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Thoracic Surgical Operations

Information for Patients, Written in Plain Words

1. Kinds of Thoracic Surgical Ops

Thoracic surgical operations are carried out whenever they are indicated either **for diagnostic exploration** (to find out, to diagnose) or **for treating** some diseases, that affect the organs located inside the "<u>Thorax</u>" (chest cavity).

Organs located inside the thorax are: the *Lung*, the *Oesophagus* (or **Esophagus**, colloquial term: 'gullet'), all structures comprising the "Chest Wall" (ribs, muscles and the parietal "pleura," that is a membrane lining internally the chest cavity) and all structures comprising the "Mediastinum" (the space in the middle between the right and the left half of the thorax, where the heart, lymph glands, residues of the thymus gland etc. are located).

Thoracic surgical Operations (or procedures), often carried out in the clinical practice, include the following ones:

- Biopsies of Lung, Pleura or mediastinal Lymph Nodes
- "Curative "Resections" ('removals') of pulmonary tissue for primary lung tumours, usually <u>malignant</u> ones (incl. Lung Cancer, a.k.a NSCLC: non-small cell lung carcinoma):
 - Pneumonectomy (taking out wholly one entire lung)
 - **Lobectomy** (taking out one "**Lobe**" or part of the lung. The right lung consists of 3 lobes and the left one of 2. Lobectomy can also be carried out in cases of *benign* tumours).
 - o Bilobectomy (taking out two lobes together in one piece, right-sided only)
- "Resections" of pulmonary tissue for taking out <u>benign</u> tumours or secondary masses in the Lungs, originating from malignant tumours elsewhere:
 - o Wedge Resection (taking out a very small part of the lung, shaped like a Wedge)
 - Anatomical **Segmentectomy** (taking out a segment: the *smallest* possibly removable part of a lung, that is *anatomically and functionally autonomous*)
- Resections of emphysematous "blebs" & "bullae" (air-filled cysts of the Lungs) and of the parietal pleura for treating recurrent or persistent spontaneous Pneumothorax ('collapsed Lung')

This informative article can be downloaded (and printed) from: www.icp-med.gr/resources/document/thorsurgops.pdf There are *more* informative articles on the same Website: www.icp-med.gr/engl/info



Wedge Resection





- Resections of Mediastinal tumours (e.g. thymomas, swannomas etc.) or of Chest Wall tumours (e.g. tumours or ribs etc.)
- Exploratory thoracotomies

- Anti-reflux procedures (for Gastro-oesophageal *Reflux* & Oesophagitis as in hiatal hernia cases: "Belsey Mark IV fundoplication" etc.) and procedures for treating Achalasia and other benign diseases of the Oesophagus (an intra-thoracic organ, after all !).
- Oesophago-gastrectomies (taking out the Oesophagus along with part of the stomach for Oesophageal Cancer) etc.

2. Predicted post-op Respiratory Function

People are often worried that they will not be able to breathe properly if their lung has been removed. **This is not** always **so!** It is quite possible to breathe normally with even one lung only, if hypothetically the other *entire* lung had surgically been removed. Of course, *lesser* operations are expected to cause even smaller difficulty in breathing: negligible difficulty or none. This not to say that some people, however, who already had breathing difficulties before the operation, may not be more breathless afterwards.

That is why I always ask for pre-op <u>breathing tests</u> (respiratory function tests, arterial blood gases etc.), to objectively measure how well your lungs work and to have this measurement quantified. On the basis of these unbiased measurements I have to decide whether or not an operation is right for you, so that I can or cannot recommend it to you for your consent.

After completion of both full recovery and convalescence a **post Pneumonectomy** patient is

able to *resume* all his/her pre-op **Social activities** of daily living **only**. These social activities include: to be out of bed during daytime, to keep on moving, walking, to get dressed and get out of the house, to go shopping or walking outdoors, to swim leisurely/unhurried and also to regain full capability of maintaining adults' interpersonal relationships (e.g. for intimate relations and intercourse). A post-pneumonectomy patient <u>cannot</u> usually take up any of his/her pre-op <u>sporting / athletic</u> activities (such as running, jogging etc).



After completion of both full recovery and convalescence **post Any Other pulmonary resec**tion a patient is usually able to resume **both**:

- All his / her pre-op Social activities of daily living normally (as already defined above) and
- Many of his / her pre-op *Sporting/Athletic* activities (e.g. athletic Swimming, Jogging etc). His/her performance, however, is expected somehow lower than preoperatively, if the thoracic operation was resection of some significant part of the lung (e.g. bilobectomy and similar pulmonary resections).



Such a *perfect functional <u>rehabilitation</u>* can take place post-operatively because any residual pulmonary lobe(s), left post-op inside the operated side of the chest, will **over-expand**. So it manages to be over-dilated (as it is air-filled) post any pulmonary resection (other than pneumonectomy). This over-expasion results into the fact that the residual pulmonary tissue can have enough room to accommodate almost as much inhaled <u>*air capacity*</u> as the pre-op whole lung did.

3. Risks & Benefits involved

Before any thoracic operation you may need to have further tests to assess your ability to cope with the surgery. The respiratory function tests alone may not be enough, depending on your past medical history and overall status.

Before any thoracic surgical Op, please make sure that you have discussed it *fully* with myself personally (or with whomever your own attending surgeon is) so that you **fully understand** what *expected Benefits* (diagnostic or therapeutic ones) and what *calculated Risks* are involved*. This discussion usually takes place immediately prior to your signing of the "Informed Consent" form.

Risks of severe complications are inherent to and involved by *any* surgical procedure and also by

<u>any</u> medical treatment in general. There may even be, in some cases, risks threatening the patient's very *Life* itself. This is the reason why every doctor feels heavily *responsible*, when found in the position <u>to balance</u> any expected **Benefits** over the calculated **Risks** in each and every individual patient's case based upon his/her own unbiased, justified <u>decision-making</u>:

• Either to *undoubtedly* recommend Surgery, as the responsible attending surgeon



• Or to be reserved (and recommend some *Other, non-surgical procedure*).

^{*} Please read chapter "7. Informed Consent" (pp. 59–71) of my **book**: "The Right To The Truth." One can get the book via its webpage: www.papachristos.eu/righttothetruth



4. Your FIRST days post-op

It may take a few days (3 - 6) up to several weeks (1 - 6) to <u>fully</u> recover from a thoracic surgical operation, although some people recover more quickly than others. This is the reason why no-one can accurately predict for sure how long it will take some individual patient to recover fully. There are, however, things **you** can do to **speed up** your own recovery:

After your operation you will be encouraged to start **moving** and **walking** as soon as possible. Usually this "<u>mobilisation</u>" takes place on the very same day that you were operated on (generally

in that evening). This is an essential part of your recovery. Even if you have to stay in bed, it is important to keep up regular leg **movements** to help your blood circulation and prevent clots.

The medical, nursing or physiotherapy staff will regularly visit you on the ward to help you with getting out of bed, with walking and with your <u>breathing exercises</u> to prevent chest

infections, atelectasis (lung collapse because of sputum retention) and other complications like blood clots.

By saying 'breathing exercises,' all of the following together are meant:

- Deep breaths <u>regularly</u> throughout the day.
- Courageous expectoration, that is coughing up <u>strong</u>
 <u>enough</u> to have all sputum removed out and away from the airways, despite some mild ache/discomfort during every coughing attempt.

• <u>Use of a Triflow</u>. Triflow is a simplest plastic disposable device, designed, manufactured,

- intended and applied for strengthening up the *inhalational* force of patients post-op. These instructions of use apply:
 - One must take a 'good,' deep, strongest breath in once every 15 20 minuts, trying hard to raise all three balls up, if possible.
 - o When the goal mentioned above is first achieved, then the patient attempts to keep all 3 balls Up *as*

Long as possible. In other words, the patient tries to *prolong* the duration of breathing *in* as long as he / she possibly can

- o Inhalation (breathing in) alone is only exercised !
- One must never exercise strong exhalations with the triflow. It is a *mistake* (often done in Thessaloniki, unfortunately) to strongly breathe *Out*, because:
 - Such 'strong exhalations' could cause *collapse* of the alveoli and consequent "*Atelectasis*" especially if more factors are also present (as they often are in case of patients immediately post-op)







www.papachristos.eu

The Goal to be achieved is to strengthen the respiratory muscles, so that they be able to perform better; these muscles' only job required is during Inhalation alone. Breathing In is <u>the only active phase</u> of every normal Respiration Cycle. On the contrary, breathing Out passively occurs in every Respiration Cycle; exhalation is a passive phase of that cycle. Even if one were to strengthen Exhalation, this would not have any benefit for the patient in terms of allowing him to breathe more efficiently for improving survival; such an exhalational strengthening might only benefit a professional musician playing the wind instruments...!

X-rays will be taken regularly to make sure your lungs are working properly.



5. Drips & Drains

A **drip** (intravenous infusion) will be used to give you fluids for up to a couple of days, until you are again fully able to eat and drink normally after thoracic procedures *to the*

lung (although it may take you longer to eat / drink after surgery to the *oesophagus*, since that is part of the digestive system).

I stop IV infusions to my patients *early*. One of the many reasons for doing so is *to facilitate* your getting out of bed and your walking post-op as



much as possible; this is imperative for speeding up your recovery. You must, however, *remember to drink* adequate amounts of fluids to be hydrated: as much as you feel that you need whenever you feel *thirsty* (all kinds of fluids are post-op allowed orally with the only exceptions of carbonated / gaseous beverages and alcohol).



You will also have one drainage tube (rarely two tubes) in your chest. This tube is usually taken out 3–7 days approximately after your operation, depend-

ing on your recovery; the maximum duration of keeping the "chest drain" *in* is 15 days (rarely needed). The wound will usually be around the side of your chest, parallel to the ribs. This will be covered by a dressing for the first 5 – 7 days.



<u>6. Post-op Pain</u>

It is rather expected and quite normal to have some *mild* pain or *discomfort* after your operation. The post-op pain will definitely be *numbed* (reduced), because of a technique performed just prior to closure of all thoracotomies, that I carry out. This technique is called *"Intercostal Nerves' Block"* and its pain-numbing result usually lasts for the first 5 postop days or so (3 – 7 days).

The post-op pain cannot be completely removed by some miracle, however it is <u>controlled</u> by painkillers and other medication ("analgesics" & "non–steroidal anti–inflammatory drugs" along with "proton-pump inhibitors").

Some of the painkillers are given *regularly* at pre-set time intervals, as "baseline analgesia," even

if you happen not to feel sore at that specific moments. Other painkillers are supposed to be given *in addition* to the regular ones only if and when the patient complains of pain.

So, let the doctor on-call or one of the nurses know, if you have any pain, so they can treat it as soon as possible.

Mild discomfort, or pain, can last for a few weeks and you will be given some painkilling *tablets to take home* with you.

Finally, any wound (either from surgery or injuries etc.) can sometimes become

the centre or focus of some long-term *sensitivity* or mild discomfort. For instance, the old wound area may give you a warning of *humid / moist* weather or an accurate prediction of forthcoming *rainfall* by some sort of mild *'needles & pricks'* sensation. This is a well-known possibility and it is so unimportant, that it requires no medication and it causes no worry to the patient.

"Chronic post-thoracotomy pain" very rarely occurs; this is defined as presence of pain for prolonged period postoperatively (e.g. several months or so); this form of pain is neuropathic and originates from the intercostal nerves. In such cases medication specific for neuropathic pain may help (such as gabapentin, pregabalin etc.) or treatment by experts in chronic pain (at "Outpatients' Clinics for Chronic Pain Management").



7. Discharge - Going home

You will probably be ready to "be discharged" or to go home about 5–10 days after your operation. If you think that you might have problems when you go home — for example, if you live alone, or have several flights of stairs to climb — let me know as soon as you are admitted: I can arrange for social workers to address this problem.

When you go home, it will be imperative that you exercise gently and gradually to build up your strength and fitness and also to achieve over-expansion of any residual lung tissue left after a possible major pulmonary resection. So, aerobic exercise is an absolute *must* for the first 2

months post op. It is a good idea to check with me which kind of exercise would be suitable for you. Rapid walking and also using an elliptical training machine (or jogging) are often good exercises, that are suitable for many people after surgery to their chest.

Specific instructions in detail are given to each and every individual patient of mine post-op and they are clearly written in my discharge report's last paragraph "Instructions / medication upon discharge." Here are some routine, standard instructions for all post-op patients :

- Flights are forbidden for three weeks at least post-operatively; in some other cases a longer avoidance of flights is ordered. In a similar way, diving is also forbidden after thoracic surgical procedures.
- Avoid exposing the surgical wound or scar to sunlight or ultraviolet radiation (solarium) for the first year post-op in order to achieve a better cosmetic final result.
- Observe *full*, adequate and balanced **feeding**, *rich in <u>protein</u>* for the first 2 months post-op. Try to increase your protein intake by all available means. Slimming diets are absolutely forbidden for the first 2 months post-op. Sources of high-biological-value proteins are: meat (not only beef and pork meat, but also chicken, turkey and poultry in general as well as fish, too), egg's white, soy, milk, cheese etc. The lack of proteins disturbs, impedes, delays and prolongs the wound healing process and it can also act as a factor leading towards fatal <u>pulmonary oedema</u> in cases of patients who underwent major pulmonary resection (low proteins' concentration

in the blood's serum \Rightarrow low colloidosmotic pressure at the same time with increased or even doubled blood flow to the residual lung left, therefore, with increased pulmonary circulation pressure).









8. Out-Patient's Appointment & FOLLOW-UP

Every single patient should best be seen <u>at least once</u> again as an out-patient by his/her own attending surgeon (or at least by a colleague of the Same hospital's Department). This way all accurate technical details of the operation carried out, histology diagnosis etc. are readily available and misunderstandings are avoided. I usually suggest that an outpatient's appointment be arranged in two weeks' time post discharge home.

During that outpatient's consultation, all of the following can take place:

- The thoracostomy **sutures** and any other non-absorbable sutures can be **removed** (thoracostomy is the **hole** through which the post-op chest drain was inserted into the chest).
- The Histopathology Report or 'biopsy Report' can be made available, in case it had been pending before and up to the very date of discharge home. On the basis of the histopathology diagnosis the whole <u>decision-making</u> can be modified as much as Follow-up or even further Treatment is concerned: for instance, Complimentary treatment (i.e. "adjuvant" or 'additional') may post-operatively be considered necessary according to some histopathology diagnoses as soon as they come to light.
- The patient can be *clinically examined* and x-rayed.
- The attending surgeon can once more be asked about any of the patient's own (or any of his / her relatives') unanswered **questions** and concerns.
- A definite timetable or schedule of regular **Follow-up** appointments can now be set or recommended, if necessary. For instance, an Outpatient's appointment every 3 or 4 months until completing 5 years post-op for *Lung Cancer* cases, or once every year for 5 years for *benign* tumours or other cases etc.—



9. Exposure or Approaches

There are *three ways* of *operatively exposing* the thoracic organs (or ways to approach the thoracic organs) for operating on them:

9.a. The Open approach

The "**Open**" approach is the Exposure through an "incision" or a linear 'cut' or 'opening' to the chest wall. *All* thoracic surgical operations are technically possi-

ble to be carried out through an open approach. Interesting abnormal *intra-operative* findings (i.e. findings *during* an operation), *as seen through an Open surgical approach*, can be browsed on the following link 'Intraoperative thoracic surgical photographs':

www.icp-med.gr/engl/photos

There are many Open approaches for thoracic surgical operations. Quite detailed information about them along with explanatory drawings can be found on the following **link**:

www.icp-med.gr/resources/document/thor_incis_appr.pdf

of the "Information For Patients" sub-page of the Website:

www.icp-med.gr/engl/info/

The vast majority (almost 80%) of all **Open** thoracic surgical operations are carried out through a "**thoracotomy**." A thoracotomy is an incision located at the

side of the chest (either right or left side), below the "axilla" (armpit, underarm), in between two ribs and

parallel to them. A thoracotomy may be "mini," "limited," "muscle-sparing," "lateral," "posterolateral," "anterior," "anterolateral" or "extended" depending on the varying surgical goal to be achieved in individual cases.

This article's author undertakes almost all open minor/diagnostic operations through a "**mini**" muscle-sparing thoracotomy (figure above-right) and he consid-

ers it as *both* "minimally-invasive" *and* "open" *at the same time*. The very same incision can also be called an "axillary thoracotomy," when it is undertaken higher up, immediately below the axilla. The author also uses this exposure for treating cases of recurrent or persistent spontaneous pneumothoraces. The *cosmetic advantage* of this approach is the fact that the final scar is concealed by the patient's arm almost always, but especially during ordinary 'naked-chest social activities' (such as walking by the sea side, swimming etc).

More demanding operations are usually performed through a "lateral" thoracotomy (below-right), which consists of a longer incision (please see the photograph on the right: a lateral thoracotomy scar, through which a Right Lower Lobectomy had been carried out for lung cancer, on a *cured* 54-yo male patient's case).

It is nowadays very rarely indeed that extensive, full–length "**posterolateral**" thoracotomies are carried out, reserved only for the most difficult

and technically challenging cases (e.g. gigantic locally advanced malignant tumours, or life-threatening emergencies from trauma, pulmonary haemorrhage etc).









There are other exposures, less often used, such as: "anterior mediastinotomy," "median sternotomy," "thoracolaparotomy" (or "thoracoabdominal approach"), Peter Goldstraw's "anterior cervicaltranssternal approach"*, the "Dartevelle approach", the "clamshell" and "hemiclamshell" incisions etc.

9.b. The Thoracoscopic approach or V.A.T.S.

The **thoracoscopic** or "VATS" approach (Video-Assisted Thoracoscopic Surgery) is the exposure obtained by watching a monitor, receiving video images from a camera inserted inside the patient's

chest cavity. Thin, long surgical instruments (usually disposable & expensive ones) are inserted through small 'holes' (or "thoracoports" or short incisions) in the chest wall. There are usually 3 holes (holes' number 1 - 4), but a "utility incision" (measuring $4 - 8 \text{ cm}^+$ or even 10 cm^+) is often added to the holes, to facilitate removal of larger–sized specimens. This procedure is also referred to as 'keyhole surgery' (colloquial term). Many



thoracic surgical operations can technically be carried out thoracoscopically.

The VATS approach is neither '*new*' nor '*modern*,' as it was described in **1911** for the first time (by H.C. Jacobaeus, Münch Med Woch 1911), but it had already been used in **1866** (by Sir Francis Richard Cruise, Gordon S, Dublin Q J Med Sci 1866). Since the 1970s–1980s there has been overenthusiasm and zeal for a revival of this approach by using "cold light" sources and monitors. Adopting this approach has steadily been ever–increasing as if it were somehow '*trendy*' or 'fashionable,' because it has been *overpublicized* (or excessively promoted) by the media and by the press.

As for any other surgical operation (or even any medical procedure in general), there are well known *Contraindications* for VATS (pp. 10-11 of the "Incisions – Approaches" informative article), as well as *Disadvantages* (pp. 8 - 10 of the same article) and *Advantages* (p. 7 of the article). VATS <u>does have</u> indeed a *rightful place* in the thoracic surgical armamentarium, but **only if** it is carried out **When** properly *indicated* and *reasonably*, without exaggerations of overusing it indiscriminately, for it is *not* "**panacea**" **§**. More in-depth details about VATS can be read in *pages* 7 – 11 of the "Incisions – Approaches" informative article:

www.icp-med.gr/resources/document/thor_incis_appr.pdf

Forthcoming improvement of VATS with further advancement, evolution and sophistication of its capabilities is expected to occur by newer and better equipment. Such advancement will—most certainly—allow any disadvantages to be overcome. *In the future,* this improvement will be achieved; the VATS–approach will gain ground and will become *most widely* accepted and

^{*} Ladas G, Rhys-Evans P.H., **Goldstraw P**. Anterior cervical-transsternal approach for resection of benign tumors at the thoracic inlet. **Ann Thorac Surg** 1999; 67: 785-789

[†] Demmy T, Dexter E. Overview of video-assisted thoracoscopic surgery (VATS). **UpToDate** Website as on Nov 16, 2015: <u>www.uptodate.com/contents/overview-of-video-assisted-thoracoscopic-surgery-vats</u>

[‡] Flores RM. Video-assisted thoracic surgery (VATS) lobectomy: focus on technique. **World J Surg** 2010 Apr; 34 (4): 616-620, doi: 10.1007/s00268-009-0340-8 . PMID: 20082195 [PubMed - indexed for MEDLINE]. Link: <u>http://www.ncbi.nlm.nih.gov/pubmed/20082195</u>

[§] Ancient Greek word "πανάκεια," meaning a kind of almost magical "universal remedy"

appreciated by all. This article's author reasonably uses the VATS approach, when it is indicated: please see the following *intraoperative* photographs of one of his clinical cases:

www.icp-med.gr/engl/photos/sarcomamyofibroblastic/

9.c. Robotic Thoracic Surgery

The **Robotic surgery** is the use of a surgical robot (*Da Vinci*[®]) under which the patient is anaesthe-

tised and "docked"; an "assistant surgeon" stands at the patient's side in order to assist with retraction or introduction of different devices and change of instruments. The actual surgeon sits at a robotic cold and lifeless "Console," that fully controls the surgical robot in real time.

The **rationale** behind the whole concept of robotic surgery, was initially the *provision of expert surgical*



services to unfortunate patients, who may happen to be *far away*, in **remote** areas (e.g. in Antarctica, on a [space-]ship, in a poor or developing country etc.), where there would be doctors but *no* highly skilled ones in surgical subspecialties, such as neurosurgery, thoracic surgery etc.

Safety considerations^{*} about *Remote* robotic surgery resulted into the current <u>nonsensical</u>, yet common practice of the actual surgeon <u>sitting Aside</u>, away from his patient, despite their being both physically present inside the very same operating theatre ! The human surgeon is, therefore, utterly deprived of any "palpable" or even "**tactile**" intra-operative findings (e.g. infiltration of major vasculature by tumour, deep intrapulmonary nodules etc.) during his manoeuvres.

An interested reader **can read more** about the three theoretical *benefits* of this *most expensive* approach and also about **144 deaths** and **1,391 injuries** (in USA alone), related to the robotic approach (*broken parts* of instruments falling into patients' bodies, electrical *sparks* causing *tissue burns* etc. according to an <u>MIT Technology Review</u> article dated Jul.20, 2015, that drew *BBC News*'s attention), in *pages* 10 - 11 of the "Incisions-Approaches" informative article:

www.icp-med.gr/resources/document/thor_incis_appr.pdf

The technological advancement, sophistication and evolution of the surgical robots is expected to occur in leaps and bounds; *in the near future*, they are to overcome any existing issues associated with some ways of their use at present:

• The inventing of <u>autonomous</u> surgical robots seems to be imminent. The latter will probably operate autonomously, on their own—in other words without any supervision by human surgeons—and they're expected to do so faster, more precisely and better than human surgeons operate. Some success towards this end has

^{*} e.g.: **a.-** likelihood of *Loss of connectivity* between a surgeon's console and the docked patient / robot, **b.-** possibility of *haemorrhage* of other complication resulting in a need to *"Convert"* the robotic Op into an Open one



already been published *, bearing the **STAR** abbreviation as its name: **S**mart Tissue *Autonomous* **R**obot. Please see also my invited commentaries during the 6th Multihospital Postgraduate lesson (organized by the Aristotle University Dept. of Cardiothoracic Surgery in 2016 in Thessaloniki, Greece), as well as during the 6th lesson in 2018, listed as numbers **5** & **11** of the "Invited Commentaries" Link: <u>www.icp-med.gr/engl/scientific/#scie5</u>.

• <u>Nano</u>-robots ⁺ will be able to enter the human body by being injected into the blood stream or by being inserted via alternative anatomical pathways. So, there won't be a need any longer for incisions, not even the tiniest ones.

The currently available equipment of Robotic Surgery will appear rather *primitive* and crude or even droll—in the future, in a way similar to how outdated (or even ridiculous) last centuries' chloroforme inhalers (and *blood-letting knives* etc.) now seem! The future is expected to shine bright, amazing with unfathomable innovations and cutting–edge technologies: *We're looking forward* to it, even if that means our forthcoming replacement by surgical robots which will be faster, more precise and more skillful than human surgeons. If so, then a remarkable accomplishment will have *happily* been achieved "for the benefit of the sick"...

Note:

Double quotation marks ("") are used for *proper* and correct *medical* or *scientific* <u>terms</u> in the whole article above (e.g. "resection").

On the contrary, **Single** quotation marks ('') are used for *explanatory*, *plain* or *colloquial* <u>words</u> (e.g. 'removal').

Links inside the article are in **blue** colour.—

- Would you trust a robot surgeon to operate on you? http://spectrum.ieee.org/robotics/medical-ro-bots/would-you-trust-a-robot-surgeon-to-operate-on-you
- This robot completes a 2-hour brain surgery procedure in just 2.5 minutes: https://futurism.com/this-ro-bot-completes-2-hour-brain-surgery-procedure-just-25-minutes/

+ The tiny robots will see you now: http://spectrum.ieee.org/the-human-os/biomedical/devices/the-tiny-robots-will-see-you-now

^{*} Shademan A, Decker RS, Opfermann JD et al. Supervised **autonomous** robotic soft tissue surgery. Science Translational Medicine 2016: 8: 337 http://spectrum.ieee.org/the-human-os/robotics/medicalrobots/autonomous-robot-surgeon-bests-human-surgeons-in-world-first

More information on thoracic surgical operations can be retrieved by:

- Browsing the author's medical Website: www.icp-med.gr/engl
- Looking at *intraoperative* Photographs & Videos: www.icp-med.gr/engl/photos/
- Browsing the website's sub-page 'Information for patients': www.icp-med.gr/engl/info/
- Reading the same author's 'Incisions Approaches' article: www.icp-med.gr/resources/document/thor_incis_appr.pdf
- Reading the author's 'The Right To The Truth' book:



www.papachristos.eu/righttothetruth

• Reading other books written by the same author on his *Writer's* Website: www.papachristos.eu



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