagnosis, Physical examination

**Appendices**

|  |  |
| --- | --- |
| Appendix 1 – List of authors | Pages 3-6 |
| Appendix 2 – Supplementary tables and materials  | Pages 7-9 |
| Appendix 3 – Definitions  | Pages 10 |
| Appendix 4 – Additional References | Page 11 |

**Appendix 1 - List of authors**

**PT Surg - Portuguese Surgical Research Collaborative: full list of PubMed citable authors**

**Writing group:**

Mafalda Sampaio-Alves (@MafSAlves) †, Ana Alagoa João (@aaljoao), Tiago Taveira-Gomes (@TTaveiraGomes), Maria Picciochi (@MariaPicciochi)

† Corresponding author

**Statistical Analysis:**

Mafalda Sampaio-Alves, Ana Alagoa João, Tiago Taveira-Gomes, Maria Picciochi

**Steering Committee:**

José Azevedo (@JGMAzevedo), Miguel Cunha (@MiguelCunhaSurg), Ana Alagoa João (@aaljoao), Mariana Peyroteo (@MarianaPeyroteo), Joana FF Simoes (@JoanaffSimoes), António Sampaio Soares (@ASampaioSoares), Bárbara Vieira (@BarbaraVieiraPT).

**Local Collaborators (alphabetically, with Hospital Leads underlined):**

**Centro Hospitalar Baixo Vouga**: Rita Lages, Alice Pimentel, Teresa Santos, Sofia Dias da Silva;

**Centro Hospitalar de Entre o Douro e Vouga**: Lúcia Carvalho, Ana Luísa Pinto Frutuoso, Rita Matias, Leonor Matos;

**Centro Hospitalar de Setúbal:** Filipe Almeida, Fabiola Amado, Alexandra Ferreira, Isabel Martins, Estanislau Mateia, Vanessa Praxedes, Joana Seabra, Xavier de Sousa, André Silva;

**Centro Hospitalar do Médio Ave**: Márcia Carvalho, João Mendes, Carlos Macedo Oliveira;

**Centro Hospitalar do Oeste - Caldas da Rainha**: Francisco Girão de Caires, Ana Luísa Rodrigues, Regina Silva;

**Centro Hospitalar do Oeste - Torres Vedras**: Rui Lacerda Cunha, Ana Rita de Sousa Marinho Falcão, Ester Ferreira, Carla Menezes, Inês Neri, Rafael de Castro Nobre, Ana de Clamouse Rebelo, Pedro Santos, David Ferra de Sousa;

**Centro Hospitalar Lisboa Central**: Ana Andrade, Inês Barros, Sofia Frade, João Gomes, Inês Nunes, Sofia Pina, Nádia Silva, Rui Sousa;

**Centro Hospitalar Lisboa Norte** **- Hospital de Santa Maria**: Aldara Faria, Ana Gomes, Carlota Ramos, Vanessa Santos;

**Centro Hospitalar Lisboa Ocidental - Hospital Egas Moniz**: Catarina Antão, Luís Castro, Joana Ferreira, Inês Lima, Filipa Policarpo, Sara Ramtula, Joana Romano, Sara Silveira;

**Centro Hospitalar Lisboa Ocidental - Hospital Santa Cruz**: Joana Romano, Nuno Rombo;

**Centro Hospitalar Lisboa Ocidental - Hospital São Francisco Xavier**: Francisco Baeta, Ana Sofia Boligo, Diogo Cardoso, Vasco S. Cardoso, Claúdia Figueiredo, Isabela Gil, Ana Rita Monte, Joana Romano;

**Centro Hospitalar Universitário Cova da Beira**: Constança M. Azevedo, Rui Cunha, Filipa Dias Mendes, Miguel Semião;

**Centro Hospitalar Universitário de Coimbra**: Ana Almeida, Maria João Amaral, André Amaro, Andreia Guimarães, Catarina Lopes, Oriana Nogueira, Eva Santos, Marta Rodrigues da Silva;

**Centro Hospitalar Universitário de São João**: Vítor Devezas, Telma Fonseca, Fábio Gomes, Joana Mafalda Monteiro, António Pereira-Neves, Jorge Nogueiro, Mariana Canelas-Pais, André Pereira, Fernando Resende, Sara Rodrigues;

**Centro Hospitalar Universitário do Algarve - Hospital de Portimão**: Edgar Amorim, Beatriz Dias, Victor Hugo Baptista, João Melo, Inês Miguel, Juan Rachadell, Antonio Rivero, Liliana Sequeira, Diogo Veiga;

**Centro Hospitalar Vila Nova de Gaia/Espinho:** Andreia Branco, Inês Costa Carvalho, Barbara Castro, Sofia Fonseca, Raquel Prata Saraiva, Tatiana Queirós, Ana Rita, Alexandra Campos da Silva, Inês Teixeira, Ana Paula Torre;

**Hospital Beatriz Ângelo**: Cátia Cunha, Marisa Peralta Ferreira, Pedro Miranda;

**Hospital da Horta**: Ana M. Cabral, Bárbara Nunes Gama, Catarina dos Santos Rodrigues, Nisalda Carla Melo Rosa;

**Hospital de Santo Espírito da ilha Terceira**: Diogo Galvão, Anaísa Silva, Ana Cláudia Soares, Bárbara Vieira;

**Hospital Distrital da Figueira da Foz**: Ana Couceiro, Marta Ferreira, Narcisa Guimarães, Inês Mónica, Simone Oliveira, Daniela Pais, Hugo Ribeiro;

**Hospital Distrital de Santarém**: Renato Barradas, Sónia Martins;

**Hospital Divino Espírito Santo**: Miguel Almeida, Ana Faustino, António Freitas, Ana Beatriz Martins, Catarina Moura, Rafaela Parreira;

**Hospital do Espírito Santo de Évora**: Joana Bolota, Ana Margarida Monteiro Cinza, Sofia Leandro, Rita Lima, Joana Oliveira, Mário Pereira, Miguel Rocha Melo, Cristina Velez;

**Unidade Local de Saúde do Litoral Alentejano - Hospital do Litoral Alentejano:** Adalberto Cardoso, Mariana Claro, Ana Cláudia Deus, Andreia Ferreira, Hugo Gameiro, Diogo Marinho, Daniel Costa Santos, Alberto Abreu da Silva, Sara Rodrigues Silva, Diogo Sousa;

**Hospital Garcia de Orta**: Ana Lúcia Preto Barreira, Filipe Borges, Pedro Silva Pereira Sousa Botelho, Brigitta Cismasiu, Margarida Silva Ferreira, Susana Henriques, José Guilherme Nobre, Maria Francisca Rodrigues de Areia Brito Da Silva, Ricardo Manuel Branco Souto;

**Hospital Particular do Algarve**: César Carvalho, Filipe Guerra, Inês Guerreiro, Paulo Sousa;

**Hospital Professor Doutor Fernando Fonseca**: Filipe André Ramalho de Almeida, David Aparício, Inês Rita Capunge, Rita Marques de Sá Carmarneiro, Jorge Cristo, Marta Fragoso, Joana Frazão, João Guimarães, Ana Rita Martins, Rita Ribeiro Reis Vale Martins, Maria de Jesus Oliveira, João Silva Ribeiro, Paula Soraya de Carvalho e Azevedo Teixeira;

**Unidade Local de Saúde Alto Minho**: Telma Rodrigues Brito, Diana Carina Lima Gomes, Mariana Silva Leite, Carolina Matos, Cristina Ferreira Monteiro, Diogo Abel Vasconcelos Nogueira Pinto, Cristina Silva, Bruno Ribeiro da Silva;

**Unidade Local de Saúde Baixo Alentejo:** Carina Baldino, Ana Guerreiro, Maria Jervis, André Pacheco, Valter Paixão, Vera Pedro, Joana Marantes Pimenta, Filipa Narciso Rocha;

Unidade Local de Saúde Castelo Branco: Manuela Mega, Rita Monteiro, Joana Peliteiro, Manuela Romano, Alexandra Soares;

**Unidade Local de Saúde de Matosinhos**: Mafalda Sampaio-Alves, Natacha Alves, Gabriel Costa, Lígia Freire, José Pedro Gonçalves, Tatiana Marques, Francisco Marrana, Sara Marques, Diogo Melo Pinto, Catarina Quintela, Irène Santos, Evgeniya Sitchikhina, Pedro Valente;

**Unidade Local de Saúde do Nordeste**: João Miguel Carvas, Maria Inês Durães, Guida Pires, Carlos Pires, Joana Gomes da Silva;

**Unidade Local de Saúde do Norte Alentejano – Hospital Dr. José Maria Grande**: Miguel Brito, Hugo Capote, Cristina Costa, Guilherme Fialho\*, Tamiris Mogne, Sara Morais, Beatriz Mourato, David Salvador;

**Unidade Local de Saúde do Norte Alentejano – Hospital Santa Luzia de Elvas**: Coral Aguero, Joaquina Dominguez, Miguel Angel Fernandez, Carlos Figueiredo, Monica Guerrero, Manuel Neuparth, Marta Reia.

**Appendix 2 - Supplementary tables and materials**

|  |  |
| --- | --- |
| **Supplementary table title** | **Pages** |
| Table 4 – Detailed description of surgical techniques | 8 |
| Table 5 – Description of anesthetic techniques. | 9 |

**Table 4** – Detailed description of surgical techniques.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Physical evaluation**(n = 448) | **Ultrasound**(n = 463) | **Total**(n = 911) |
| **Surgical Technique** | Lichtenstein | 225 (50.4%) | 235 (51.3%) | 460 (50.9%) |
|  | Minimally invasive | 14 (3.1%) | 23 (5.0%) | 37 (4.1%) |
|  | Others open with mesh | 34 (7.6%) | 36 (7.9%) | 70 (7.7%) |
|  | Plug and Patch | 172 (38.6%) | 158 (34.5%) | 330 (36.5%) |
|  | Open without mesh | 1 (0.2%) | 6 (1.3%) | 7 (0.8%) |

 **Table 5** – Description of anesthetic techniques.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Physical Evaluation**(n = 448) | **Ultrasound**(n = 463) | **Total**(n = 911) |
| **Anesthesia** | General | 280 (62.5%) | 291 (62.9%) | 571 (62.7%) |
|  | Regional | 161 (35.9%) | 165 (35.6%) | 326 (35.8%) |
|  | Local | 5 (1.1%) | 6 (1.3%) | 11 (1.2%) |
|  | (Missing) | 2 (0.4%) | 1 (0.2%) | 3 (0.3%) |
| **Nerve Block** | Iliohypogastric | 6 (4.1%) | 7 (3.8%) | 13 (4.0%) |
|  | Ilioinguinal | 26 (17.9%) | 33 (17.9%) | 59 (17.9%) |
|  | Subcutaneous | 107 (73.8%) | 141 (76.6%) | 248 (75.4%) |
|  | Subfascial | 6 (4.1%) | 3 (1.6%) | 9 (2.7%) |

**Appendix 3 - Definitions**

**ASA grade** 21

The American Society of Anesthesiologists (ASA) physical status classification system appeared in 1941, as a tool of operative risk prediction, based on the patient's physiological status. It is widely used to assess the patient's general condition, which results in a 6-level grading system.

A normal healthy patient is classified as ASA 1, but a patient with mild systemic disease is categorized as ASA 2. In the case of severe systemic disease, if this is non-life-threatening the patient is ASA 3, but ASA 4 if it is a constant threat to life. ASA 5 pertains to the patient who is not expected to survive more than 24 hours without surgical intervention. ASA 6 refers to the brain-dead patient.

**BMI** 22

When calculating an estimate of body fat, for all ages and both sexes, the Body Mass Index (BMI) is commonly used. This results from dividing a person’s weight (kilograms (kg)) by their squared height (meters (m)), allowing for classification into underweight (<18.5 kg/m2), normal weight (18.5-24.9 kg/m2), overweight (25 - 29.9 kg/m2), or obese ($\geq $30 kg/m2).

**European Hernia Society Quality of Life (EuraHS-QoL)** 23

EuraHS-QoL is a numerical quality-of-life score, for pain evaluation at the hernia/repair site, activity restriction and cosmetic discomfort. A patient-reported outcome measure can be used both pre- and postoperatively.

Pain at rest, during activities and peak pain in the previous week are evaluated. Activity restriction is evaluated inside and outside the house, as well as during sports and heavy labor. Cometic discomfort is described in terms of abdomen shape and discomfort at the hernia site.

In this analysis focused on preoperative evaluation, but the questionnaire was also reapplied postoperatively. As all items are rated from 0 (most positive) to 10 (most negative), patients who achieved higher scores had worse preoperative quality of life.

**Appendix 4 - Additional References**

21 - Doyle DJ, Hendrix JM, Garmon EH. American Society of Anesthesiologists Classification. StatPearls. 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK441940/

22 - Weir CB, Jan A. BMI Classification Percentile And Cut Off Points. StatPearls. 2024. Available from: https://www.ncbi.nlm.nih.gov/books/NBK541070/

23 - Muysoms F, Campanelli G, Champault GG, DeBeaux AC, Dietz UA, Jeekel J, et al. EuraHS: the development of an international online platform for registration and outcome measurement of ventral abdominal wall hernia repair. ***Hernia***. 2012 Jun;16(3):239-50. doi: 10.1007/s10029-012-0912-7. Epub 2012 Apr 18.