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ECHO LASER News

SPECIAL EDITION

My Point of view regarding **Ablation technique of thyroid solid nodules**

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Introduction

Laser, an acronym for "light amplification by stimulated emission of radiation", is a device capable of emitting a coherent, monochromatic and collimated beam of light by means of a quantistic process of stimulated photon emission.

The term "laser ablation"' refers to the irreversible thermal destruction of tissue induced by the conversion of the absorbed laser light into heat which causes the denaturation of the proteins and subsequent coagulative necrosis of the cells. The laser light is conveyed from the source to the tissue through extremely flexible, small-gauge (300 µm in diameter) quartz optical fibres, capable of transmitting huge amounts of energy even over long distances, without any significant loss. The optical fibres are inserted percutaneously directly into the lesion to be treated through inserted-needles. Several fibres appropriately spaced apart and simultaneously activated can be used to increase the coagulation area[1,2] up to 6-7 cm in diameter.

Ablation technique of thyroid solid nodules

These instructions for use of the percutaneous laser ablation technique have been obtained from numerous trials and clinical studies published in literature since the 1980s and don't constitute advice or suggestion to the operator who is the only one to have the medical expertise and information on the specific fact (patient history, nature, size, morphology, site and biology of the lesion to be ablated) necessary for the opportunity, evaluation and execution of treatments.

The EchoLaser is a multi-source (4 channels), integrated ultrasound-laser system intended to treat thyroid nodules via use of a laser light with a wavelength of 1064 nm. The energy is conveyed into the lesion through flat-tipped quartz optical fibres with a diameter of 300 µm, introduced into the tissue through needles with a gauge of less than one millimetre (21G)[3,4]. Laser emission through a flat-tipped fibre produces a lesion (coagulation area) with an ellipsoidal shape, one third of which is positioned behind the tip of the fibre, and two-thirds in front.

Before inserting the needles, the operator may consider to apply a local ultra-sound guided anaesthetic (e.g. 2-5 ml of 2% lidocaine) [several authors recently reported a reduction in the number of complications due to not applying anaesthesia].

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European **EchoLaser Club**

Created in Paris, October 2013 by a group of Endocrinologists and Radiologists.

- **To promote** the echo-guided laser ablation procedures at the European level in order to decrease the number of unnecessary surgical interventions.
- **To spread** the knowledge concerning the role of laser ablation procedures in clinical practice
- **Memebership of EchoLaser Club** is open to all Esaote/Elesta EchoLaser Users
- **Memebership of EchoLaser Club** can be recognised to all who are active i the field of Minimally Invasive Therapies and, in particular, of echo-guided Laser Ablation performed in means of EchoLaser systems
- **Today more than 100 members** participating to EchoLaser club activities

Echolaserclub@esaote.com

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Bucharest, Romania
Workshop for endocrinology
(Elias hospital)

3-7 May
Wrocław, Poland
ECE 2014
16th European Congress of Endocrinology
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6-10 September
Santiago de Compostela, Spain
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Ablation technique of thyroid solid nodules

Depending on the shape and volume of the nodule to be treated, the operator can decide using one or more needles positioned parallel to each other under ultra-sound guidance along the longitudinal axis of the nodule. In the majority of case reported in literature, two needles are positioned about one centimetre apart along the same plane. Once the needles have been positioned (see Figures 2-6), an optical fibre is introduced into each needle with its tip protruding 5 mm out of the needle and in direct contact with the tissue to be ablated. The examined literature showed the opportunity to position the tip of the fibre under ultra-sound guidance at a safety distance of about 10 mm (laterally) and 15 mm (frontally) away from the critical structures of the neck such as the blood vessels, recurrent laryngeal nerve, trachea, and oesophagus.

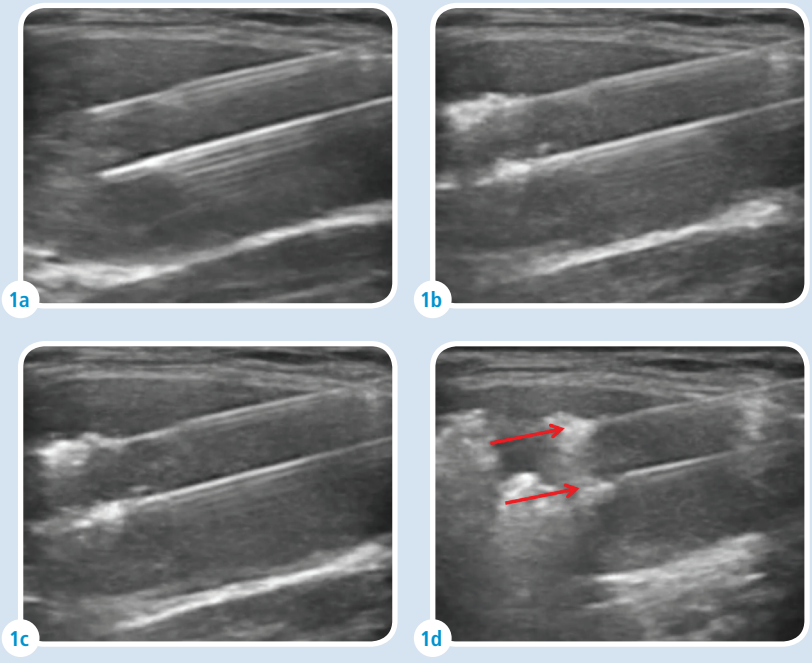
Power output and exposure time parameters

Table 1. Layout of the percutaneous treatment of thyroid nodules with EchoLaser operating at 1064 nm with a fix-power protocol (3W power), changing the application time case by case according to target size and shape and the feedback from real time US monitoring.

Nodule Size and Volume (mL)	Power (W)	Application* time per fiber (sec)	Fibers number	Energy per fiber (Joules)	Pull-back per treatment	Energy per single application* (Joules)	Total application* time (sec)	Total energy applied (Joules)	Total application* number
≤5 mL (i.e., 3 (L) x2 (T) x1,5 (AP) cm)	3	400** 500**	1 1	1,200 1,500	– –	1,200 1,500	400 500	1,200 1,500	1 1
5-13 mL (i.e., 3,5 (L) x2,5 (T) x2 (AP) cm)		500 or 500	1*** 2***	1,500 1,500	1 –	1,500 3,000	1,000 500	3,000 3,000	2 1
13-30 mL (i.e., 4,5 (L) x3,5(T)x2 (AP) cm)		500	2	1,500	1	3,000	1,000	6,000	2
≥30 mL (i.e., 6,5 (L) x5,0 (T)x3,5 (AP) cm)		500	2	1,500	2	3,000	1,500	9,000	3

* application = laser illumination; ** the choice of application time is based on nodule shape; *** the choice of one or two fibers is based on nodule shape

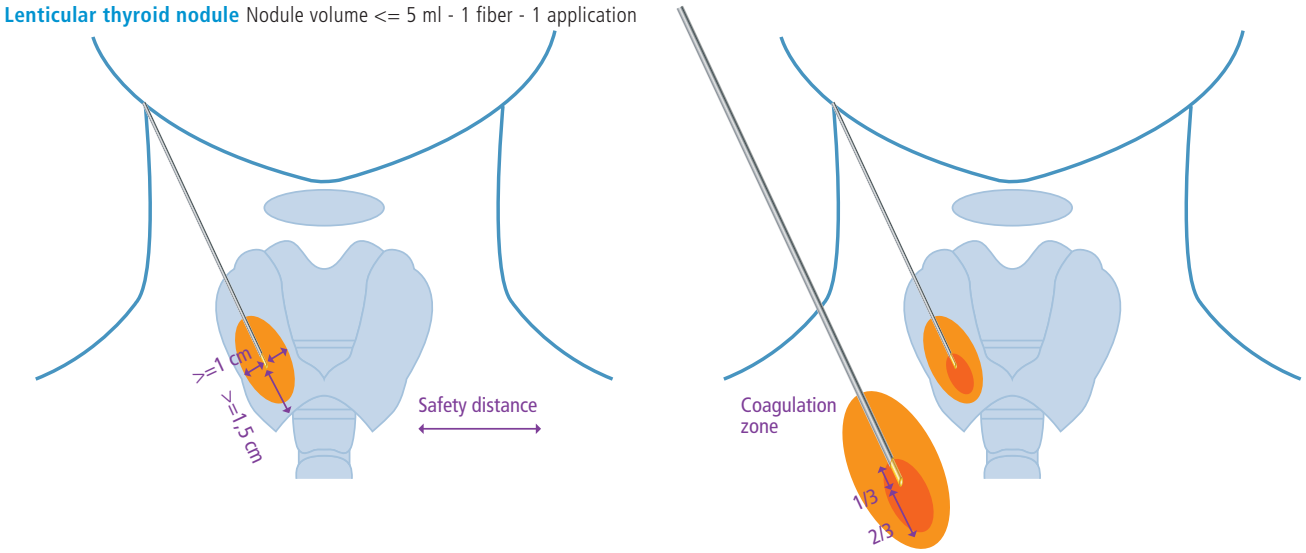
Figure 1. US images about laser ablation in Thyroid nodule **1a**: Inserted Fiber and needle **1b**: Initial formation of vapour due to the energy delivery **1c**: Energy delivery continues to produce vapour **1d**: Pull-back manoeuvre



The use of thin needles makes it possible to position one or more needles according to the initial size of the nodule. The number of laser sources and the application times depending on the lesion sizes, according to the data available to date, are illustrated in Table 1 where the nodules in lesions are classified as very small when they have a volume **equal to or less than 5 ml**, small when they have a volume of **between 5 and 13 ml**, intermediate in cases of a volume **between 13 and 30 ml**, and large when they **exceed 30 ml**. The operator must evaluate, case by case, the spatial positioning and number of the laser sources in order to deliver the laser energy evenly throughout the nodule and to obtain the maximum coagulation area in the shortest possible time. By maintaining a fixed power of 3W, it is possible to vary the application times and also carry out several applications [an application is defined as the time elapsing between turning on and turning off the laser source]. The application times vary between 400 and 500 seconds, with a consequent release of energy ranging between 1,200 to 1,500 joules per fibre and per single application (1 W x 1 sec. = 1 joule). In the event of a single application, the coagulated area will have an ellipsoidal shape (one third of which is positioned behind the tip of the fibre and two-thirds in front) (Figure 2). During the same treatment session it is possible to carry out as many as three applications (Figures 4-5) by pulling back along the needle and fibre axis (pull-back technique) by 1.0-1.2 cm so as to treat the tissue area not yet treated in the previous application. After treatment, as soon as most of the fluid vaporization and the micro bubbles of gas deriving from the high temperatures (over 120-130° C at the fibre tip) have dissipated, the coagulated area can be inspected using a contrast medium ultrasound that

ensures excellent assessment of the actual extent of the destroyed area. Thanks to the ellipsoidal shape it is possible to estimate the volume of the baseline nodule and the coagulated area obtained. The treatment can be considered successful when the volume of the coagulated area is equal to at least 40% of the nodule's baseline volume. The necrosis achieves its maximum extension 72 hours after treatment[5] since the cell damage continues to expand on the following days, directly due to the hyperthermia and to the occlusion of small and medium-size blood vessels of the nodule, the endothelium of which has been subjected to thermal damage. This technique allows to achive significant results in a single session. From the data collected from literature it can be stated that the reduction in volume of the nodule continues over time and after 12 months a reduction of more than 50% can usually be observed.

Figure 2. Illustration about laser ablation of thyroid nodule



Selecting the patients

According to the data available to date, Nodules to be ablated are **uniformly solid or primarily solid with a liquid component equal to or less than 20% of total volume of the nodule**, localised or variously distributed in the parenchyma. Nodules with a greater cystic component show a more pronounced volumetric reduction compared to uniformly solid nodules[6].

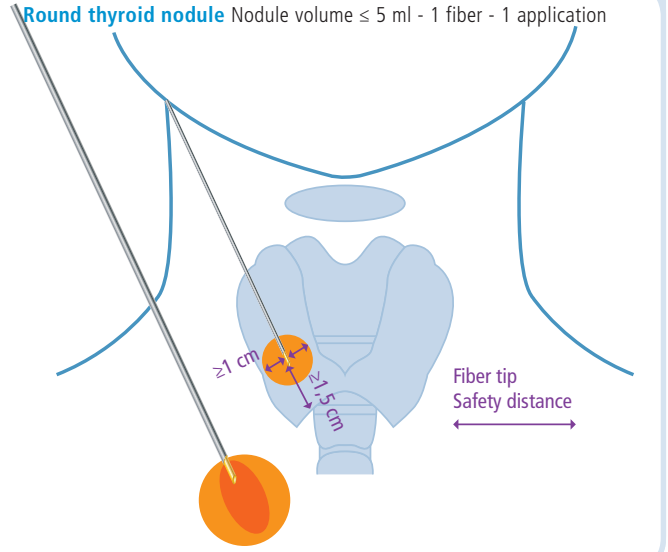
Looking at international guidelines[7] for the management of thyroid nodules and scientific publications about the current clinical practice, Inclusion criteria are: a) patient's age >18 years; b) single or dominant nodule easily identifiable clinically and by ultrasound inside a multi-nodular goitre; c) cold or hot* solid or primarily solid nodule; d) at least 2 negative cytological examinations for suspected tumour (Class THY 2, SIAPEC classification) (99.8% VPN) performed no more than six months earlier; e) symptoms of local compression (a tightening sensation in the throat and/or breathing difficulties) or cosmetic damage, patients deemed inoperable or who refuse to undergo surgery.

It is recommended to discontinue anticoagulation therapy 48 hours and antiaggregant therapy 72 hours before treatment.

All patients must undergo a preliminary direct laryngoscopy.

The operator should evaluate to exclude patients with a suspected or known family history of thyroid cancer, as should those who have undergone radiation treatment of the neck[6].

Figure 3



Complex lesions with a fluid component between 30% and 50% are best treated with the drainage of the fluid component and alcohol injection followed by laser thermal ablation[8].

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2 **Pacella CM, Bizzarri G, Francica G, Bianchini A, De Nuntis S, Pacella S, Crescenzi A, Taccogna S, Forlini G, Rossi Z, Osborn J, Stasi R** 2005 Percutaneous laser ablation in the treatment of hepatocellular carcinoma with small tumors: analysis of factors affecting the achievement of tumor necrosis. J Vasc Interv Radiol 16:1447-1457

3 **Pacella CM, Bizzarri G, Spiezia S, Bianchini A, Guglielmi R, Crescenzi A, Pacella S, Toscano V, Papini E** 2004 Thyroid tissue: US-guided percutaneous laser thermal ablation. Radiology 232:272-280

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5 **Nikfarjam M, Muralidharan V, Malcontenti-Wilson C, Christophi C** 2005 Progressive microvascular injury in liver and colorectal liver metastases following laser induced focal hyperthermia therapy. Lasers Surg Med 37:64-73

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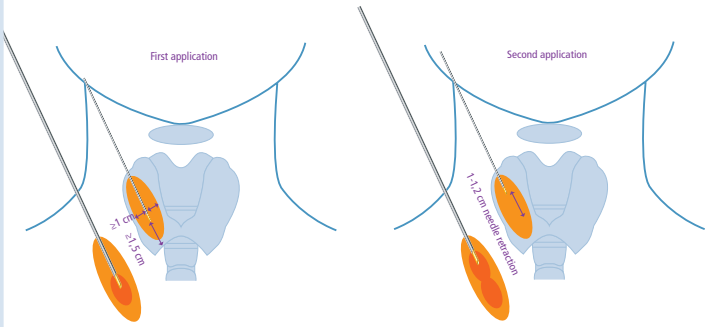
8 **Døssing H, Bennedbaek FN, Hegedüs L**, 2006 Beneficial effect of combined aspiration and interstitial laser therapy in patients with benign cystic thyroid nodules: a pilot study. Br J Radiol. 2006 Dec;79(948):943-7

* application with limited case series

Figure 4

Lenticular thyroid nodule
Nodule volume 5 ml-13 ml - 1 fiber - 1 pull back - 1 application



Lenticular thyroid nodule
Nodule volume 5 ml-13 ml - 2 fibers - 1 application

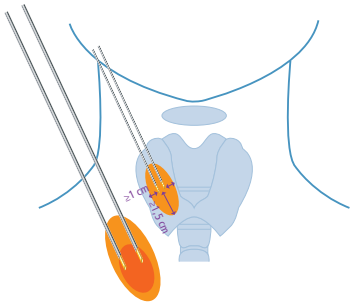


Figure 5

Lenticular thyroid nodule
Nodule volume 13 ml-30 ml - 2 fibers - 1 pull back - 2 applications

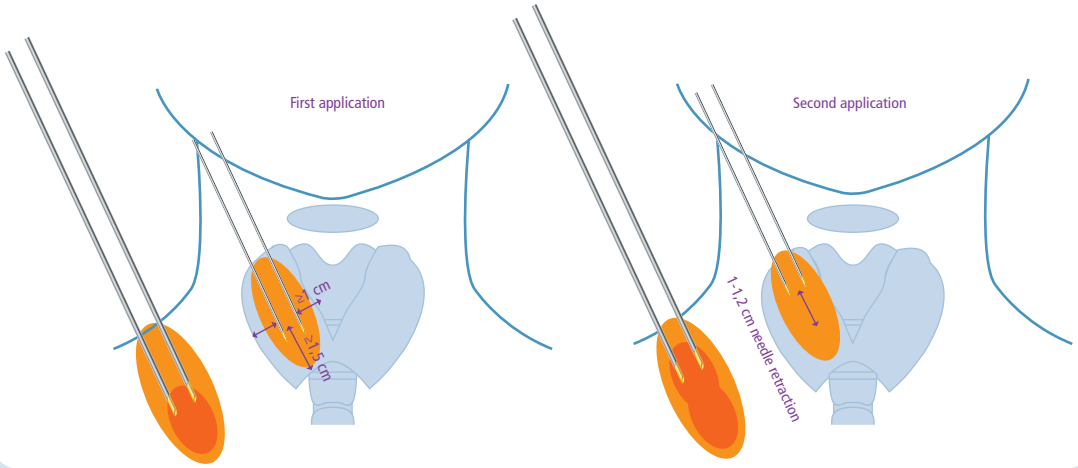
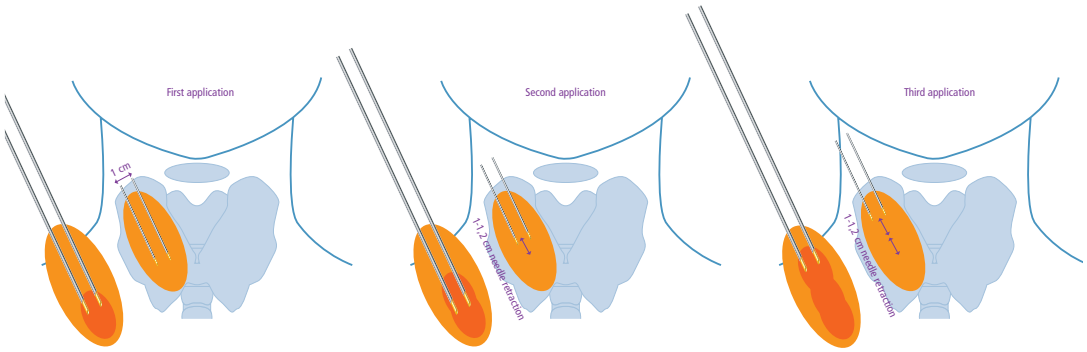


Figure 6

Lenticular thyroid nodule
Nodule volume 30 mll - 2 fibers - 2 pull back - 3 applications



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