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Variace abnormalit foramen obturatum a retropubického prostoru a jejich vztah ke komplikacím páskových operací

Variation of abnormalities of foramen obturatum and retropubic space and its relation to complications of tape surgery

Disertační práce

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Obsah

Abstrakt

Úvod: Znalosti anatomie jsou zásadní při zaváděních nových operačních metod. Zejména se pak uplatní při řešení operačních komplikací u operací s omezeným operačním polem, kdy omezený přístup následné řešení komplikací ztěžuje. Předpokládalo se, že se běžné anatomické variace budou podílet na rozdílné úspěšnosti operace a že právě těmito variacemi je možné vysvětlit operační komplikace.

Metodika: Během pitevních cvičení bylo pitváno padesát ženských kadaverů a byly zkoumány tahuprosté pásky TVT-S H, TVT-S U, TVT Abbrevo a Ajust. Byl vytvořen popisný systém pro určení polohy pásky v prostoru ve vztahu k referenčním bodům. Během anatomické pitvy pak byla lokalizována páska, její případný kotvící mechanismus a její vztah ke klíčovým anatomickým strukturám.

Výsledky: Běžnou anatomickou odchylkou v souboru byla corona mortis s četností 72 %. V obturatorním kanálu byl ve 40 % pozorován preperitoneální tuk, který někteří autoři považují za první stupeň obturátorové hernie. Správná fixace pásky TVT-S H byla dosažena v 53,6 %. V 10,5 % došlo k poranění močového měchýře. V případě pásky TVT-S U bylo dosaženo správné fixace v 63,8 %. Ve dvou případech byl zavaděč v těsném kontaktu s anastomózou zvanou corona mortis. V případě pásky TVT Abbrevo byla páska v 81,25 % dostatečně dobře zavedena do oblasti foramen obturatum, avšak bez průniku do skupiny adduktorů. Páska Ajust byla v 86,3 % fixována do vazivově-svalového komplexu ve foramen obturatum.

Závěr: Byly popsány mechanismy a příčiny selhávání některých tahuprostých vaginálních pásek.

Klíčová slova: anatomie, komplikace, tahuprostá vaginální páska, urogynekologie

Abstract

Introduction: The knowledge of anatomy is crucial for introduction of new surgical methods. It is also of especial use while dealing with surgical complications during surgeries with limited surgical field, where the way of approach limits the management of complications. It was assumed that common anatomical variations would influence different efficacy of surgeries and would explain potential complications.

Methods: During anatomical dissections fifty female cadavers were dissected and tension-free vaginal tapes TVT-S H, TVT-S U, TVT Abbrevo and Ajust were studied. A novel descriptive system for localisation of the tape was created. During the dissection the tape was located and its localisation and fixation was described.

Results: Common anatomical variation in the sample was corona mortis with frequency of 72 %. Preperitoneal fatty plug, which is recognized by some authors as the first stage of obturator hernia, was found in 40 % in obturator canal. The proper fixation of TVT-S H was achieved in 53.6 %. In 10.5 % urinary bladder was injured. In case of TVT-S U the proper fixation occurred in 63.8 %. In two cases the inserter was nearby corona mortis. Within the group of TVT-O Abbrevo the tape was fixated properly into the obturator complex (consists of the obturator membrane and obturator muscles) in 81.25 %, but did not penetrate into the group of thigh adductors. Ajust tape was inserted properly into the obturator complex in 86.3 %.

Conclusion: Mechanism and causes of failures and complications of selected TVT were described.

Key words: anatomy, complications, tension-free vaginal tape, urogynecology

Úvod a literární přehled

Foramen obturatum je otvor v kostěné pánvi tvořený rameny sedací a stydké kosti. V něm se nachází vazivová membrana obturatoria, v jejíž horní části prochází při horním okraji arteria obturatoria společně s vena obturatoria a nervus obturatorius. Tento otvor je vyplněn membrana obturatoria a z ní se rozprostírajícími svaly musculus obturator internus a musculus obturator externus. Znalost anatomie malé pánve, a tedy i anatomie foramen obturatum a retropubického prostoru, nabývá na potřebnosti díky rozvoji miniinvazivních operačních metod užívaných k léčbě stresové inkontinence moči u žen.

Inkontinence moči u žen je každý nechtěný únik moči. Představuje sociální, zdravotní a společenský problém. Incidence dosahuje jedné poloviny ženské populace (Dooley *et al.*, 2008). Pravděpodobnost výskytu inkontinence se zvyšuje s narůstajícím věkem a Body Mass Indexem (BMI) (Lopez *et al.*, 2009; Wing *et al.*, 2010).

Inkontinence se dělí na tři pro urogynekologickou praxi významné typy - urgentní inkontinenci, stresovou inkontinenci a smíšenou inkontinenci - a další méně časté typy (Haylen *et al.*, 2010). Urgentní inkontinence je definována jako nechtěný únik moči, kterému předchází výrazné nutkání k močení. Základním pilířem terapie urgentní inkontinence je farmakoterapie. Druhým typem inkontinence moči je stresová inkontinence. Ta je definována jako nechtěný únik moči, k němuž dochází bez varování, přičemž vyvolávajícím faktorem je zvýšení nitrobřišního tlaku – tedy typicky kašel, smích, prudký pohyb a podobně. Základním pilířem terapie je operační léčba. Posledním typem inkontinence moči je smíšená inkontinence. Jedná se o kombinaci obou předchozích typů. Řešení spočívá v terapii převažujících obtíží a zpravidla se zahajuje farmakoterapií.

Stresová inkontinence moči má kromě věku a BMI (Lopez *et al.*, 2009; Wing *et al.*, 2010) pozitivní korelaci s počtem porodů a je závislá na rase – zatímco

bělošky jsou více ohroženy stresovou inkontinencí, černošky trpí zejména urgentní inkontinencí (Buckley *et al.*, 2010).

Vzhledem k tomu, že stresová inkontinence je způsobená hypermobilitou uretry (DeLancey, 1994) a anatomickými defekty pánevního dna, spočívá terapie zejména v operačním řešení anatomických odchylek. Po dlouhou dobu byla za zlatý standard řešení považována Burchova kolpopexe (Burch, 1961), která spočívá ve fixování močového měchýře k ligamentum Cooperi a vytvoření podpory uretrovesikální junkci. Klíčovou změnu v chápání anatomie malé pánve a podpěrného systému močové trubice přinesl DeLancey (DeLancey, 1994) se svou teorií houpací sítě (hammock).

V roce 1995 Ulmsten (Ulmsten *et al.*, 1995) zavedl pod střed močové trubice tahuprostou vaginální pásku a tím vytvořil novou podporu pro močovou trubici. Tato metoda se díky své minimální invazivitě a vysoké úspěšnosti stala standardem v operační terapii stresové inkontinence moči. Původní Ulmstenova metoda byla nazvána Tension-free Vaginal Tape (TVT) a spočívala v zavedení tahuprosté pásky pod močovou trubici z vpichů nad horním raménkem kosti stydké (ramus superior ossis pubis). Pro výskyt komplikací, které ve své práci Tamussino (Tamussino *et al.*, 2001) rozdělil na mírné (poranění močového měchýře a drobné krvácení) a závažné (poranění střeva, masivní krvácení), byly hledány nové způsoby.

Za možný způsob řešení komplikací spojených s vedením zavaděčů v retropubickém prostoru navrhl Delorme (Delorme, 2001) zavést pásku z vnitřní strany stehna skrze foramen obturatum pod močovou trubici – tedy směrem outside-in. Tím se jednak vyhnul retropubickému prostoru, jednak více napodobil fyziologický stav podpory močové trubice, kdy je páska vedená více horizontálně. Pro tuto metodu se vžilo označení Trans-Obturator Tape (TOT). Ovšem ani tato metoda nebyla zcela spolehlivá a nesla s sebou možná rizika spojená s poraněním močového měchýře či močové trubice. Z tohoto důvodu

byla metoda transobturatorní pásky modifikována de Levalem (de Leval, 2003) ve smyslu zavedení pásky zpod močové trubice skrze foramen obturatum na vnitřní stranu stehna – tedy směrem inside-out. Pro tuto metodu se vžilo označení Tension-free Vaginal Tape – Obturator (TVT-O). Tato metoda minimalizuje jak rizika poranění močové trubice při zavádění, tak rizika poranění močového měchýře a zcela se vyhýbá retropubickému prostoru.

S odkazem na nutnost minimalizace cizorodého materiálu a na rizika poranění obturatorního nervu, který mohl být na vnitřní straně stehna poraněn při transobturatorních metodách, byly do klinické praxe zavedeny takzvané miniinvazivní pásky; první z nich byla Tension-Free Vaginal Tape Secur (TVT-S). Tyto miniinvazivní pásky měly při použití menšího množství materiálu dosahovat stejných, či ještě lepších výsledků operačního řešení (Neuman, 2007) a měly dokonale napodobovat anatomii podpůrného aparátu močové trubice. Tato očekávání se jim však nepodařilo zcela beze zbytku naplnit, jelikož se TVT-S od počátku potýkala s horší dlouhodobou účinností a byly zaznamenány i závažné komplikace (Martan *et al.*, 2007; Masata *et al.*, 2008).

Cíle práce

Důvodem vzniku této disertační práce byl rozmach urogynekologických operací, které jsou prováděny pomocí zavaděčů naslepo, s minimální možností řešení perioperačního krvácení a s obtížnou diagnostikou poranění orgánů v malé pánvi.

Tato práce si klade za cíl dokumentovat nástrahy, které čekají na operatéra v podobě anatomických odchylek. Sledované odchylky byly ty ze skupiny častějších, tedy takové, se kterými se může běžný gynekolog, urogynekolog či lékař zabývající se operativou v malé pánvi setkat. Hlavním cílem práce pak bylo popsat možné komplikace z poranění orgánů v malé pánvi, zejména močového měchýře, a z poranění cév a nervů v oblasti foramen obturatum.

Metodika

Páskové operace byly prováděny na ženských kadaverech. První skupina kadaverů byla fixovaná formalínem. Do druhé skupiny byly zařazeny čerstvě zemřelé ženy a těla byla pouze chlazena.

Skupina formalínem fixovaných těl byla majetkem Anatomického ústavu 1. lékařské fakulty Univerzity Karlovy. Těla byla ústavu odkázána za života dárkyní na základě smlouvy a byl získán souhlas s dalším výzkumem. Těla byla fixována pitevními laboranty za použití standardních postupů. Před zahájením pitvy vnitřních orgánů zkušený urogynekolog (školitel) zavedl standardním způsobem jednotlivé pásky pod močovou trubici. Těla byla při zavádění polohována následovně: v poloze na zádech, s dolními končetinami abdukovanými v kyčli v úhlu 30° a flektovanými v kyčli v úhlu 30°. Následovala disekce břišním přístupem s pečlivou preparací anatomických struktur v malé pánvi a jejich identifikace. Výhodou fixovaných těl je dobrá přehlednost anatomických struktur, dostatek času na preparaci a kvalitní obrazová dokumentace. Úskalí fixování však spočívá v tom, že struktury jsou nepohyblivé, a tak se zavedení pásky odchyluje od reálné operace.

Skupina čerstvě chlazených těl byla zkoumána na půdě Ústavu patologie 1. lékařské fakulty Univerzity Karlovy. Výzkum byl schválen Etickou komisí Všeobecné fakultní nemocnice v Praze (souhlas číslo 148/08). Poloha těl byla shodná s polohou těl fixovaných formalínem s jediným rozdílem, a to, že díky možnosti zrušit posmrtnou ztuhlost (rigor mortis) bylo možné umístit končetiny do identické polohy jako při urogynekologické operaci na živé pacientce. Dolní končetiny byly proto v kyčli polohovány takto – abdukce 30° a flexe 90°. Pásky opět zaváděl školitel. Během břišní pitvy byla opět vyhledána páska a změřeny vzdálenosti k jednotlivým strukturám. Nefixovaná těla, tedy pouze chráněná chlazením, mají tu výhodu, že je možné prostřednictvím polohování končetin

simulovat reálnou operaci. Toto je vykoupeno horší přehledností a vysokými požadavky na časovou flexibilitu a rychlost preparace.

Způsob zaměření pásky

Již před samotnou břišní pitvou bylo zřejmé, že pro reprodukovatelnost jednotlivých výsledků není možné měřit pouze vzdálenost k jedné struktuře. Proto byly zvoleny tři body, které jsou jednoznačně identifikovatelné, neměnné a od sebe dostatečně vzdálené, tedy vznikla jakási soustava referenčních bodů. Poloha hrotu zavaděče byla pak referována jako vzdálenost k těmto bodům.

Prvním referenčním bodem byl vnitřní vstup obturatorního svazku (vasa obturatoria a nervus obturatorius) do canalis obturatorius. Tato pevná vazivová struktura nemá přesný anatomický popis. Je možné ji popsat jako anulus obturatorius profundus. Z něj často vychází anastomóza k zevním ilickým cévám. Tuto vzdálenost můžeme chápat jako základní bezpečnostní parametr jak z pohledu krvácivých komplikací, při možném poranění arteria či vena obturatoria, tak z pohledu neurologických komplikací z poranění nervus obturatorius.

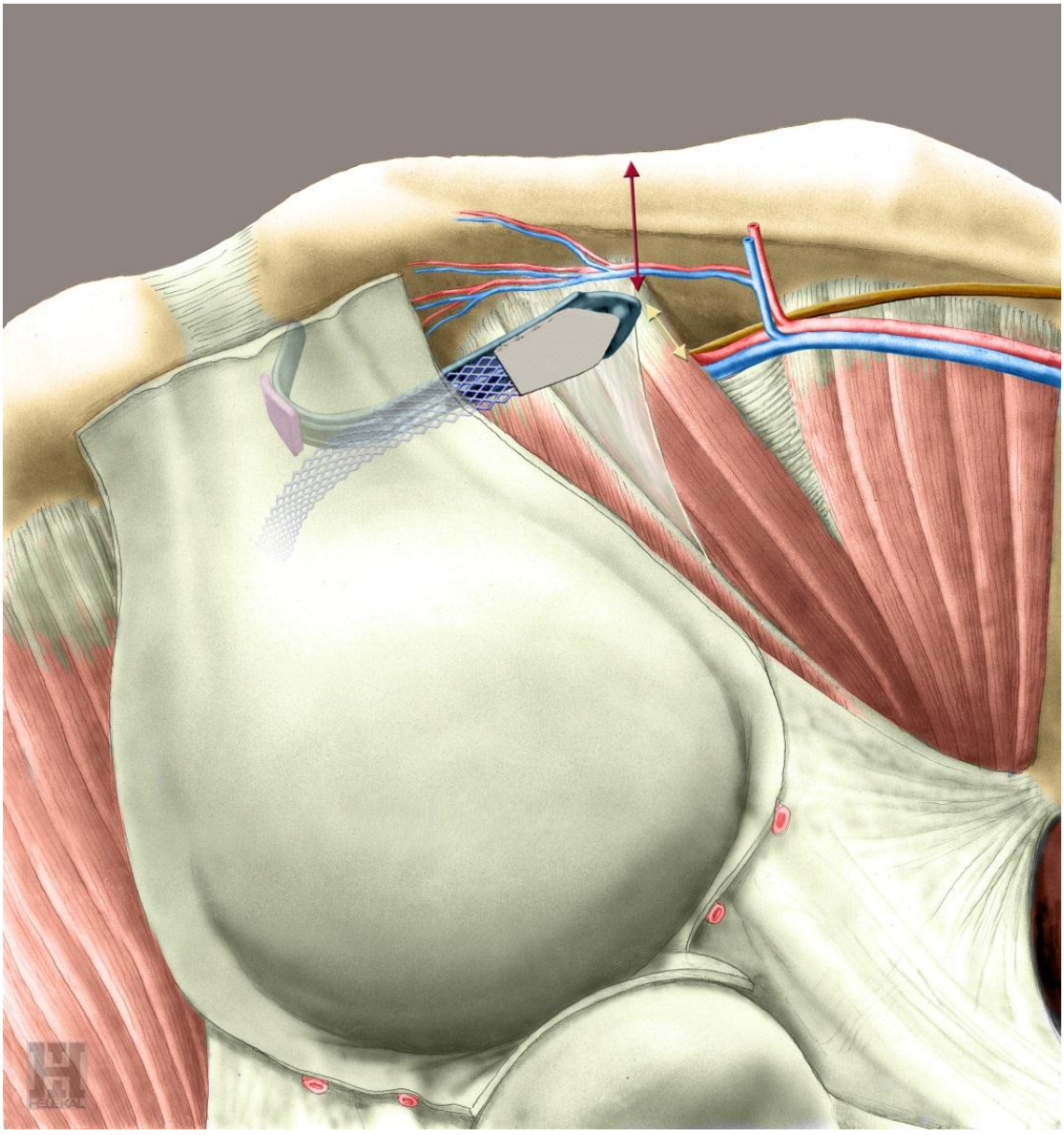
Druhým referenčním bodem byla nejmenší vzdálenost od horního okraje horního raménka kosti stydké (margo superior rami superior ossis pubis). Nejmenší vzdálenost byla zvolena z toho důvodu, že se snadno měří a současně eliminuje problém s popisem v případě různých rozměrů pánve.

Třetím referenčním bodem byla zvolena fascia musculus obturator internus. Od této roviny byla opět měřena nejmenší vzdálenost k hrotu zavaděče. V případě, že byl zavaděč v musculus obturator internus, nabývala tato vzdálenost kladných hodnot. V případě průniku zavaděče skrz fascii musculus obturator internus nabývala záporných hodnot a bylo značeno, zda poranila nějakou strukturu v malé pánvi. Tento bod, resp. rovina, byla zvolena z toho důvodu, že

představuje další informaci o bezpečnosti dané metody a lze pravděpodobně úspěšně korelovat s dlouhodobou úspěšností metody vzhledem k místu fixace.

Umístění do vazivově svalového komplexu ve foramen obturatum bylo hodnoceno následovně.

Následující obrázek znázorňuje měřené vzdálenosti v případě TVT-S v pozici U.



Nesprávné zavedení bylo takové, kdy hrot zavaděče či kotvící prvek nebyl vůbec v daném komplexu – například byl prevesikálně mezi fascia musculus obturator internus a močovým měchýřem nebo došlo k poranění močového měchýře.

Akceptovatelné zavedení pásky TVT-S bylo takové, kdy zavaděč nepronikl skrze fascii musculus obturator internus hlouběji do malé pánve anebo byl kryt alespoň několika svalovými vlákny do tloušťky 1 mm. V případě pásky Ajust byl kotvící prvek zaveden v musculus obturator internus nebo došlo k zavedení skrze membrana obturatoria hluboko od musculus obturator externus.

Správné zavedení nastalo v případě TVT-S, pokud byl zavaděč dostatečně kryt svalovinou musculus obturator internus, a v případě Ajust umístěním kotvícího prvku do membrana obturatoria.

Zkoumané pásky

Zkoumány byly tyto pásky: ze skupiny minipásek Tension-free Vaginal Tape Secur (TVT-S) a Ajust, ze skupiny transobturátorových pásek Tension-free Vaginal Tape Obturator (TVT-O) a TVT Abbrevo (TVT Abbrevo je modifikovaná TVT-O páska, která má kratší délku a bylo by ji možno chápat jako o něco delší transobturátorovou minipásku). Všechny pásky, které byly zkoumány, jsou makroporézní, monofilamentózní, splétané prolenové (typ I dle Amida).

Páska TVT-S patří do kategorie miniinvazivních pásek, jedná se přitom o třetí generaci tahuprostých vaginálních pásek. Její celková délka je osm centimetrů a šířka je jeden centimetr. Dodává se společně se dvěma zavaděči. Má dva způsoby zavedení, a to polohu H – odvozenou od hammock (anglicky houpačka) – a polohu U – odvozenou od tvaru zavedení pásky (byť se tvar zavedení pásky více podobá písmenu V).

V poloze H je páska směřována směrem k foramen obturatum a cílem fixace pásky je musculus obturator internus. Průběh by měl odpovídat transobturatorní

pásce. Způsob zavedení je následovný. Ve vzdálenosti 1,5 cm od zevního ústí močové trubice na přední stěně pochvy je provedena incize v délce 1 cm, následně je ostře pod endopelvickou fascií postupováno směrem k foramen obturatum, tedy kraniálně a laterálně do vzdálenosti cca. 4 cm. Po oboustranném vytvoření tunelů je uchopen nejdříve pravý zavaděč, zaveden do malé pánve a poté zaveden analogicky levý zavaděč. Po správném zavedení by se měly oba zavaděče dotýkat koncovou manipulační částí.

Poloha U pásky se přibližuje způsobu zavedení pásky TVT, tedy do retropubického prostoru směrem kraniálním, ventrálním a laterálním. Páska se umisťuje ze stejné incize jako v případě polohy H s tím rozdílem, že zavaděč je odkloněn od sagitální roviny v úhlu 45° laterálně. Zavaděče mají po zavedení spolu svírat v koncové části pravý úhel a připomínají písmeno V.

Páska Ajust je další z generace minipásek, avšak má proměnnou délku. Zavádí se směrem do foramen obturatum a ideální kotvící struktura je membrana obturatoria. Nejdříve dojde k zavedení fixně upevněného kotvícího prvku a následně na druhé straně je do kotvící struktury zaveden mobilní kotvící prvek. Tím volně prochází páska a je možno upravit délku pásky. Následně dojde k zafixování pásky v mobilním kotvícím prvku pomocí jistícího mechanismu a zbytek pásky je odstřižen.

Páska TVT-O je typickým představitelem dnešních transobturatorních pásek. Zavádí se z identické incize na přední straně poševní stěny jako páska TVT-S a pomocí nůžek je vytvářen v tomto případě tunel až k membrana obturatoria, která může být pomocí nůžek proražena ve shodě s původním doporučeným postupem výrobce. V oblasti skupiny adduktorů stehna může být provedena kožní incize, která je od zevního ústí močové trubice vzdálená dva centimetry laterálně a dva centimetry dorsálně. Kromě toho, že má tato incize usnadnit vyvedení pásky, je dobrým orientačním bodem pro vedení zavaděče. Do této incize se pak vede hrot zavaděče po zavedení skrz membrana obturatoria. Díky

evoluci operačního postupu se většina pracovišť odklonila od prvotního postupu, kdy se prováděly kožní incize a membrana obturatoria se prorážela nůžkami. Novější způsob nabývá na významu s představením nové pásky TVT Abbrevo v srpnu 2010. Tato páska má zavaděč totožný s TVT-O, avšak její délka je pouze dvanáct centimetrů a díky tomu by se dala řadit do kategorie miniinvazivních pásek. Dle výrobce by neměla zasahovat do skupiny adduktorů stehna, měla by však být dostatečně fixována v musculus obturator internus a musculus obturator externus. Zda se tento předpoklad výrobce potvrdí i ve skutečnosti, je doposud nejisté.

Měření vzdáleností hrotu zavaděče TVT-S a kotvících prvků pásky Ajust od jednotlivých bodů v malé pánvi stejně tak jako měření vzdálenosti zavaděče TVT-O a TVT Abbrevo od větví nervus obturatorius prováděl školenec. Měření byla prováděna třikrát v krátkém časovém odstupu za účelem eliminovat chybu měření a ze získaných hodnot byl vypočítán průměr. Ten byl následně užíván pro další zpracování v tabulkách a grafech. Pro statistické zpracování byly poskytnuty veškerá data, tedy jak průměr, tak jednotlivá měření.

Statistické hodnocení

Statistické hodnocení souboru provedla prof. RNDr. Jana Zvárová, DrSc. z EuroMISE pomocí statistického programu R. Standardní popisná statistika užívala párový *t* test a Wilcoxonův párový test. Volba testů byla ponechána na statistikovi. Pro power-analýzu bylo pro měření počítáno s možnou odchylkou ±2,5 mm. Tato odchylka byla zvolena pro možnost pohybu jednotlivých struktur vůči sobě stejně jako z důvodu případné chyby způsobené nedolehnutím měřidla či jeho prohnutím. I z tohoto důvodu se statisticky zjistitelný rozdíl v našem souboru pohybuje kolem 1,5 cm. Při souboru nefixovaných a fixovaných těl v poměru 1:3 je pro dosažení statisticky zjistitelného rozdílu 0,5 cm při síle testu 80 %, alpha 5 % a statické odchylce (SD) 1,3 cm třeba soubor 71 a 214 těl. Blíže v následující tabulce.

Počet těl nutných pro průměrnou odchylku delta (alpha = 5%, power = 80%, SD = 1.3 cm)		
	Nefixovaná těla	Fixovaná těla
Delta=0.5	71	214
Delta=1	18	54
Delta=1.5	8	25
Delta=2	5	15
Delta=2.5	3	10
Delta=3	2	7

Výsledky

TVT-S H

V první studii na čtrnácti fixovaných a pěti nefixovaných tělech byla zkoumána páska TVT-S v pozici H. Nefixované těla byla navíc zkoumána s končetinami umístěnými ve správné poloze a s končetinami umístěnými shodně jako těla fixovaná.

Na fixovaných tělech byla průměrná vzdálenost od obturatorního svazku 3,05 cm (SD 1,18) vlevo a 3,07 cm (SD 1,17) vpravo. Průměrná vzdálenost od horního okraje horního raménka kosti stydké byla vlevo 4,48 cm (SD 0,97) a vpravo 4,69 cm (SD 0,83 cm).

Na nefixovaných tělech byly získány podobné výsledky - průměrná vzdálenost od obturatorního svazku vlevo 2,63 cm (SD 1,08) a vpravo 2,97 cm (SD 1,43). Průměrná vzdálenost od horního okraje horního raménka kosti stydké byla vlevo 4,30 cm (SD 0,89) a vpravo 4,83 cm (SD 1,03).

Při statistickém srovnání výsledků nebyl nalezen statisticky signifikantní rozdíl ani ve vzdálenostech od obturatorního nervu, ani od kosti stydké, ani v uložení pásky.

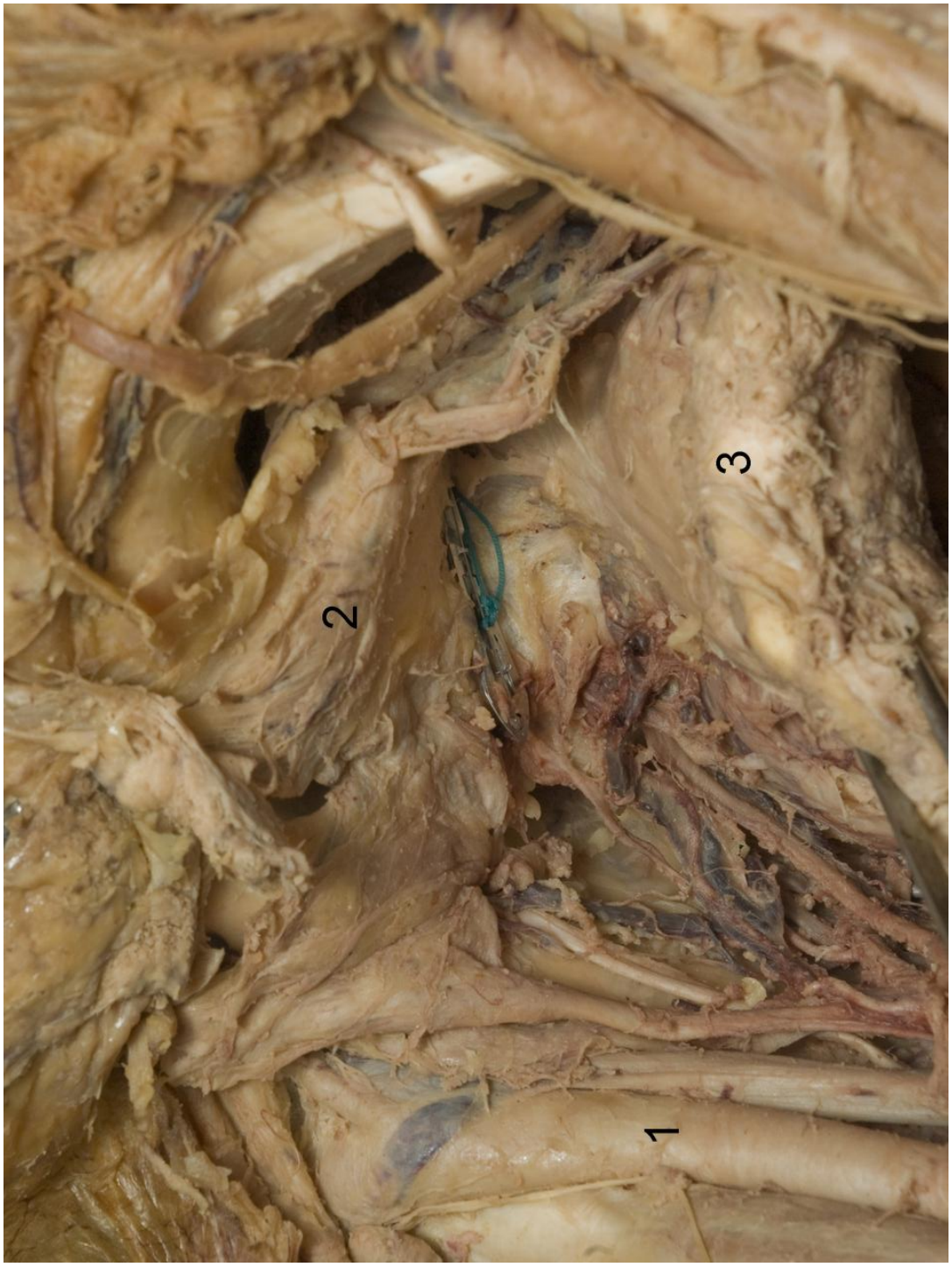
Dalším ze sledovaných parametrů bylo umístění pásky do vazivově svalového komplexu foramen obturatum – k němu v celé skupině devatenácti těl došlo pouze v 53,6 % případů. Ve zbylých případech došlo k průniku zavaděče skrz fascii musculus obturator internus do prevesikálního prostoru nebo prostoru v malé pánvi. Za zmínku stojí jeden případ průniku do malé pánve, kdy byl ostrý zavaděč v přímém kontaktu s varikózní vena uterina. Ve čtyřech případech zavedení došlo k poranění močového měchýře, kdy zavaděč byl přímo zaveden do močového měchýře nebo jeho svaloviny. I při zavedení do musculus obturator internus může dojít ke komplikacím – v jednom případě byl zavaděč v intimním

kontaktu s nutriční cévou pro musculus obturator internus a převládl názor, že její poranění by jistě mohlo přivodit značné krvácení.

K souboru těl s páskou TVT-S H se váže příloha 1 - HUBKA, P.; MASATA, J.; NANKA, O. et al. Anatomical relationship and fixation of tension-free vaginal tape Secur. *Int Urogynecol J Pelvic Floor Dysfunct,* 2009, vol. 20, no. 6, p. 681-688.

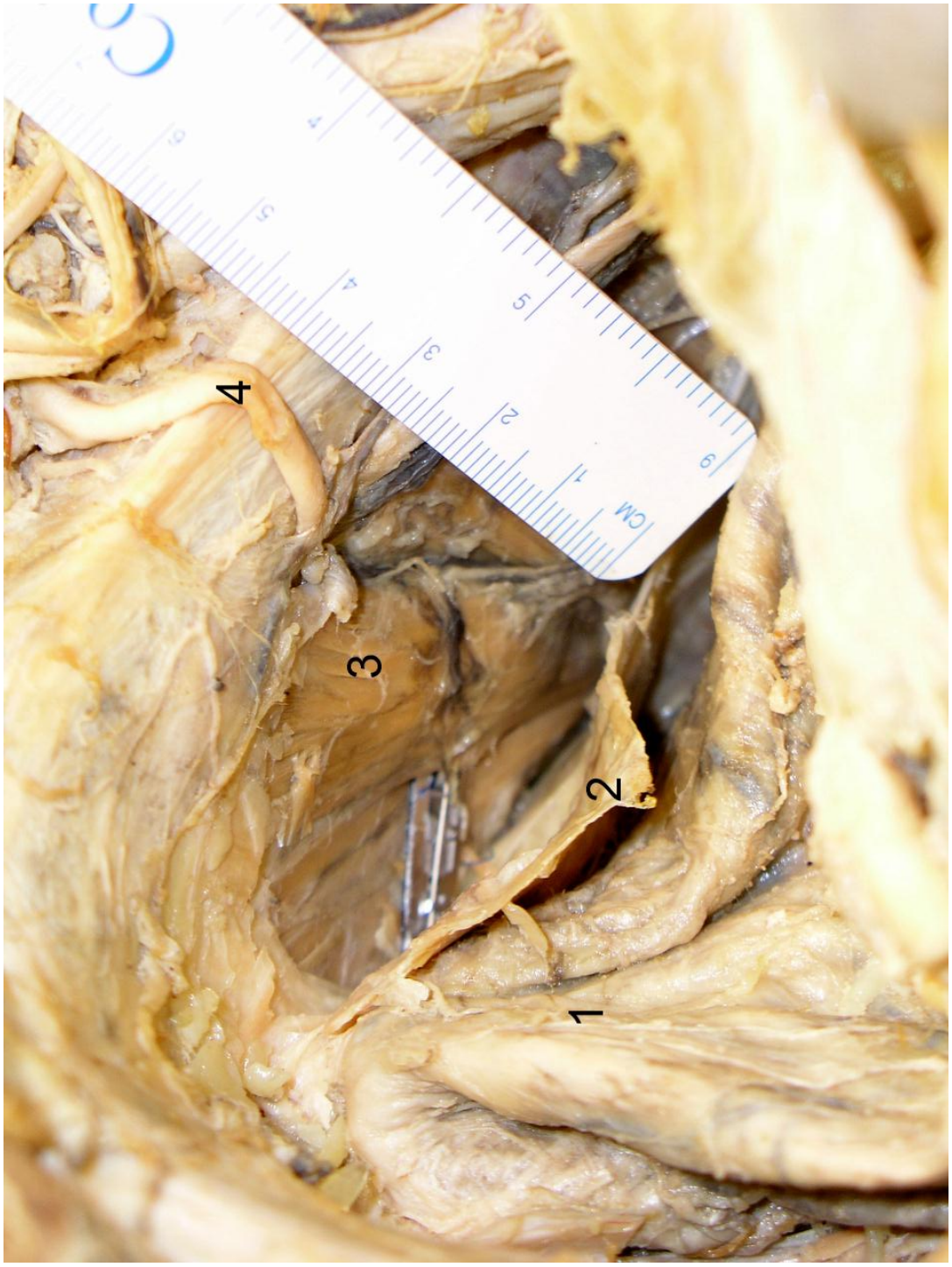
Na následujících obrázcích je dokumentován blízký vztah zavaděče a varikózní uterinní žíly, přítomnost nutriční cévy pro musculus obturator internus a v tabulce je přehledně dokumentováno zavedení jednotlivých zavaděčů.

Varikózní vena uterina



1 – a. iliaca externa l. sin., 2 – vesica urinaria, 3 – uterus

Nutriční céva pro musculus obturator internus



1 – vesica urinaria, 2 – fascia musculus obturator internus, 3 – musculus obturator internus l. dx., 4 – corona mortis

Tabulka s výsledky TVT-S v pozici H

	levá strana			pravá strana		
	Průměrná vzdálenost od hrotu TVT-S k hornímu okraji ramus superior ossis pubis (cm)	Průměrná vzdálenost od hrotu TVT-S k nervus obturatorius (cm)	Umístění	Průměrná vzdálenost od hrotu TVT-S k hornímu okraji ramus superior ossis pubis (cm)	Průměrná vzdálenost od hrotu TVT-S k nervus obturatorius (cm)	Umístění
Fixované 1	2,17	1,67	intramusculárně	3,00	2,17	intramusculárně
Fixované 2	5,17	4,83	v malé pánvi	5,17	5,33	intramusculárně
Fixované 3	3,33	0,67	intramusculárně	3,83	1,17	v malé pánvi
Fixované 4	4,17	3,33	v malé pánvi	4,83	2,17	intramusculárně
Fixované 5	4,83	3,17	subfasciálně	5,17	2,83	intramusculárně
Fixované 6	4,83	2,67	v malé pánvi	5,67	4,17	intramusculárně
Fixované 7	4,17	2,17	v malé pánvi	5,00	3,17	intramusculárně
Fixované 8	4,83	2,83	v malé pánvi	4,00	1,83	v malé pánvi
Fixované 9	5,83	4,83	v malé pánvi	5,83	5,00	subfasciálně
Fixované 10	5,17	3,33	v malé pánvi	4,67	2,83	subfasciálně
Fixované 11	4,00	2,83	subfasciálně	4,17	2,67	v malé pánvi
Fixované 12	4,17	2,50	subfasciálně	4,33	3,17	v malé pánvi
Fixované 13	4,17	3,17	v malé pánvi	5,83	3,83	subfasciálně
Fixované 14	5,83	4,67	v malé pánvi	4,17	2,67	intramusculárně
Nefixované 1	4,33	2,33	intramusculárně	3,33	1,17	intramusculárně
Nefixované 2	4,17	2,67	subfasciálně	5,00	2,83	v malé pánvi
Nefixované 3	3,17	1,17	v malé pánvi	4,33	2,17	v malé pánvi
Nefixované 4	4,17	2,83	v malé pánvi	5,67	4,83	v malé pánvi
Nefixované 5	5,67	4,17	subfasciálně	5,83	3,83	v malé pánvi
Nefixované 1 v malpozici	4,33	2,67	intramusculárně	3,67	1,00	intramusculárně
Nefixované 2 v malpozici	4,33	2,83	subfasciálně	4,83	2,67	v malé pánvi
Nefixované 3 v malpozici	3,67	1,83	v malé pánvi	4,33	2,17	v malé pánvi
Nefixované 4 v malpozici	3,83	2,67	v malé pánvi	5,83	4,67	v malé pánvi
Nefixované 5 v malpozici	5,67	4,33	subfasciálně	5,67	3,67	v malé pánvi

TVT-S U

Druhá studie se zaměřila na pásku TVT-S v pozici U. Skládala se z třinácti fixovaných a pěti nefixovaných těl. Bylo postupováno identicky s předchozí studií s tím rozdílem, že pásky byly zavedeny do pozice U.

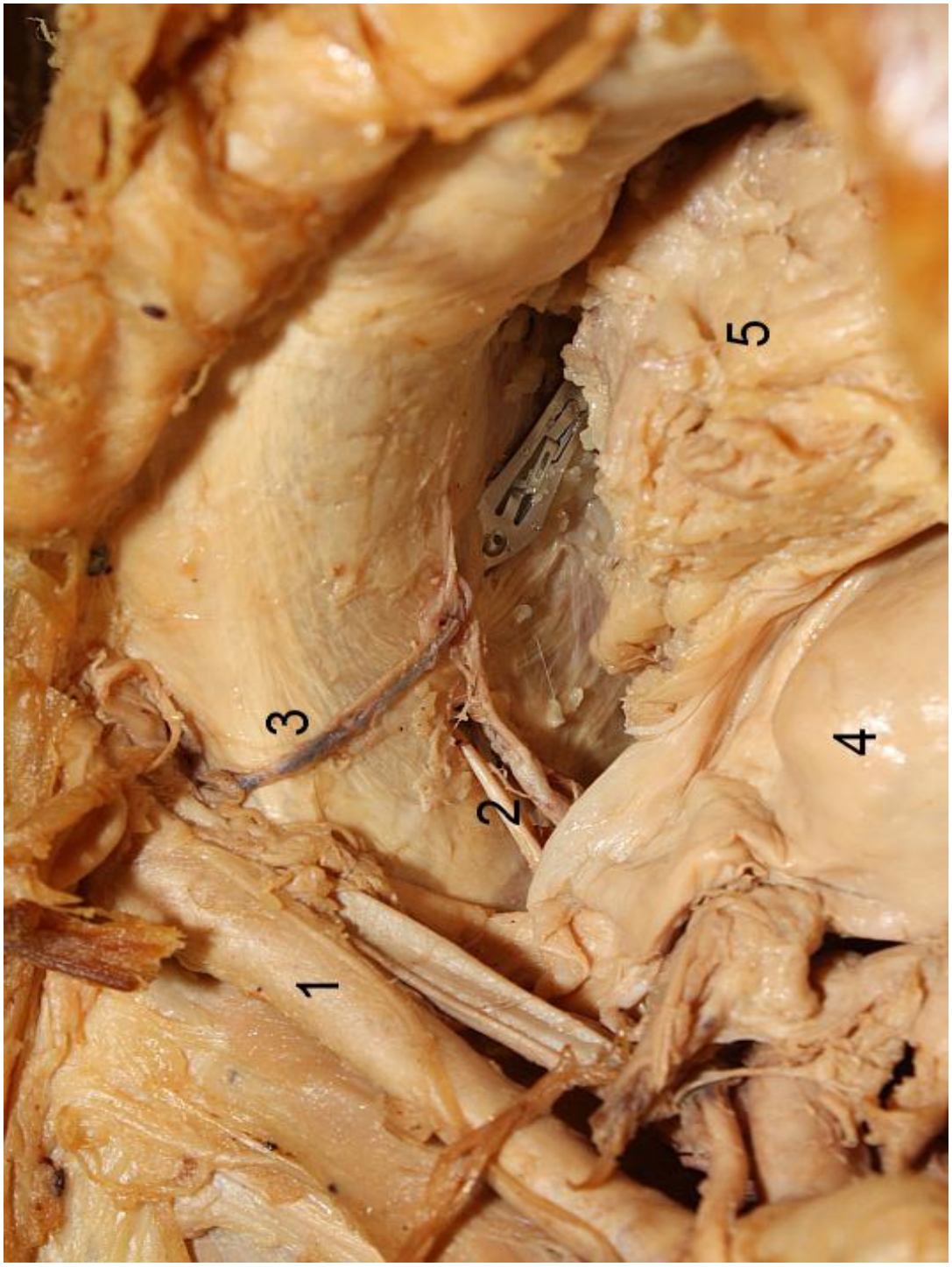
Ve skupině fixovaných těl byla průměrná vzdálenost od obturatorního nervu vlevo 2,83 cm (SD 0,87) a vpravo 2,92 cm (SD 1,24). Průměrná vzdálenost od horního okraje ramus superior ossis pubis byla vlevo 3,90 cm (SD 0,86) a vpravo 3,97 cm (SD 0,83). Ve 38,5 % došlo k průniku zavaděče do malé pánve – tedy skrz fascia musculus obturator internus směrem k močovému měchýři. V jednom případě byl u fixovaného těla zavaděč v těsném kontaktu s nervus obturatorius a v jednom případě byl zavaděč v těsném kontaktu s coronou mortis – anastomózou mezi povodím vasa iliaca interna, konkrétně vasa obturatoria, a povodím vasa iliaca externa či vasa circumflexa ilium profunda.

Na nefixovaných tělech byly výsledky podobné – průměrná vzdálenost od obturatorního nervu vlevo byla 2,20 cm (SD 1,11) a vpravo 2,17 cm (SD 0,97). Průměrná vzdálenost od horního okraje horního raménka kosti stydké byla vlevo 3,67 cm (SD 0,87) a vpravo 4,33 cm (SD 0,91). Do prostoru malé pánve bylo proniknuto třikrát, z čehož jednou došlo k poranění močového měchýře a v jednom případě byl opět zavaděč v kontaktu s corona mortis.

Obrazová dokumentace a tabulky s výsledky jsou součástí přílohy 3 - HUBKA, P.; SVABIK, K.; MARTAN, A. et al. A serious bleeding complication with injury of the corona mortis with the TVT-Secur procedure: two cases of contact of TVT-S with the corona mortis during cadaver study. *Int Urogynecol J Pelvic Floor Dysfunct*, 2010, vol. 21, no. 9, p. 1179-1180.

a přílohy 6 - HUBKA, P.; NANKA, O.; MARTAN, A. et al. TVT-S in the U position-anatomical study. *Int Urogynecol J Pelvic Floor Dysfunct*, doi: 10.1007/s00192-010-1239-5.

Vztah zavaděče ke corona mortis



1 – a. iliaca externa l. sin., 2 – a. obturatoria l. sin., 3 – corona mortis, 4 – uterus, 5 – vesica urinaria

Tabulka s výsledky TVT-S v pozici U

	levá strana			pravá strana		
	Průměrná vzdálenost od hrotu TVT-S k hornímu okraji ramus superior ossis pubis (cm)	Průměrná vzdálenost od hrotu TVT-S k nervus obturatorius (cm)	Umístění	Průměrná vzdálenost od hrotu TVT-S k hornímu okraji ramus superior ossis pubis (cm)	Průměrná vzdálenost od hrotu TVT-S k nervus obturatorius (cm)	Umístění
Fixované 1	3,33	2,83	v malé pánvi	4,00	2,83	v malé pánvi
Fixované 2	3,33	4,33	intramuskulárně	5,17	3,33	v malé pánvi
Fixované 3	5,83	4,17	intramuskulárně	4,00	4,67	v malé pánvi
Fixované 4	4,83	3,83	intramuskulárně	5,33	4,83	intramuskulárně
Fixované 5	3,83	2,17	intramuskulárně	3,83	2,67	v malé pánvi
Fixované 6	3,83	2,17	intramuskulárně	3,67	2,33	intramuskulárně
Fixované 7	4,83	2,33	intramuskulárně	3,67	2,67	subfasciálně
Fixované 8	3,17	2,33	v malé pánvi	2,67	0,00	v malé pánvi
Fixované 9	3,17	2,33	v malé pánvi	4,83	3,67	intramuskulárně
Fixované 10	3,67	2,33	subfasciálně	3,33	2,83	intramuskulárně
Fixované 11	2,67	1,67	v malé pánvi	2,83	1,67	v malé pánvi
Fixované 12	4,33	3,67	subfasciálně	4,67	3,67	intramuskulárně
Fixované 13	3,83	2,67	intramuskulárně	3,67	2,83	intramuskulárně
Nefixované 1	3,17	3,17	v malé pánvi	4,83	3,00	intramuskulárně
Nefixované 2	4,83	2,83	intramuskulárně	4,67	2,67	intramuskulárně
Nefixované 3	2,83	0,50	intramuskulárně	2,83	0,50	v malé pánvi
Nefixované 4	4,33	2,83	intramuskulárně	5,17	2,33	intramuskulárně
Nefixované 5	3,17	1,67	v malé pánvi	4,17	2,33	intramuskulárně

Ajust

Další zkoumanou páskou byla páska Ajust. V tomto případě se soubor skládal z jedenácti fixovaných těl a pěti nefixovaných těl. Průměrná vzdálenost kotvícího prvku od nervus obturatorius byla u fixovaných těl vlevo 4,24 cm (SD 0,85) a vpravo 4,21 cm (SD 0,95). Fixace do obturátorové membrány u fixovaných těl byla v 68,1 % a při započtení případů, kdy došlo k fixaci do musculus obturator externus či internus, se jedná o 86,3 %. Ve dvou případech (9 %) došlo k zavedení prevesikálně. Na nefixovaných tělech byla průměrná vzdálenost od obturatorního nervu vlevo 2,90 cm (SD 0,49) a vpravo 3,40 cm (SD 0,43). Fixace do obturatorní membrány byla v 60 % a při započítání i obturatorních svalů bylo fixace v cílovém místě dosaženo v 90 %. V jednom případě (10 %) došlo k zavedení prevesikálně.

Při statistickém hodnocení umístění nebyl prokázán statisticky signifikantní rozdíl, nicméně při srovnání vzdáleností od obturatorního nervu byl statisticky signifikantní rozdíl ($p < 0.05$) pozorován v případě srovnání všech výsledků pro fixovaná a nefixovaná těla, a to jak pomocí *t* testu, tak Wilcoxonova testu. Vzhledem k tomu, že statisticky signifikantní rozdíl nebyl sledován při srovnávání pravé strany, ale pouze při srovnání levé strany a výsledků bez rozlišení stran, je třeba rozšířit soubor zejména o nefixovaná těla a poté opět provést statistické zhodnocení.

TVT-O

Předposlední zkoumanou páskou byla klasická TVT-O. Na čtrnácti fixovaných tělech byly končetiny polohovány s 30° abdukcí a 30°flexí v kyčelním kloubu (malpozice). Taktéž na pěti nefixovaných tělech byly končetiny umístěny v malpozici. Na posledních pěti tělech byly končetiny polohovány tak, jak je vyžadováno dle operačního postupu. Na fixovaných tělech byla průměrná vzdálenost od předního raménka obturatorního nervu 8,57 mm (SD 6,91) vlevo a 7,14 mm (SD 7,52) vpravo. Průměrná vzdálenost od zadního raménka obturatorního nervu byla v této skupině 8,36 mm (SD 6,51) vlevo a 8,93 mm (SD 7,12) vpravo. V šesti případech (21,4 %) došlo ke kontaktu s předním raménkem a taktéž v šesti případech došlo ke kontaktu se zadním raménkem.

Na skupině nefixovaných těl s končetinami špatně polohovanými byly výsledky podobné. Průměrná vzdálenost od předního raménka obturatorního nervu byla 8,00 mm (SD 2,74) vlevo a 8,00 mm (SD 5,70) vpravo. Průměrná vzdálenost od zadního raménka obturatorního nervu byla 5,00 mm (SD 5,00) vlevo a 8,00 mm (SD 2,74) vpravo. Ve dvou případech (20 %) došlo ke kontaktu s předním raménkem a v jednom (10%) se zadním raménkem.

Ve skupině nefixovaných těl se správně polohovanými končetinami byla průměrná vzdálenost od předního raménka obturatorního nervu výrazně vyšší – 24,00 mm (SD 4,18) vlevo a 23,00 mm (SD 5,70) vpravo. Průměrná vzdálenost od zadního raménka obturatorního nervu byla 23,00 mm (SD 5,70) vlevo a 23,00 mm (SD 4,47) vpravo. Ani v jenom případě nedošlo ke kontaktu s raménkem obturatorního nervu.

Ani v jednom ze všech případů nedošlo k proniknutí skrz musculus obturator internus do prostoru před močovým měchýřem.

Při statistickém porovnání výsledků skupiny fixovaných těl a nefixovaných těl se špatně polohovanými končetinami nebyla shledána statisticky významná

odchylka. Statisticky významný rozdíl byl však mezi skupinou nefixovaných těl s končetinami umístěními správně dle operačního postupu a zbylými dvěma skupinami.

Ke skupině TVT-O se váže příloha 7 - HUBKA, P.; NANKA, O.; MARTAN, A. et al. Anatomical study of position of the TVT-O to the obturator nerve influenced by the position of the legs during the procedure: based upon findings at formalin-embalmed and fresh-frozen bodies. *Arch Gynecol Obstet*, doi: 10.1007/s00404-010-1775-8.

K modifikovanému postupu TVT-O, kdy je odlišný způsob zavedení stejné pásky, se váže příloha 5 - NEUMAN, M.; HUBKA, P.; MARTAN, A. et al. Modified needle route for potential reduction of the trans-obturator inside-out-related thigh pain: a cadaveric study. *Gynecological Surgery*, p. 1-4.

Těsný vztah zavaděče TVT-O k raménkům obturatorního nervu.

1 – musculus adductor longus, 2 – ramus anterior nervi obturatorii, 3 – musculus adductor brevis, 4 – ramus posterior nervi obturatorii

Tabulka s výsledky souboru TVT-O

	Průměrná vzdálenost od r. anterior n. obturatorii vlevo (mm)	Průměrná vzdálenost od r. posterior n. obturatorii vlevo (mm)	Průměrná vzdálenost od r. anterior n. obturatorii vpravo (mm)	Průměrná vzdálenost od r. posterior n. obturatorii vpravo (mm)
Fixované 1	5	0	5	10
Fixované 2	0	2	5	0
Fixované 3	15	10	5	10
Fixované 4	0	0	5	5
Fixované 5	15	5	5	10
Fixované 6	15	15	0	25
Fixované 7	0	15	5	10
Fixované 8	5	10	0	0
Fixované 9	20	20	0	10
Fixované 10	0	10	10	5
Fixované 11	15	10	10	10
Fixované 12	10	5	30	20
Fixované 13	10	15	10	0
Fixované 14	10	0	10	10
Nefixované 1	25	25	25	20
Nefixované 2	25	30	25	25
Nefixované 3	20	20	15	20
Nefixované 4	30	25	30	30
Nefixované 5	20	15	20	20
Nefixované v malpozici 1	5	10	0	10
Nefixované v malpozici 2	5	10	5	10
Nefixované v malpozici 3	10	0	15	10
Nefixované v malpozici 4	10	0	10	5
Nefixované v malpozici 5	10	5	10	5

TVT Abbrevo

Poslední zkoumanou páskovou metodou byla modifikovaná páska TVT Abbrevo. Tato zkrácená transobturatorní páska by neměla zasahovat do skupiny adduktorů stehna, což by mělo vést k omezení rizika dráždění předního nebo zadního raménka obturatorního nervu. Jak bylo potvrzeno ve studii o páskách TVT-O (příloha 7), je transobturátorové zavedení závislé na poloze končetin mnohem více než jiné zkoumané pásky. Vzhledem k tomu, že ve studii o páskách TVT-O nedošlo k proniknutí zavaděče do prevesikálního prostoru, bylo u této metody pouze sledováno, kde končí páska ve vztahu k obturátorové membráně. U osmi fixovaných těl, tedy přesně v polovině případů, páska končila v membrana obturatoria. V jednom případě (6,25 %) se páska nacházela pouze v musculus obturator internus a nedosáhla ani do obturatorní membrány. V pěti případech (31,25 %) byla páska v musculus obturator externus, nicméně nepronikla do skupiny adduktorů stehna. V posledních dvou případech (12,5 %) páska pronikla do skupiny adduktorů stehna - v jednom případě 3 mm a v druhém případě 10 mm. Ani v jednom případě nebyl zaznamenán kontakt pásky s obturatorním nervem nebo jeho raménky.

Anatomické odchylky v souboru

Při sledování frekvence výskytu corona mortis v celém souboru byla tato anastomóza pozorována v 72 %. V případě pásky TVT-S U byl pozorován kontakt zavaděče s touto anastomózou. Při tomto sledování byl jako druhotný znak sledován výskyt preperitoneálního tuku v canalis obturatorius. Tento preperitoneální tuk je relativně kompaktní tukový útvar, který šlo reponovat do dutiny břišní a který vyplňoval volný prostor v canalis obturatorius. Relativní četnost 40 % je poměrně vysoká, nicméně v případě předpokladu, že se jedná o fyziologický nález, by se dala očekávat ještě vyšší. Navíc, pouze ve dvou případech byl tento preperitoneální tuk nalezen současně oboustranně. K této části se váže příloha 2 - HUBKA, P.; SPACKOVA, J.; NANKA, O. et al. Existence of the preperitoneal fatty plug and hernia in obturator canal. *Ceska Gynekol*, 2010, vol. 75, no. 3, p. 208-211.

Diskuze

Naše výsledky umístění pásek TVT-S jak v pozici H, tak v pozici U a pásky Ajust jsou vůbec prvními publikovanými výsledky jak na domácí, tak na mezinárodní půdě.

V předchozích studiích na kadaverech byly použity výrazně menší skupiny, kdy autoři vyvozovali poměrně dalekosáhlé závěry na základě souboru sestávajícího z jednoho či pouhých několika pozorování (Hinoul *et al.*, 2007; Whiteside *et al.*, 2004). Bez ohledu na případnou shodu nelze na základě jednoho pozorování dělat jakékoliv závěry. Naše soubory pro jednotlivé skupiny čítaly pravidelně kolem patnácti až dvaceti těl, a tedy převyšují jiné studie svou výpovědní hodnotou.

Výhody a nevýhody fixovaných a nefixovaných těl

Při zkoumání zavedení různých implantátů je možné užít jak fixovaná, tak nefixovaná těla. Fixovaná a nefixovaná těla mají své přednosti i zápory. Výhodou fixovaných těl je dobrá přehlednost anatomických struktur, dostatek času na preparaci a kvalitní obrazová dokumentace. Úskalí fixování však spočívá v tom, že struktury jsou nepohyblivé, a tak se zavedení pásky odchyluje od reálné operace. Nefixovaná těla, tedy pouze chráněná chlazením, mají tu výhodu, že je možné díky polohováním končetin simulovat reálnou operaci. To je vykoupeno horší přehledností a vysokými požadavky na časovou flexibilitu a rychlost preparace.

Naše kombinace fixovaných a nefixovaných těl je z pohledu výzkumu unikátní, neboť díky možnosti srovnat výsledky na fixovaných a nefixovaných tělech můžeme též zhodnotit, zda během fixace dochází ke změnám, což nám umožňuje mnohem lépe dokumentovat výsledky výzkumu.

Další předností výzkumu na tělech na Anatomickém ústavu je fakt, že těla jsou odkázána pro vědecké a výzkumné účely a není proto třeba získávat další

souhlasy. Ačkoliv je výzkum na nefixovaných tělech možný, je toto vždy jistým kritickým místem projektu, kdy je nutné pro každý jednotlivý výzkum získat souhlas etické komise.

TVT-S

Na příkladu pásky TVT-S bylo dokázáno, že teoretické předpoklady designérů pásky se ukázaly jako zcestné a míra fixace pásky na kadaverech (Hubka *et al.*, 2009; Hubka *et al.*, 2011) byla ve shodě s kliniky popisovanou úspěšností (Khandwala *et al.*, 2010; Krofta *et al.*, 2010a; Martan *et al.*, 2007; Martan *et al.*, 2008a; Martan *et al.*, 2008b; Meschia *et al.*, 2009; Tommaselli *et al.*, 2010).

Naším urogynekologickým týmem byla popsaná komplikace hematomu po zavedení TVT-S v pozici H (Masata *et al.*, 2008). Díky náhodě byla při pitvě nalezena atypická nutriční céva běžící pod fascia musculus obturator internus a vyživující musculus obturator internus (Hubka *et al.*, 2009). Dalo by se předpokládat, že při poranění nutriční cévy pro musculus obturator internus by mělo dojít ke spontánní zástavě krvácení díky nárůstu tlaku v compartmentu – musculus obturator internus je překryt na jedné straně membrana obturatoria a na druhé fascia musculus obturator internus. Při penetraci zavaděče skrz tuto fascii však bude tento mechanismus méně pravděpodobný.

Pokud se týká krvácivých komplikací při TVT-S při dalším zavedení v pozici H, kdy došlo k poranění corona mortis (Larsson *et al.*, 2010), předpokládal náš tým, že tato komplikace vznikla spíše nedodržením postupu a zavedením zavaděče do pozice U (Hubka *et al.*, 2010a). Tento předpoklad byl následně potvrzen při oznámení komplikace u reálné operace dalším týmem (Gobrecht *et al.*, 2011).

Publikace našeho týmu nakonec napomohly tomu, že se dnes v České republice ani v zahraničí již prakticky nepoužívá metoda TVT-S, která se ukázala jako značně neúčinná a byl popsán mechanismus jejího selhání, kdy samotná páska nebyla dobře zavedena do svalu.

TVT-O

Z naší studie (Hubka *et al.*, 2010b) na fixovaných kadaverech vyplývá, že umístění pásky je značně závislé na pozici končetin – příloha 7. Naše zjištění je ve shodě s předchozí studií (Hinoul *et al.*, 2007), která však postrádá statistickou hodnotu z důvodu postavení hypotézy na jednom jediném případě.

Při správném postavení končetin, dostatečné flexi v kyčelním kloubu, se zavaděč nedostává do blízkosti předního nebo zadního raménka obturatorního nervu. V případě nedostatečné flexe, případně nesprávně provedené operace, se může zavaděč dostat do jeho těsné blízkosti. Ramus anterior nervi obturatorii je odpovědný za inervaci musculus pectineus, musculus adductor longus, musculus adductor brevis, musculus gracilis a senzitivní inervaci vnitřní plochy stehna. Ramus posterior nervi obturatorii je odpovědný za inervaci musculus adductor brevis a musculus adductor magnus. Vzhledem k diploneurální inervaci některých svalů může být poranění jedné větve nervus obturatorius bez klinických známek.

TVT Abbrevo

U další z páskových operací TVT Abbrevo bylo zkoumáno, zda bude páska zasahovat alespoň do musculus obturator internus. Tato metoda je modifikací původní pásky TVT-O inside-out, kdy se nemění trajektorie vedení pásky a postup je jedním z nejrozšířenějších v současné praxi (Krofta *et al.*, 2010b; Meschia *et al.*, 2007; Oliveira *et al.*, 2011; Tommaselli *et al.*, 2010). Samotná páska TVT-O byla zkrácena na pouhých dvanáct centimetrů s poukazem na to, že díky této délce nebude zasahovat do skupiny adduktorů stehna více než 5 mm, což eliminuje riziko vzniku přetrvávající bolesti v třísle – ta bývá připisována dráždění obturatorního nervu. Tato komplikace, ač řídká, je značně obtěžující a odstranění pásky nemusí vést k ústupu obtíží (Hazewinkel *et al.*, 2009; Neuman *et al.;* Roth, 2007). Z námi provedené studie plyne, že páska nepronikla do

prostoru prevesikálně a v polovině případů dosahovala k obturatorní membráně. Pouze ve dvou případech (12,5 %) pronikl konec do skupiny adduktorů stehna. Z toho pouze jednou významně.

Ajust

Poslední ze zkoumaných pásek byla páska Ajust. Tato délkově nastavitelná páska se zavádí transobturátorově a výrobce předpokládá, že by se měla kotvit nejspíše do membrana obturatoria. Stav poznání asi nejlépe dokumentuje samotný propagační materiál výrobce, kdy jednou je kotvící prvek zaveden po protihroty do membrana obturatoria, podruhé je celý kotvící mechanismus zaveden skrz membrana obturatoria až do musculus obturator externus. Pouze v 61,5 % bylo pozorováno přímé ukotvení do membrana obturatoria a v dalších 15,5 % byl zavaděč zaveden do svalů přímo nasedajících membrana obturatoria – tedy musculus obturator internus a musculus obturator externus. Ačkoliv doposud nebyly publikovány odborné práce s výsledky, z neformální komunikace s kliniky, kteří tuto operaci provádí, se zdá, že úspěšnost je kolem osmdesáti a více procent. Naskýtala by se tedy odpověď, že kotvení do svalu může být dostatečné. První publikaci výsledků je možno očekávat v průběhu druhé poloviny roku 2011.

Anatomické odchylky

Z cévních odchylek v oblasti foramen obturatum stojí za zmínku výskyt corona mortis. Četnost 72 % zapadá do popisovaných rozmezí výskytu dané cévní spojky, tedy od 28 % (Karakurt *et al.*, 2002) do 83 % (Darmanis *et al.*, 2007). Za zmínku v oblasti canalis obturatorius jistě stojí i výskyt preperitoneálního tuku, který je dle některých autorů (Perry *et al.*, 2005) prvním stádiem obturátorové hernie – vzácné (0,073 % - 3,9 % z frekvence všech kýl (Bjork *et al.*, 1988; Haraguchi *et al.*, 2007)), nicméně často fatální komplikace (úmrtnost 11 %-70 % (Callaghan *et al.*, 2002)). V klasickém pojetí kýly nelze preperitoneální tuk

označit za samotnou kýlu, protože zmíněný útvar se nachází před peritoneem. Za rizikové faktory je považován vyšší věk, ženské pohlaví, multiparita, nízký body mass index a aktuální váhový úbytek více než 10 kilogramů. Samotným úbytkem váhy je vysvětlován i mechanismus vzniku kýly, tedy resorpce jinak prakticky neresorbovatelného tuku a vtažení peritonea. Přítomnost preperitoneálního tuku ve 40 % je poměrně častý jev, nicméně jenom ve dvou případech byl tento tukový útvar pozorován na obou stranách současně. Jedná se tedy o relativně častou odchylku, kterou je však obtížné označit za zcela fyziologickou.

Závěr

Páskové operace s sebou nesou komplikace. Ty je možno rozdělit na ovlivnitelné (příkladem může být nedostatečně zvládnutá technika operace) a neovlivnitelné (příkladem může být anatomická odchylka vedoucí ke krvácení nebo poranění nervu). Přesto znalost anatomických odchylek je jednou z cest, jak porozumět a lépe pochopit rizika a dříve odhalit případné komplikace. Podobně se znalost anatomických variací uplatní i při řešení operačních komplikací.

Závěrem lze konstatovat, že cíl práce, tedy popsat anatomické odchylky ve vztahu k páskovým operacím, se podařilo naplnit.

1, corona mortis s výskytem 72 %

2, přítomnost preperitoneálního tuku v obturatorním kanálu v 40 %

3, při 30° flexi v kyčli TVT-O blízko nervus obturatorius

4, správná fixace TVT-S v 53,6 % v poloze H, resp. 63,8 % v poloze U

5, nesprávné zavedení TVT-S ohrožuje corona mortis

6, TVT Abbrevo neproniká více než 10 mm do skupiny adduktorů

Práce je jednou z prvních takto obsáhlých prací a v budoucnu jistě poskytne další data pro publikační činnost. Rozsah a objem práce získává uznání i v mezinárodním měřítku.

Jednotlivé publikované práce našeho týmu napomohly tomu, že se prakticky přestala používat operační metoda TVT-S jak ve variantě H, tak ve variantě U a zvýšil se zájem o publikování komplikací – chtělo by se věřit, že nastává renezance klasické zásady *Primum non nocere.*

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ORIGINAL ARTICLE

Anatomical relationship and fixation of tension-free vaginal tape Secur

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Abstract
Objective The objective is to describe the anatomical localisation of tension-free vaginal tape Secur (TVT-S) in the H-position regarding possible injury of vessels and fixation site.
Methods We placed TVT-S inserters bilaterally in 14 embalmed and five fresh frozen female bodies. After dissection, we measured distances from the obturator bundle (obturator nerve and obturator vessels).
Results In embalmed bodies, the mean distance of TVT-S from the obturator bundle was 3.05 cm (standard deviation (SD) 1.18 cm) on the left, 3.07 cm (SD 1.17 cm) on the right. Perforation of the fascia of obturator internus muscle occurred in 46.4%. In fresh frozen bodies, results were fundamentally similar. Injury of variable vessels can occur.
Conclusion There is a minimal risk of injury to the obturator bundle during TVT-S; however, there is a significant risk of inserting the TVT-S inserter into the obturator fossa. The position of TVT-S does not change significantly after legs mal-positioning.

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Keywords Anatomy · Female · Obturator bundle · Stress urinary incontinence · Tension-free vaginal tape

Introduction

Since its invention by Ulmsten [1] in 1995, the tension-free vaginal tape (TVT) has gained great popularity due to its efficacy [2, 3] and safety, becoming the standard treatment of stress urine incontinence. Nevertheless, complications such as bowel injury [4, 5] and haemorrhage [6, 7] prompted the search for various modifications. It was Delorme [8] who first introduced TVT trans-obturator tape (TOT), which avoided the retro-pubic space and hence minimised the risk of perforation of the urinary bladder. In 2003, de Leval [9] introduced TVT trans-obturator inside-out tape (TVT-O) to further minimise the risk associated with this procedure. The differences between TOT and TVT-O have been described [10–13]. However, TVT-O entails the risk of haemorrhage [14] and damage to the anterior or posterior branch of the obturator nerve, especially when hip joints are in insufficient flexion [15]. A new method of TVT, known as tension-free vaginal tape Secur (TVT-S), aimed to reduce complications and was introduced in 2006. Our first experiences were described by Martan [16–18], showing lower efficacy in comparison with previous TVT procedures.

TVT-S is intended to provide sufficient fixation with less foreign material, reducing the risk of nerve and vessel injury [19, 20]. The surgeon can choose between trans-obturator (hammock) and retro-pubic position (U-shaped). In the hammock position, the tape points with the tip towards to the content of the obturator canal (obturator bundle containing obturator nerve, obturator artery and obturator vein). So far, there has not been any anatomical

study focussed on TVT-S, so we decided to investigate anatomical localisation, assess the safety of this method and examine the fixation site of the TVT-S tape in the light of reported haemorrhagic complication during TVT-S [21, 22].

To obtain higher quality photos, we used formalin-embalmed female bodies, and in order to simulate more accurately real-life surgery and decide whether the position of TVT-S changes with the position of the legs during insertion of the tape, we also used fresh frozen bodies.

Materials and methods

We performed TVT-S on 14 formalin-embalmed female bodies at the Institute of Anatomy, First Faculty of Medicine, Charles University in Prague, and on five fresh frozen female bodies at the Institute of Pathology, First Faculty of Medicine, Charles University in Prague. The study complied with Czech and International laws on science and research, and the study was approved by the local ethics committee. The terminology used hereinafter is based on current anatomical terminology (Terminologia Anatomica by FCAT [23]). We have used standard measures derived from the SI measures centimetres cm (1/100 m), millimetres mm (1/1,000 m).

In order to evaluate the risks associated with TVT-S, the surgeon bilaterally inserted TVT-S in the "hammock" position, as described in the standard operation procedure in procedural steps. This means a sagittal incision about 1 1.5 cm was made approximately 1 cm below external urethral meatus, and with a small pair of scissors, two small paraurethral dissections were made approximately 1 cm in length. Using the needle driver, the inserter is inserted into previously dissected paraurethral incisions. The tip is oriented at an angle of 45° from the midline, towards the ischiopubic ramus, while holding the needle driver and inserter so that they are parallel to the floor. The inserter tip will be approximately in the 9 o'clock position. The inserter is advanced, contacting the inferior edge of the pubic ramus. Whilst maintaining contact with the bone, further advance is made into the obturator internus muscle. The same procedure is carried out on the other side. The bodies were positioned as follows: formalin-embalmed bodies due to the rigidity of the joints lying on the back with legs in 30° abduction and 30° flexion of hips; fresh frozen bodies lying on the back with legs in gynaecological position (hips in 90° flexion). The surgeon is experienced in various tension-free vaginal tape methods, including TVT-S. During the insertion, he controlled the position of the inserters by palpation, as in standard surgery. The first author afterwards abdominally dissected the bodies. With fresh frozen bodies, we studied whether localisation depends on position of the legs. This was done as follows: After inserting the inserter with the legs in the position recommended by the manufacturer, abdominal dissection takes place. The tip of the inserter is localised and its position measured, and then the inserter is removed, the legs repositioned to 60° of flexion in the hip joint and the inserter inserted as it would be during normal procedure, apart from the position of the legs; the new location was then measured.

The dissector identified the following structures: obturator nerve (nervus obturatorius), obturator artery (arteria obturatoria), obturator vein (vena obturatoria), obturator internus muscle (musculus obturatorius internus), fascia of obturator internus muscle (fascia musculi obturatorii interni), urinary bladder (vesica urinaria). We identified anatomical anomalies that were present.

The position of the TVT-S inserter was described as follows. The shortest distance from the tip of the inserter to the obturator nerve was measured. The obturator bundle containing the obturator artery, vein and nerve is about 3 mm thick; we chose the obturator nerve because it is the most visible and constant structure in the obturator canal. Also, the shortest distance from the tip to the top of the superior ramus of the pubic bone was measured (Fig. 1). To describe localisation of the TVT-S tape in obturator fossa, we used three groups of placement. The first was intramuscular in the obturator muscle (i.e. the tip was deeper than 1 mm from the fascia of obturator internus muscle). This position was considered the correct position (Fig. 2). The distance of 1 mm was chosen because under this value, the inserter was covered by only a few fibres of muscle, which was spread apart, and the tip was already visible underneath the fascia of the obturator internus muscle. The second position was subfascial (i.e. the tip was just underneath the fascia of obturator internus muscle or covered by the muscle to a depth of less than 1 mm). We

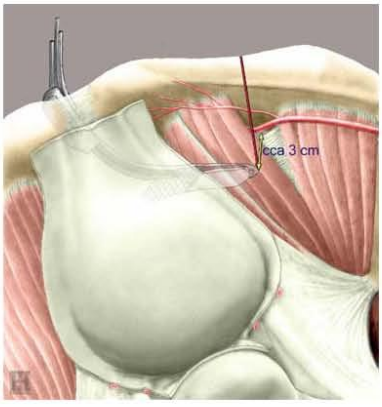

Fig. 1 Orientation in small pelvis and drawn distances measured

Fig. 2 Correct position of TVT-S. *1* Pubic symphysis (symphysis). *2* Urinary bladder (vesica urinaria). *3* Uterus (uterus). *4* Left obturator nerve (nervus obturatorius lateris sinistri). *5* Left obturator vein (vena obturatoria lateris sinistri). *6* Left obturator artery (arteria obturatoria lateris sinistri). *7* Left obturator internus muscle (musculus obturatorius internus lateris sinistri). *8* Anastomosis between left obturator vein and external iliac vein (corona mortis venarum). *9* Left internal iliac vein (vena iliaca externa lateris sinistri)

considered this position as acceptable (Fig. 3). The third position was in the small pelvis (i.e. the tip penetrated the fascia of obturator internus muscle into the small pelvis, the tip was mainly paravesical and subvesical in the obturator fossa in between the fascia of obturator internus muscle and urinary bladder). We considered this position unacceptable due to possible damage to the bladder veins, bleeding during and after the surgery and damage to the urinary bladder, damage to varicose uterine veins.

The same investigator measured the distances in different stages of the dissection three times and calculated the mean distance. During the dissection, when the tip of inserter could be visualised, the shortest distance was measured to the top of superior ramus of pubic bone and to the obturator bundle. The distances are measured again a short time later, in the same way previously described, in order to lower the risk of personal error during measurement. If the tip was not visible right after exploration of the lesser pelvis, it was located by palpation of the obturator internus muscle and the urinary bladder. The thickness of the tissue covering the inserter was measured as follows: A straight cut through the tissue was made until the inserter was reached. After measuring the thickness of the tissue covering the tip during the cut, the tissue covering the inserter was gently dissected to investigate whether veins or nerves ran through the cut or around the inserter. We documented all the steps involved.

Fig. 3 Subfascial placement of the TVT-S with present nutritive vessels for obturator internus muscle. *1* Nutritive vessels for obturator internus muscle (arteria et vena nutritia musculi obturatoris interni). *2* Obturator internus muscle (musculus obturator internus). *3* Obturator fascia (fascia musculi obturatoris interni). *4* Urinary bladder (vesica urinaria). *5* Anastomosis between right obturator artery and deep epigastric artery (corona mortis arteriarum). *6* Right obturatory artery and veins (arteria obturatoria lateris dextri cum venarum obturatoriarum lateris dextri)

Statistical analysis of data was performed as follows: We calculated means from triples of measured distances. From these data, we estimated mean, variance and standard deviation for the measured distance from obturator bundle at the right and left sides in the group of embalmed bodies and in the group of fresh frozen bodies. Statistical analysis of distance to the obturator nerve was performed based on these factors: difference in position of TVT-S placed in fresh frozen bodies and embalmed bodies, difference in TVT-S placed in fresh frozen bodies with legs in proper position and with legs incorrectly positioned. Statistical comparisons were performed using two sample t test or Mann Whitney test for differences between groups and Wilcoxon-paired test for differences between left and right side. All statistical tests were performed at the 5% level of significance alpha using statistical system R.

Due to the small number of bodies in both groups, we tried to estimate the number of bodies needed for comparison of mean differences between groups. We used two sample t test, where one group has three times more

objects than the other group, approximately. We made a rough estimate of standard deviation SD from given data as 1.3 cm. At a 5% level of significance and with the power of the test 80%, the numbers of fresh frozen bodies and embalmed female bodies needed to detect the mean difference delta are given in Table 1. Therefore, we can see that with the required quality of test results and the number of bodies in our study, we would be able to detect a mean difference of approximately 2 cm. For detection of a mean difference of 0.5 cm, we would need 71 fresh frozen bodies and 214 embalmed female bodies.

Results

We studied 28 trajectories of TVT-S on embalmed bodies and 20 trajectories (ten trajectories of TVT-S with the legs in the proper position and ten trajectories of TVT-S with the legs incorrectly positioned) on fresh frozen bodies. Table 2 lists the distances from the tip of the TVT-S inserter to the obturator nerve, where the mean distance to the obturator nerve on the left side was 3.05 cm (SD 1.18 cm) and 3.07 cm (SD 1.17 cm) on the right on embalmed bodies. The mean position towards the top of ramus superior ossis pubis was 4.48 cm (SD 0.97 cm) on the left and 4.69 cm (SD 0.83 cm) on the right on embalmed bodies.

We obtained fundamentally similar results on fresh frozen bodies: The mean distance to the obturator nerve on the left side was 2.63 cm (SD 1.08 cm) and 2.97 cm (SD 1.43 cm) on the right. The mean position towards the top of ramus superior ossis pubis was 4.30 cm (SD 0.89 cm) on the left and 4.83 cm (SD 1.03 cm) on the right.

The position did not significantly change after incorrectly positioning the legs to 60° flexion in the hips: The mean distance to the obturator nerve on the left side was 2.87 cm (SD 0.91 cm) and 2.83 cm (SD 1.40 cm) on the right. The mean position towards the top of ramus superior ossis pubis was 4.37 cm (SD 0.79 cm) on the left and 4.87 cm (SD 0.91 cm) on the right. However, the distance to the obturator nerve is not the sole parameter according to which we consider the safety of TVT-S.

Table 1 Number of bodies needed for detection of mean difference delta (alpha=5%, power=80%, SD=1.3 cm)

Numbers	Fresh frozen bodies	Embalmed bodies
Delta=0.5	71	214
Delta=1	18	54
Delta=1.5	8	25
Delta=2	5	15
Delta=2.5	3	10
Delta=3	2	7

We measured the position of the TVT-S tape. The nutritive artery for the obturator internus muscle can be seen in Fig. 3, with the tip of the inserter within a very short distance (approximately 5 mm).

The correct position was achieved on embalmed bodies only in nine cases and the acceptable position in six cases (a total of 53.6%). The unacceptable position occurred in 13 cases—46.4%. Results on fresh frozen bodies were as follows: correct position twice, acceptable position also twice—a total of 40%. The unacceptable position occurred in six cases—60%. No change in position happened when the legs were incorrectly positioned and the inserter was reinserted. Injury to the urinary bladder by inserting the inserter into the wall of the bladder or by penetrating into the urinary bladder occurred in four cases from 38 insertions, which is more than 10% of cases.

Statistics showed that when applying the mean, there is no significant difference between fresh frozen bodies and embalmed bodies in the position of the TVT-S to the obturator nerve or to the top of the superior ramus of the pubic bone. Evaluation of the data of TVT-S on fresh frozen bodies with legs in proper position and legs incorrectly positioned only indicated a statistically significant factor (the distance of the inserter to the obturator nerve on the right side) when using *t* test; because of the small group of bodies, we preferred the Wilcoxon test, which did not prove statistical significance in any group.

Discussion

We have established that TVT-S minimally endangers the obturator bundle and that the position of fixation does not change significantly with changing the position of the legs from 90° to 60°. We also proved that the rate of correct placement is relatively poor in comparison with other TVT methods. The aim of this study was to describe the anatomical location of TVT-S in view of inserting into obturator internus muscle and possible risk of damage to the obturator bundle. We succeeded in indicating possible complications, such as severe bleeding, after this procedure when describing the variable nutritive vein for obturator internus muscle.

There have been some promising results of industry-led research with TVT-S [19], indicating that the short-term failure rate was only 3%, with no complications during 150 operations. On the other hand, there have also been indications from independent researchers that the failure rate can be much higher [17, 18, 24–30]. We recently experienced a case of haemorrhagic complication during TVT-S [22], and others have also reported severe haemorrhage [21]. Faced with the lack of anatomical studies of the location of TVT-S, we searched for a possible explanation

Table 2 Positions of TVT-S

	Left side			Right side		
	Mean distance of tip of TVT-S from top of superior ramus of pubic bone (cm)	Mean distance of tip of TVT-S to obturator nerve and veins (cm)	Localisation	Mean distance of tip of TVT-S from top of superior ramus of pubic bone (cm)	Mean distance of tip of TVT-S to obturator nerve and veins (cm)	Localisation
Formalin-embalmed 1	2.17	1.67	Intramuscular	3.00	2.17	Intramuscular
Formalin-embalmed 2	5.17	4.83	In small pelvis	5.17	5.33	Intramuscular
Formalin-embalmed 3	3.33	0.67	Intramuscular	3.83	1.17	In small pelvis
Formalin-embalmed 4	4.17	3.33	In small pelvis	4.83	2.17	Intramuscular
Formalin-embalmed 5	4.83	3.17	Subfascial	5.17	2.83	Intramuscular
Formalin-embalmed 6	4.83	2.67	In small pelvis	5.67	4.17	Intramuscular
Formalin-embalmed 7	4.17	2.17	In small pelvis	5.00	3.17	Intramuscular
Formalin-embalmed 8	4.83	2.83	In small pelvis	4.00	1.83	In small pelvis
Formalin-embalmed 9	5.83	4.83	In small pelvis	5.83	5.00	Subfascial
Formalin-embalmed 10	5.17	3.33	In small pelvis	4.67	2.83	Subfascial
Formalin-embalmed 11	4.00	2.83	Subfascial	4.17	2.67	In small pelvis
Formalin-embalmed 12	4.17	2.50	Subfascial	4.33	3.17	In small pelvis
Formalin-embalmed 13	4.17	3.17	In small pelvis	5.83	3.83	Subfascial
Formalin-embalmed 14	5.83	4.67	In small pelvis	4.17	2.67	Intramuscular
Fresh frozen 1	4.33	2.33	Intramuscular	3.33	1.17	Intramuscular
Fresh frozen 2	4.17	2.67	Subfascial	5.00	2.83	In small pelvis
Fresh frozen 3	3.17	1.17	In small pelvis	4.33	2.17	In small pelvis
Fresh frozen 4	4.17	2.83	In small pelvis	5.67	4.83	In small pelvis
Fresh frozen 5	5.67	4.17	Subfascial	5.83	3.83	In small pelvis
Fresh frozen 1 malpositioned	4.33	2.67	Intramuscular	3.67	1.00	Intramuscular
Fresh frozen 2 malpositioned	4.33	2.83	Subfascial	4.83	2.67	In small pelvis
Fresh frozen 3 malpositioned	3.67	1.83	In small pelvis	4.33	2.17	In small pelvis
Fresh frozen 4 malpositioned	3.83	2.67	In small pelvis	5.83	4.67	In small pelvis
Fresh frozen 5 malpositioned	5.67	4.33	Subfascial	5.67	3.67	In small pelvis

of this relatively high failure rate. As we have documented, haemorrhagic complication can be caused by the nutritive artery of the obturator internus muscle (see Fig. 3).

The advantages of using embalmed bodies include better visualisation of the anatomical structures, easier anatomic dissection, more time for studying pelvic floor and steady relative position of the anatomical structures.

The disadvantages are rigidity of the body, with movement in the joints virtually impossible, and fixed position of the anatomical structures, which is more difficult preparation for insertion the tapes. Despite being unable to provide exactly the same conditions as during real surgery, we established on fresh frozen bodies that the trajectory of TVT-S does not significantly change with the position of the legs.

What could be disputed is the immobility of anatomical structures. During real surgery, mobility of structures is possible and therefore risk of injury to the important structures such as the nerves and veins, caused by the tip of TVT-S, could be lower. This also prompted us to use fresh frozen bodies.

In certain cases, where the TVT-S inserter penetrated the fascia of the obturator internus muscle, the operating surgeon sensed a loss of resistance. Although we cannot prove that loss of resistance means perforation of the fascia of the obturator internus muscle, in our opinion, this is the most probable explanation for this sensation.

Perforation of the fascia of the obturator internus muscle cannot really be evaluated in comparison with our clinical experience due to the low rate of severe complications. What we have witnessed several times on ultrasound is that the tape is not fixated and it folds (Fig. 4). This was always accompanied by recurrence of stress urine incontinence. We think that this happens when the fascia is perforated. The inserter was always pointing cranially and laterally, i.e. from the obturator internus muscle towards the fascia of obturator internus muscle, not very parallel with the fascia.

Fig. 4 Folded TVT-S tape on coronary section

Therefore, for the surgeon, it would be just a matter of pushing further (inserting the inserter more than necessary) to penetrate the fascia. It seems to us that using a different shaped inserter, perhaps with a slight bend at the end, could help to fixate the tape laterally back into the obturator internus muscle even in case of perforation of the fascia of obturator internus muscle.

Due to the size of the tip of TVT-S, we feel that the movement of the inserter should be as minimal as possible, so as not to damage the surrounding structures. Excessive movement, shaking or rotation of the tip in case of perforating the fascia would probably tear the crucial fixation point in this case, considering the thin tissue of muscle around it, the tape would probably not hold properly on site. Failure would be the logical outcome.

We cannot agree with the recommendation of the manufacturer to twist, shake or move the inserter tip after positioning it. In cases when the fascia of the obturator internus muscle is perforated, which happened in our study in 46.4% of embalmed bodies and 60% of fresh frozen bodies, excessive movement might enlarge the hole in the fascia, which could in turn reduce fixation; the tip could also tear or puncture veins, as we personally experienced and witnessed during the dissections. In case of perforation of the fascia of obturator internus muscle, haemorrhage from obturator internus muscle will be less likely to stop spontaneously by compression together with the obturator membrane, the fascia of obturator muscle can be regarded as a compartment.

Perforation of urinary bladder, which occurred in more than 10% of cases in this study, is in striking contrast with our clinical experience, where with 160+ patients who underwent TVT-S in our department, we have had perforation of urinary bladder only once; in other clinical studies, this complication did not occur frequently either. The explanation for this may be that with formalin fixated bodies the urinary bladder, like other tissues, are in steady relative position. Also, during the sole perforation of the urinary bladder in case of fresh frozen bodies, the lesser pelvis was fibrotic and the dissection was difficult.

The success rate of fixation in the obturator internus muscle in this study is almost identical to our success rate of treatment in long-term follow-up after the TVT-S procedure (62%) [18].

The hand preference of the surgeon may explain the different results on the left and right side. We think that a well-experienced surgeon is trained to perform the surgery on both sides with virtually the same outcome. After many operations, the manner of insertion is stable on each side. Statistical analysis also failed to prove significant difference on the right or left side in any of the procedures.

The size of our sample could be questioned; as far as we know, common sizes of similar anatomical studies range

from five to ten bodies. We used 14 embalmed bodies and five fresh frozen bodies. Despite using a sample two to four times bigger than usual, for truly valid statistical data, further research needs to be done. As stated under "Material and methods", hundreds of bodies would be needed to be able to detect a mean difference of 0.5 cm.

Our group is still small, and we would like to investigate further in order to provide more precise statistical data. We would like to also focus in future more on the arterial and venous system in lesser pelvis.

In conclusion, we succeeded in providing an explanation for severe haemorrhagic complications during TVT-S surgery. The course of the inserter is less often confined within the body of the obturator internus muscle than anticipated by the manufacturer, and it often penetrates into the lesser pelvis, thus risking visceral injury. The course of the tape does not seem to change if hip flexion is changed between 60° and 90°.

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Conflicts of interest None

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Článek

Výskyt preperitoneálního tuku a hernia obturatoria v canalis obturatorius

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Článek: Čes. Gynek.2010, 75, č. 3 s. 208–211
Počet zobrazení článku: 39x

Cíl studie:
Zmapovat výskyt preperitoneální tukové tkáně a hernie v canalis obturatorius.

Typ studie:
Prospektivní studie a přehled literatury.

Název a sídlo pracoviště:
Anatomický ústav 1. lékařské fakulty Univerzity Karlovy, Praha.

Předmět a metoda studie:
Na deseti fixovaných ženských tělech byla provedena pitva malé pánve se zaměřením na možnou přítomnost anatomických variabilit v malé pánvi, konkrétně na přítomnost hernia obturatoria a preperitoneální tukové tkáně.

Výsledky:
V šesti případech byl nalezen útvar reponovatelný do dutiny břišní, který je možné označit za preperitoneální tuk či lipom (podle jiné klasifikace za hernia obturatoria typu I). Byla provedena fotografická dokumentace a odběr vzorku na histologické ověření, zda je na povrchu přítomno

peritoneum. Histologické vyšetření bylo provedeno standardním postupem – barvením hematoxylin-eozinem.

Závěr:
Na šesti ženských tělech jsme pozorovali preperitoneální tukovou zátku v pěti případech vlevo a třech vpravo.

Klíčová slova:
anatomie, hernia obturatoria, preperitoneální tuk.

ÚVOD

Hernia obturatoria, prvně popsaná Ronsilem v roce 1724, je relativně vzácná, v současnosti se uvádí incidence mezi 0,073 % [2] až 3,9 % [4] všech břišních kýl. Její existence může být jak asymptomatická, tak může způsobovat opakované epizody střevní neprůchodnosti. V případě strangulace a perforace se stává život ohrožujícím stavem s mortalitou mezi 11 a 70 % [3]. Mezi rizikové faktory patří ženské pohlaví (přibližně šestkrát častější než u mužů), multiparita, nízký body mass index, aktuální váhový úbytek více než 10 kilogramů. Ve výskytu mírně převažuje pravá strana.

Mezi klasické příznaky se řadí bolest v třísle vyzařující na vnitřní plochu stehna (Howshipovo-Rombergovo znamení) a ztráta adduktorového reflexu při zachování patelárního reflexu (Hanningtonovo-Kiffovo znamení). Záludnost kýly spočívá ve velmi časté absenci klasických příznaků a absenci prominence kýlního vaku. Howshipovo-Rombergovo znamení je přítomno asi jen u jedné třetiny případů. Vyhmatat kýlu je možné pouze ve 12 % případů.

Canalis obturatorius je otvor v oblasti sulcus obturatorius, kde chybí membrana obturatoria vyplňující foramen obturatum. Obsahem canalis obturatorius je vasa obturatoria a nervus obturatorius. Samotný canalis obturatorius je dva až tři centimetry dlouhý a jeho průměr je kolem jednoho centimetru. Názor na fyziologický výskyt tzv. preperitoneálního tuku (též preperitoneální tukové zátky) vyplňujícího canalis obturatorius je předmětem diskuse. Někteří autoři Koebke [5] a Skandalakis [9] považují přítomnost zmíněného tuku za zcela normální fyziologický stav a uvádí, že se vyskytuje až ve sto procentech [9]. Anson [1] a Calaghan [3] považují preperitoneální tuk za nefyziologický obsah a uvádějí, že se vyskytuje pouze v řádech procent. Perry [7] již tento nález považuje za stupeň hernia obturatoria. V jeho práci se lze setkat s klasifikací, která dělí hernia obturatoria na tři typy. Zmnožení preperitoneálního tuku, který

vyplňuje samotný canalis obturatorius, nazývá prvním typem hernia obturatoria. Přítomnost peritonea s preperitoneálním tukem v canalis obturatorius bez přítomnosti dalšího obsahu pak nazývá druhým typem hernia obturatoria. Při třetím typu hernie do canalis obturatorius vstupuje v kýlním vaku další obsah – nejčastěji střevo, jde tedy o kýlu v pravém smyslu slova.

SOUBOR A METODIKA

Do souboru bylo zahrnuto deset fixovaných ženských těl, která byla pitvána v Anatomickém ústavu 1. LF UK. Těla byla poskytnuta v souladu s platným zákonem k výukovým a vědeckým účelům a nebyla selektována. Během pitvy malé pánve a oblasti foramen obturatum byla zaznamenávána přítomnost výplně canalis obturatorius. Makroskopicky měl útvar charakter lipomu či tuhého tuku v canalis obturatorius reponovatelného do malé pánve. Preperitoneální tukovou zátku (podle jiné klasifikace hernia obturatoria I. typu) jsme zdokumentovali a ve dvou případech byl odebraný materiál zaslán na histologii k zjištění přítomnosti peritonea na povrchu.

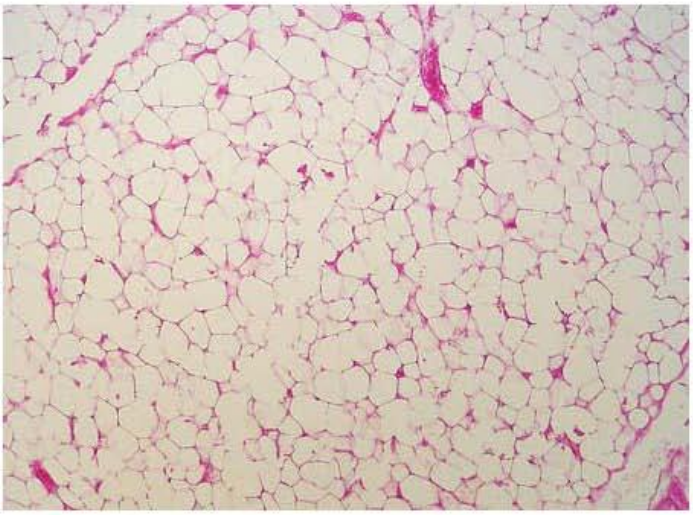
Histologický preparát byl uchován v 10% formolu, zpracován standardním postupem zalitím do parafínového bločku a po zhotovení tenkého řezu barven hematoxylinem-eozinem.

K vyhodnocení výsledků byly užity standardní statistické funkce Microsoft Excelu – průměr, směrodatná odchylka a interval spolehlivosti (alfa 0,05) až 95% CI.

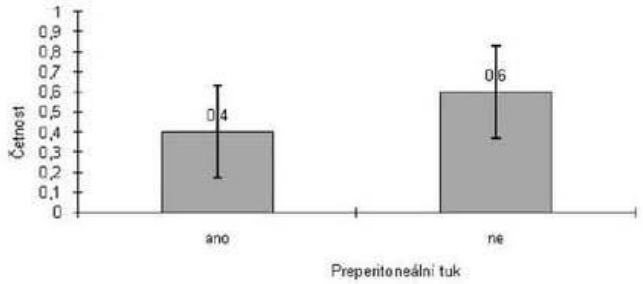
VÝSLEDKY

Z dvaceti pitvaných obturátorových kanálů byl ve třech případech vpravo a pěti vlevo identifikován tukový útvar, který byl reponovatelný do malé pánve (obr. 1, 2). Četnost v celém souboru je 40 % (±22 %) (graf 1). Po rozdělení podle stran je četnost 50 % (±33 %) vlevo a 30 % (±30 %) vpravo. Na dvou tělech byl tukový útvar bilaterálně.

Obr. 1. Preperitoneální tuk
1 – močový měchýř; 2 –stydká spona; 3 – preperitoneální tuk v canalis obturatorius



Obr. 2. Mikroskopický preparát preperitoneálního tuku (HE 100x)



Graf 1. Vyznačená celková četnost společně s 95% CI

V jednom případě bylo patrné mírné vhloubení peritonea do canalis obturatorius. Celkem dvakrát byl útvar po repozici do malé pánve resekován in toto a odeslán k histologickému vyšetření. Ani v jednom z případů do kýlní branky nezasahoval další obsah dutiny břišní. Ve zbylých šesti případech nebyl útvar histologicky zkoumán pro makroskopicky dobře patrné hladké peritoneum, které nezasahovalo do canalis obturatorius. Histologické vyšetření by v těchto případech pouze potvrdilo makroskopický nález. Výskyt na jednotlivých tělech dokumentuje tabulka 1. Podle patologa byl útvar zaslaný k vyšetření označen za tukovou tkáň, přítomnost peritonea obalující útvar se prokázat ani jednou nepodařilo.

Tab. 1. Výskyt preperitoneálního tuku

	vlevo	vpravo
Tělo 1	ano	ano
Tělo 2	ne	ano
Tělo 3	ano	ne
Tělo 4	ne	ne
Tělo 5	ano	ano
Tělo 6	ano	ne
Tělo 7	ne	ne
Tělo 8	ano	ne
Tělo 9	ne	ne
Tělo 10	ne	ne

DISKUSE

Preperitoneální tuk, jeho přítomnost a výskyt je předmětem diskuse. Někteří autoři (Koebke [5], Skandalakis [9]) považují přítomnost preperitoneálního tuku v canalis obturatorius za fyziologický stav. Preperitoneální tukovou zátku lze chápat jako tukový útvar, který splňuje

podmínku reponovatelnosti. Útvar musí tedy mít dostatečnou soudržnost a je možné jej tupou preparací odloučit od stěn canalis obturatorius.

U těl s vyšším stupněm výživy bylo patrné zmnožení pouhého řídkého tuku v canalis obturatorius. Tuk byl uložen intraperitoneálně i extraperitoneálně. Nebyl však volně reponovatelný do malé pánve.

Označení přítomnosti preperitoneálního tuku jako hernia obturatoria typu I, tak jak navrhuje Perry [7], je v rozporu s klasickým pojetím kýl, kdy kýla má kýlní vak, kýlní branku a kýlní obsah [6]. Zmnožení tuku, resp. přítomnost preperitoneální tukové zátky v canalis obturatorius, lze chápat jako předstupeň vzniku obturátorové kýly. V případě přítomnosti zátky a náhlé významné ztráty hmotnosti může dojít k úbytku tukové tkáně v canalis obturatorius. Následně by mohlo být vtaženo peritoneum do obturátorového kanálu. Tím vzniká vlastní kýla, jak naznačil Treves [10]. Shodný mechanismus popisuje u jiné kýly Šedý [8]. Pro výše popsaný mechanismus vzniku kýly je třeba předpokládat, že zmíněná tuková tkáň není lipom, který se neresorbuje ani při ztrátě hmotnosti.

Podařilo se nám prokázat, že v omezené míře se v canalis obturatorius vyskytuje tuková tkáň, která není konstantní anatomickou strukturou. Nelze však akceptovat terminologii podsouvající termín hernia obturatoria I. typu útvaru, který nesplňuje základní podmínky pro označení jako kýla.

ZÁVĚR

V našem souboru jsme ve 40 % pozorovali přítomnost preperitoneální tukové zátky, kterou někteří považují za předstupeň obturátorové kýly. Samotný útvar měl mikroskopicky charakter tuku bez přítomnosti peritonea na vnějším povrchu. Mikroskopicky jsme neprokázali peritoneum tvořící kýlní vak.

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Diskuze čtenářů

Vstoupit do diskuze

Int Urogynecol J (2010) 21:1179–1180
DOI 10.1007/s00192-010-1190-5

LETTER TO THE EDITOR

A serious bleeding complication with injury of the corona mortis with the TVT-Secur procedure: two cases of contact of TVT-S with the corona mortis during cadaver study

Petr Hubka · Kamil Svabik · Alois Martan · Jaromir Masata

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Dear Editor,

Recently, Larsson et al. [1] reported a case bleeding from corona mortis during tension-free vaginal tape (TVT)-Secur procedure. As is stated in their article, the tape at the left side was correctly placed at the second attempt. After the surgery, early laparotomy was performed due to suspicion of haemorrhage which was confirmed, and the bleeding corona mortis was ligated.

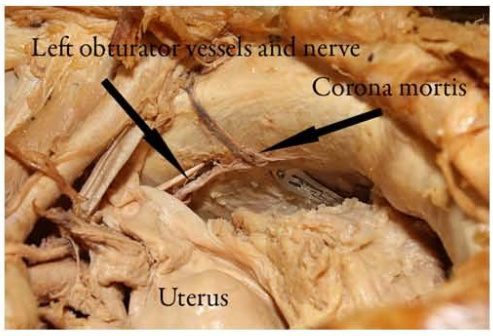
Our team performed several cadaver studies in order to describe possible complications that might occur during new methods for treatment of stress urinary incontinence. One of the methods evaluated is TVT-S in the U position. We have witnessed and well documented two cases of very near proximity (could be described as almost direct contact) of the TVT-S inserter and the vessels communicating between obturator vessels and external iliac or deep epigastric vessels.

The first contact we witnessed in the group for evaluation of TVT-S in the U position that consists of 19 formalin-embalmed bodies. Due to the rigidity of the formalin-embalmed bodies, the legs needed to be placed in 30° flexion in the hip joint and in 30° abduction in the hip joint. For that reason, we have also included a group of fresh frozen bodies, where the legs were positioned as recommended in standard procedure. In this group of six bodies, we have witnessed also one contact with the corona mortis after placing TVT-S in the U position.

As can be seen on the attached pictures, the near contact with the corona mortis is well shown and it would be a matter of fortune if those vessels will start bleeding after touching them with a scalpel-shaped inserter.

We assume that the injury of the corona mortis described by Larsson and colleagues [1] happened during the first attempt to place the TVT-S and it seems to us that the first attempt was made more upwards similar to the TVT-S in the U position.

For the first time, we thought that the direct contact with the corona mortis does not have to lead towards injury of the aforementioned corona mortis and that the correlation with the cadaver study to the live surgery might be difficult; still, the description of the injury witnessed by Larsson is more than clear proof that cadaver study might show possible complications occurring during a normal urogynecological surgery.



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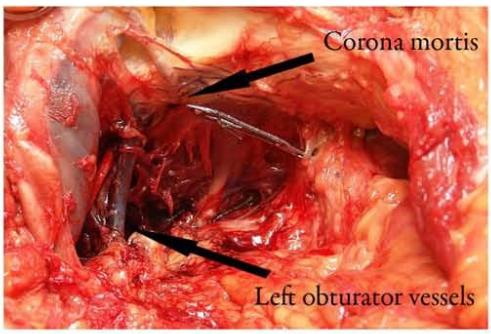

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ORIGINAL ARTICLE

Modified needle route for potential reduction of the trans-obturator inside-out-related thigh pain: a cadaveric study

Menahem Neuman · P. Hubka · A. Martan · V. Sosnovski · J. Bornstein

Received: 17 September 2010 / Accepted: 13 October 2010

Abstract To evaluate the anatomical aspects and relations of a modified tissue passage with the tension-free vaginal tape obturator (TVT-O) needle, designed for the purpose of reduction of the thigh pain, related with this anti-urinary incontinence operation. The distances between the modified TVT-O surgically inserted needle and obturator nerve branches were measured in fresh cadaver. The introduced surgical needle caused no trauma to any of the adjacent cadaveric organs, and the distances between the surgical needle and the obturator nerve branches was 4 cm. The modified TVT-O needle route is shown to be safe and remote from the obturator nerve branches, thus conduction of a clinical study for evaluation of related pain reduction is recommended.

Keywords TOT · TVT-O · Outside-in · Inside out · TVT-O FM

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Introduction

The tension-free vaginal tape (TVT) has been used since described by Ulmsten at 1996 for the treatment of female stress urinary incontinence. This mid-urethral Prolene tape support operation is now accepted worldwide as an easy-to-learn, effective, and safe surgical procedure [1–5]. However, the TVT harbors few typical operative complications such as bladder penetration (4–8%), urinary outlet obstruction (2%–5%), and rare occurrence of bowel penetration, intra-operative bleeding, and postoperative infections [2, 3, 5–10]. That reality led Delorme to design a novel mid-urethral sling in the form of a trans-obturator TVT-like procedure (2001). In such, the TVT needle bypasses the retro-pubic area, which is in proximity with the bladder, bowel, and blood vessels, by making the needle pass through the relatively safe medial compartment of the obturator fossa area, remote from the pelvic viscera and vessels [11]. This trans-obturator tape (TOT) outside-in operation was shown to be safe minimally invasive anti-incontinence procedure, yet related bladder injuries were reported [12–16]. Two years later, De Leval presented an inside-out approach, the tension-free vaginal tape obturator (TVT-O), aimed to reduce the bladder injury rate [17, 18]. This TVT-O was later claimed to cause perioperative thigh pain [19, 20]. Flam then raised the idea

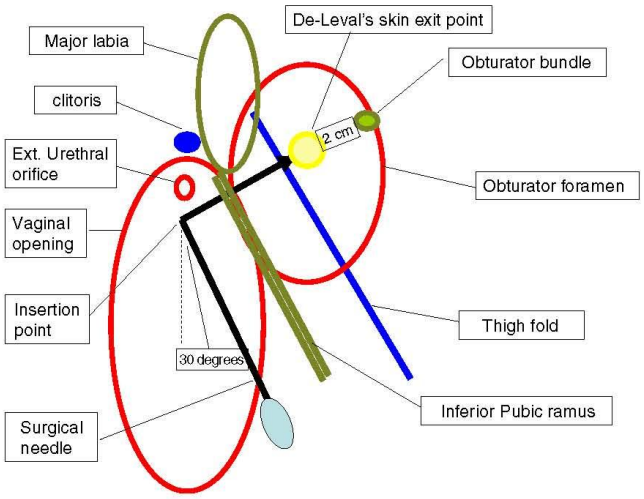

Fig. 1 De Leval's TVT-O technique

that the TVT-O-related thigh pain might be attributed to the oblique, thus long, path of the TVT-O needle through muscles and connective tissue at the obturator foramen. Long needle path was thought to entail heavy tissue damage and cause high related pain levels. Additionally, the rather close proximity of the surgical TVT-O needle to the obturator nerve branches might aggravate the peri-operative pain. Flam designed a perpendicular TVT-O needle passage through the obturator foramen to yield a shorter route for this inside-out procedure. Flam passed the TVT-O needle as close as possible to the inferior pubic ramus and with a skin exit at the outer aspect of the labia majora rather than laterally to the inguinal fold, as described by De Leval earlier [21]. This alternative route was aimed to extend the distance between the needle and the obturator nerve branches as well.

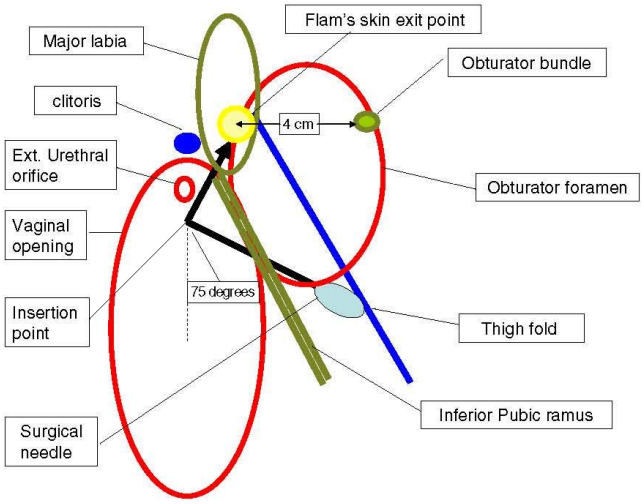

Fig. 2 Flam's TVT-O FM technique

Fig. 3 TVT-O FM procedural steps: (1, 2) insertion, (3, 4) advancing and exiting the surgical needle

Methods

The second author performed the TVT-O with the Flam method (TVT-O FM) in an anatomic laboratory on a fresh cadaver (legs positioned at 90° flexion and 30° abduction with the hip joint). The TVT-O FM differs from the De Leval method with the needle passage, being as close to the inferior pubic ramus as possible, exiting the skin not laterally to the inguinal fold as with De Leval but at the major labia. The obturator area crossing is perpendicular rather than tangential, making the throughway shorter. Achieving these required changes with De Leval's angle of the needle handle: instead of introducing it at a 30° angle to penetrating the obturator membrane, it is inserted at 75° (see Figs. 1, 2, 3, 4). The distances between the needle and the obturator nerve

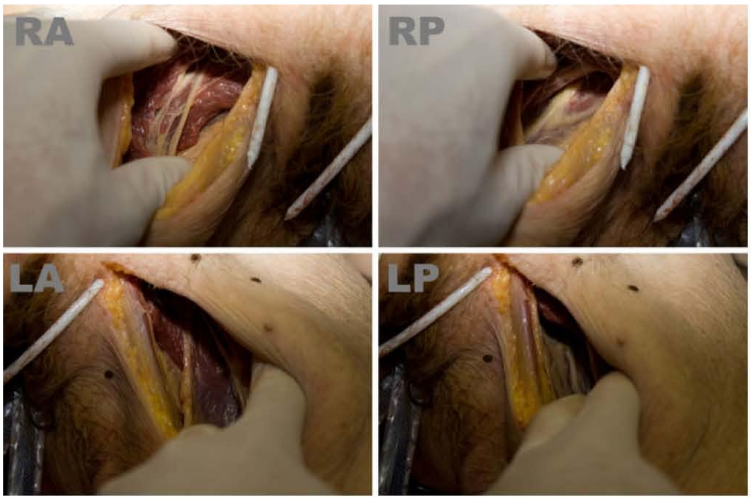

Fig. 4 Relations between the surgical needle with TVT-O FM and the obturator nerve branches. *RA* Right anterior, *RP* right posterior, *LA* left anterior, *LP* left posterior

and vessels branches were measured at the fresh cadaver right after dissection of the adductor region.

Results

Introducing the TVT-O surgical needles by Flam's modification to the obturator foramen did not endanger the surrounding organs. The passage through the muscular and connective tissue was perpendicular for shortening the path. The distances measured between the surgical needle passed by the TVT-O FM technique and the obturator nerve and vessels branches were 40 mm on both sides.

Discussion

Delorme and De Leval launched outside-in (TOT) and inside-out (TVT-O) trans-obturator submid-urethral supportive tape anti-incontinence procedures to avoid the TVT aforementioned complications. This included bladder penetration, intra-operative bleeding, postoperative field infection, and bowel injury [1–3, 5–10]. The TVT-O was thought to be less hazardous than the TOT to the bladder, yet it was accused to induce postoperative thigh neuralgia [19, 20]. The close similarity with the accurate needle passage of the TOT, which was not reported to cause postoperative pain, and the TVT-O FM grounded the hypothesis of thigh pain reduction with the proposed surgical method. Thus, the TVT-O FM [21] proposes an alternative to the original TVT-O inside-out needle passage for the reduction of the tissue damage and related pain. Since 2005, Dr. Flam has performed about 2,500 such procedures, with no clinical evidence of nerve or large vessel damage and with reduced postoperative thigh pain occurrence (personal communications). This might be explained now by a shorter pass through the obturator tissues as well as by an increased distance between the TVT-O FM surgical needle and the obturator nerve branches (4 cm) in comparison with De Leval's technique (2 cm) [17].The present cadaveric study results proves the TVT-O FM safety and indicates a clinical trial. Usually, more than one cadaver study would be recommended for showing reasonable surgical safety bounders, yet the definitely large safety margins found with this single cadaver overcame potential individual anatomical variations.

Conclusion

Our data support the notion that the TVT-O FM procedure draws safety margins for this procedure in terms of the hazards to obturator bundle branches, thus a clinical study is recommended here.

Conflicts of interest M. Neuman and A. Martan are consultants for Gynecare

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ORIGINAL ARTICLE

Ultrasound appearances after mesh implantation—evidence of mesh contraction or folding?

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Received: 31 March 2010 / Accepted: 14 October 2010

Abstract
Introduction and hypothesis Polypropylene meshes are frequently used in abdominal and vaginal reconstructive surgery. Recently, several authors have claimed that mesh-associated complications may be linked to mesh shrinkage. We have performed a prospective study with postoperative follow-up by ultrasound examination at two time points after Prolift anterior implantation to assess changes in the ultrasound appearance of mesh implants over time.
Methods We assessed 36 patients who had undergone mesh implantation with Prolift anterior™ mesh for the correction of symptomatic anterior vaginal wall prolapse. During the surgery, we measured the actual midline length of the mesh (initial length). On the fourth postoperative day, we performed a vaginal ultrasound examination (US) to measure mesh length in the midsagittal plane. A second US was performed 3–5 months after surgery to repeat this measurement.
Results There was a significant difference in mesh length determined before and 4 days after surgery (90.3 vs. 57.1 mm, $P=<0.0001$) indicating intraoperative folding. On comparing early and late postoperative ultrasound measurements, there was a reduction in length from 57.1 to 48.3 mm ($P<0.0001$), indicating possible shrinkage or retraction.
Conclusions Intraoperative folding seems to be responsible for a large part of the difference between preoperative (in vitro) and postoperative (US) measurements of mesh dimensions, suggesting that surgical techniques may require adjustment.

Keywords Prolift anterior · Mesh shrinking · Mesh retraction · Vaginal ultrasound · Vaginal surgery

Abbreviations

POP-Q	Pelvic organ prolapse quantification system
US	Ultrasound
ICC	Intraclass correlation
CT	Computer tomography
MR	Magnetic resonance

Introduction

Polypropylene meshes are frequently used in abdominal and vaginal reconstructive surgery. Its use in vaginal surgery is in the process of becoming routine, but we are still lacking good quality studies [1]. It is often assumed that mesh contraction or retraction/shrinkage is a possible cause of complications such as mesh erosion [2–4].

We know from animal studies that polypropylene mesh can cause a strong inflammatory reaction that is associated with retraction or shrinkage of the area occupied with mesh. The majority of published studies on mesh retraction were performed on animal abdominal wall [5]. Shrinking of macroporous polypropylene mesh in such animal models is described at around 16% for diameters or 28% for mesh area. The degree of shrinkage seems to depend on type of mesh, pore size, and on the presence of wound infection

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[5 8]. According to those animal studies, the dimensions of macroporous polypropylene mesh reach stability after 3 months [5, 9], although, for obvious reasons, long-term studies are lacking. To date (April 2010), there is no published data confirming mesh shrinkage or retraction in humans.

There have been several attempts at describing retraction of anterior vaginal wall mesh after implantation using ultrasound. Tunn et al. used introital ultrasound to study mesh dimensions and reported a reduction of as much as 60% compared to preimplantation length [10]. Velemir et al. showed an association between clinical prolapse recurrence and the degree of mesh retraction 1 year after mesh implantation. Both these studies used only one postoperative time point, comparing these ultrasound measurements with preimplantation mesh dimensions; however, there are at least two mechanisms that could explain shortening of the mesh after implantation.

Firstly, insufficient spreading of the mesh at the time of implantation or folding at or shortly after the surgery may cause an apparent reduction in dimensions. This effect would be independent of the mesh type and is determined mainly by dissection and insertion, i.e., surgical technique. Secondly, inflammatory processes could cause a reduction in diameters due to collagen deposition and possibly chemical alteration or degradation of the mesh material. To distinguish those two mechanisms, one would need at least two time points for ultrasound measurements. To this purpose, we undertook a prospective study with postoperative follow-up by vaginal ultrasound at two time points after Prolift anterior implantation.

Materials and methods

For a prospective observational study, we enrolled 36 patients who underwent a Prolift anterior procedure (Prolift Anterior™, Gynecare, Ethicon, Sommerville, NJ, USA) for symptomatic prolapse of the anterior vaginal wall [stage 2 or higher on pelvic organ prolapse quantification system (POP-Q)].

All patients underwent a preoperative clinical (POP-Q) and ultrasound examination with GE Voluson 730 Expert system (GE Medical Systems, Zipf, Austria) equipped with 8 4 MHz curved array volume transducer and 9 5 MHz vaginal volume transducer with an acquisition angle of 146°×120°. Ultrasound is the method of choice for imaging polypropylene mesh implants [11, 12] since these implants are radiolucent and impossible to image using plain X-ray, CT, or MR.

The Prolift procedure was performed according to the original technique [13]. At the time of insertion, the original mesh length was measured with the ruler before its placement. This time point was defined as time point 0, and the mesh length at this time is the "initial length." The mesh was fixed in position with Vicryl Rapid® (Ethicon, Sommerville, NJ, USA) to prevent peri and early postoperative slipping (see Fig. 1).

Transvaginal ultrasound was performed on the fourth day after surgery (time point 1, "early US length") and at 3 5 months after surgery to measure the mesh length in the midsagittal plane (time point 2, "late US length"). The ultrasound operator (KS) was blinded against all earlier measurements. After introducing the vaginal probe into the vagina, the proximal and distal ends of the mesh were localized in the midsagittal plane, and the mesh was traced and measured. A two-screen mode was used to view those cases where the entire mesh length could not be accommodated on one screen. The viewing needs never exceeded two screens. Then, the distances from the proximal and the distal ends of the mesh to the designated corresponding landmark either the urethrovesical junction or the ureteral ridge in case of need for distal corresponding point visible on both screens were measured and summated (see Fig. 2). We had to used the urinary bladder wall landmarks only due to lack of unmistakable points on the mesh. Additionally, a 4D volume-rendered cine loop of the entire mesh length was stored.

All measurements were taken three times once at the time of examination and twice from saved 4D volumes using the proprietary software GE Kretz 4D View v. 7.0 (GE Medical Systems). We used the mean value of all three measurements for further analysis and we performed intra-observer reliability correlation (Table 1). The vaginal approach was chosen to approximate the transducer as

Fig. 1 Prolift anterior mesh folds—at site—before closing the vaginal skin and stretching of the mesh

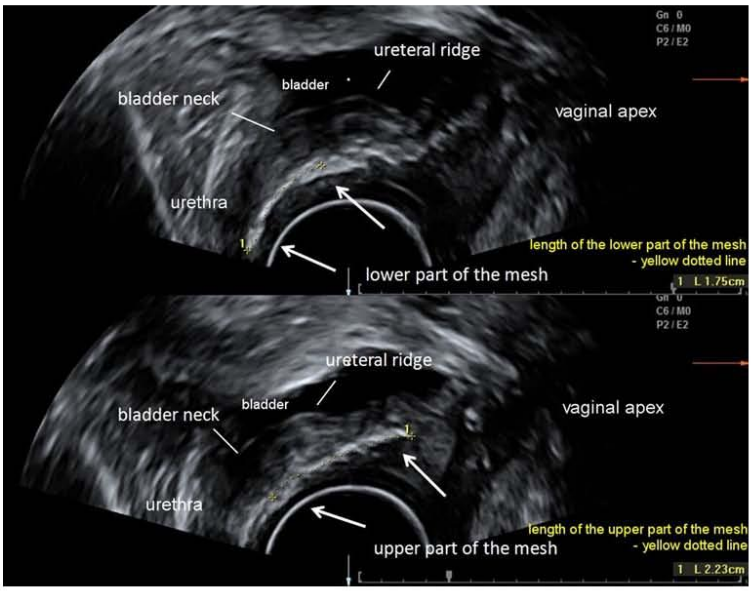

Fig. 2 Vaginal ultrasound mesh length measurement in two-screen mode

closely to the mesh for better visualization and to allow complete unfolding of the vaginal skin. The visualization on vaginal ultrasound seemed clearer compared to introital imaging. This method was evaluated in our pilot series with different mesh sizes [14].

To check for the consistency of measurements an interobserver reliability series for each value was performed on 30 patients by AM from saved volumes with the results given in Table 1.

The typical measurement error is 3.6% in late US measurements and 7.7% for the early US scan (see Table 2).

All data were analyzed using the software "statistical environment R," version 2.9.1. Continuous data were summarized as mean with standard deviation or as median and interquartile range (IQR; for comparisons of different measurements we used the paired *t* test. The reliability was assessed via intraclass correlation coefficient computed on the basis of analysis of variance model (library IRR). All tests were performed at 5% level of significance.

This study was approved by the local ethics committee and all participated patients gave written informed consent.

Table 1 Reliability

	ICC	CI		*P* value
Intraobserver				
Early US length	0.90	0.76	0.95	<0.0001
Late US length	0.97	0.94	0.98	<0.0001
Interobserver				
Early US length	0.74	0.51	0.86	<0.0001
Late US length	0.82	0.63	0.91	<0.0001

ICC intraclass correlation; *CI* confidence interval

Results

We included 36 patients with Prolift anterior with a mean age of 60.4 years (SD, 10.6); mean height of 163.3 cm (SD, 5.9); mean weight of 76.2 kg (SD, 11.0); mean body mass index of 28.6 (SD, 3.8); and parity of 2.0 (QR, 1.0). Six patients with an uneventful postoperative course were not seen by KS for the early US assessment, and two of them missed the late US assessment. The initial length of the Prolift anterior group was measured at 90 mm (range, 90 100 mm). The first ultrasound was performed on the fourth postoperative day in all patients, the second ultrasound 119 days after the procedure (median, 119 days; IQR, 94 139 days).

On comparing the intraoperative mesh length with the ultrasound measurement obtained on the fourth postoperative day (n=30), there was a marked reduction in midsagittal

Table 2 Measurement errors

Measurement errors	Typical error (mm)	Typical error (%)
Early US length	3.9	7.7
Late US length	1.9	3.6

mesh length 90.3 mm (SD, 1.8) vs. 57.1 mm (SD, 10.0), $P<0.001$ (38% initial length reduction). When early and late ultrasound measurements were compared ($n=30$, time point 1 and 2), we observed a further reduction of about 15% in the midsagittal dimensions [57.1 mm (SD, 10.0) vs. 48.3 mm (SD, 10.2), $P<0.001$] (Table 3).

Discussion

Ultrasound imaging has been widely used in the follow-up of tension-free vaginal tapes and has yielded detailed information on the position and tightness of the tape [11, 12]. Ultrasound is the method of choice for imaging such implants as macroporous polypropylene meshes are highly echogenic and cannot be imaged with X-ray, CT, or MR [15]. It is therefore only plausible to use ultrasound imaging for follow-up after mesh implantation to gain information about placement and extent of the mesh and, ultimately, to correlate such findings with clinical success and failure.

In this paper, we present the first clinical imaging study applying two time points to allow assessment of changes in mesh dimensions occurring within the first months after implantation of macroporous polypropylene mesh. The degree of shrinkage observed by us (approximately 15%) agrees with data from experimental animal studies using a similar type of mesh, where shrinkage of between 15% and 28% of the original area was described [5, 7, 16].

It is assumed that macroporous polypropylene mesh should achieve biological stability after about 3 months, once the healing process is complete [5, 9]; however, Letuzey et al. have recently presented long-term ultrasound data suggesting a linear decrease in mesh dimensions, implying ongoing contraction/retraction of mesh. Contrary to our study, however, Letouzey et al. used only a single time point. In view of the marked effect of surgical technique on mesh dimensions observed in our study, one wonders whether the marked difference between implantations performed over a period of 9 years may rather be due to changes in surgical technique.

Table 3 Mesh lengths in different time points

	Prolift		
	Number	Mean (SD)	95% CI for mean
Time point 0: initial length (mm)	36	90.3 (1.8)	(89.7; 91.0)
Time point 1: early US length (mm)	30	57.1 (10.0)	(53.6; 60.7)
Time point 2: late US length (mm)	34	48.3 (10.2)	(44.7; 52.0)

Tunn et al. used introital ultrasound to compare preimplantation mesh length with ultrasound measurements of mesh length after 6 weeks and showed a reduction in length of about 60% [10]. This corresponds with the 12% of length lost when one compares preimplantation length with measurements obtained at 3–5 months, and it is clear that most of this loss in length is due to intraoperative events (i.e., the surgeon) rather than postoperative processes (i.e., the patient).

Our data does not allow any conclusions as to whether intraoperative folding or postoperative mesh shrinkage is of clinical significance. Velemir et al. associated a higher degree of retraction with recurrence of prolapse [4]. It seems conceivable that a greater degree of intraoperative folding, i.e., insufficient spreading of the mesh, would result in a lesser degree of support of the vaginal wall, potentially leading to prolapse recurrence; however, given the much smaller degree or numerical change, this seems less likely for postoperative retraction or shrinkage, if such exists.

Based on the assumption of substantial mesh retraction or shrinkage over time, Feiner et al. conclude that there is a need for newer graft materials with diminished shrinkage properties [2]. Our data does not support this conclusion, and our clinical experience does not support the assumption of continuous shrinking. We have no prospective longitudinal data to assess symptoms over time; however, our data clearly suggests that the main means of improving mesh appearance and dimensions should be a change in surgical technique and mesh size in order to allow the mesh to be implanted flat and well spread out, anchored to underlying tissues in order to prevent immediate postoperative folding. Imaging techniques can serve to monitor and audit surgical results as a clinical standard. Together with investing in the development of new materials, we should focus as well on improving surgical technique and quality control.

We have to acknowledge several weaknesses of the current study. We were unable to accurately measure transverse mesh diameters and consequently have not attempted to calculate area due to the uneven shape and width of the mesh. This implies that we are unable to determine whether the reduction in midsagittal diameters observed by us may have been due to lateral stretching. Stretching would be expected once load bearing commences. Consequently, it seems possible that at least some of the observed changes in midsagittal diameters may be due to lateral stretching of the mesh, rather than retraction. Future studies into postoperative mesh appearances should include coronal or transverse measurements as well as those obtained in the midsagittal plane.

Secondly, our data are valid only for Prolift mesh implanted into the anterior vaginal wall, and our surgical technique may also have played a significant role; however, most of the

currently used implants used in pelvic reconstructive surgery are polypropylene macroporous meshes (amid type I) with similar pore sizes, and similar results may be expected from other meshes of the same type.

Conclusion

We observed a large and highly significant difference in pre- and postoperative dimensions of Prolift anterior mesh. Most of this difference seemed to be due to intraoperative folding rather than postoperative mesh retraction. This raises questions regarding the appropriate size of mesh implants and insertion technique.

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Conflicts of interest A. Martan provides consultation for Gynecare, Bard, and AMS.

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ORIGINAL ARTICLE

TVT-S in the U position—anatomical study

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Abstract
Introduction and hypothesis The objective is to describe the anatomical position of tension-free vaginal tape Secur (TVT-S) in the U position regarding possible injury and fixation site.
Methods We placed TVT-S inserters bilaterally in 13 embalmed and five fresh frozen female bodies. After dissection, we measured distances from the obturator bundle.
Results In embalmed bodies, the mean distance of TVT-S from the obturator bundle was 2.83 cm (standard deviation (SD) 0.87 cm) on the left, 2.92 cm (SD 1.24 cm) on the right. Perforation of the fascia of obturator internus muscle occurred in 38.5%. In fresh frozen bodies, results were fundamentally similar ($p>0.05$).
Conclusions There is a risk of injury to the obturator bundle and urinary bladder during TVT-S; however, there is a significant risk of inserting the TVT-S inserter outside the obturator internus muscle (into the lesser pelvis). The position of TVT-S does not change significantly after legs mal-positioning.

Keywords Anatomy · Female · Obturator bundle · Stress urinary incontinence · Tension-free vaginal tape

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Introduction

Since the invention of tension-free vaginal tape (TVT) by Ulmsten [1] in 1995, the procedure has gained great popularity due to its efficacy [2, 3] and safety, becoming the standard treatment for stress urine incontinence. Further modifications were designed in order to minimise possible complications. A new method of minimally invasive TVT, known as tension-free vaginal tape Secur (TVT-S), aimed to reduce complications, was introduced in 2006. Our first experiences were described by Martan [4–6], showing lower efficacy in comparison with previous TVT procedures. Fixation of the TVT-S in H-position was described by our team [7].

TVT-S is intended to provide sufficient fixation with less foreign material, reducing the risk of nerve and vessel injury [8, 9]. The surgeon can choose between transobturator (hammock) and retro-pubic position (U-shaped). In the U position, the tape points with the tip upwards behind the pubic bone. So far, there has not been any anatomical study focussed on TVT-S in the U position, so we decided to investigate anatomical localisation, assess the safety of this method and examine the fixation site of the TVT-S tape in the light of reported haemorrhagic complication during TVT-S [10–12] and problems with fixation of TVT-S in H position [7].

To obtain higher-quality photos, we used formalin-embalmed female bodies. In order to simulate more

accurately real-life surgery and decide whether the position of TVT-S changes with the position of the legs during insertion of the tape, we also used fresh frozen bodies.

Materials and methods

We performed TVT-S on 13 formalin-embalmed female bodies at the Institute of Anatomy, First Faculty of Medicine, Charles University in Prague, and on five fresh frozen female bodies at the Institute of Pathology, First Faculty of Medicine, Charles University in Prague. The study complied with Czech and international laws on science and research, and the study was approved by the local ethics committee. The terminology used hereinafter is based on current anatomical terminology (Terminologia Anatomica by FCAT [13]). We have used standard measures derived from the SI measures—centimetres, cm (1/100 m), millimetres, mm (1/1,000 m).

In order to evaluate the risks associated with TVT-S, the surgeon bilaterally inserted TVT-S in the U position, as described in the standard operation procedure in procedural steps. This means a sagittal incision about 1 1.5 cm long was made approximately 1 cm below the external urethral orifice, and with a small pair of scissors, two small paraurethral dissections were made, each approximately 1 cm in length. Using the needle driver, the inserter was inserted into previously dissected paraurethral incisions. The tip was oriented at an angle about 45° from the midline, towards the inferior pubic ramus, while holding the needle driver and inserter so that they were parallel to the floor. The inserter was advanced, contacting the inferior edge of the inferior pubic ramus. Whilst maintaining contact with the bone, further advance was made into the obturator internus muscle behind the pubic bone. The same procedure was carried out on the other side. The bodies were positioned as follows: formalin-embalmed bodies due to the rigidity of the joints lying on the back with legs in 30° abduction and 30° flexion of hips; fresh frozen bodies lying on the back with legs in gynaecological position (hips in 90° flexion). The surgeon was experienced in various TVT methods, including TVT-S. During the insertion, he controlled the position of the inserters by palpation, as in standard surgery. Afterwards, abdominal dissection took place. With fresh frozen bodies, we studied whether localisation depends on position of the legs. This was done as follows: After inserting the inserter with the legs in the position recommended by the manufacturer, abdominal dissection was performed. The tip of the inserter was localised and its position measured.

The dissector identified the following structures: obturator nerve, obturator artery, obturator vein, obturator internus muscle, fascia of obturator internus muscle and urinary bladder. We identified anatomical anomalies that were present.

The position of the TVT-S inserter was described as follows: The shortest distance from the tip of the inserter to the obturator nerve was measured. The obturator bundle containing the obturator artery, vein and nerve was about 3 mm thick; we chose the obturator nerve because it is the most visible and constant structure in the obturator canal. Also, the shortest distance from the tip to the top of the superior pubic ramus was measured (Fig. 1). To describe localisation of the TVT-S tape in obturator fossa, we used three groups of placement. The first was intramuscular in the obturator internus muscle (i.e. the tip was deeper than 1 mm from the fascia of obturator internus muscle). This position was considered to be the correct position (Fig. 2). The distance of 1 mm was chosen because, under this value, the inserter was covered by only a few fibres of muscle, which were spread apart, and the tip was already visible underneath the fascia of the obturator internus muscle. The second position was subfascial (i.e. the tip was just underneath the fascia of obturator internus muscle or covered by the muscle to a depth of less than 1 mm). We considered this position as acceptable. The third position was in the lesser pelvis (i.e. the tip penetrated the fascia of obturator internus muscle into the lesser pelvis; the tip was mainly prevesically in the obturator fossa—in between the fascia of obturator internus muscle and urinary bladder). We considered this position unacceptable, due to possible damage to the bladder veins, poor fixation, bleeding during and after the surgery and damage to the urinary bladder.

We measured the distances in different stages of the dissection three times and calculated the mean distance. During the dissection, when the tip of the inserter could be visualised, the shortest distance was measured to the top of

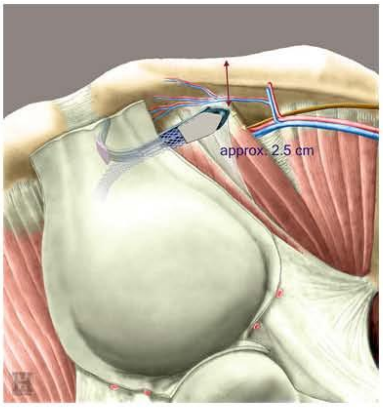

Fig. 1 Orientation in lesser pelvis and drawn distances measured

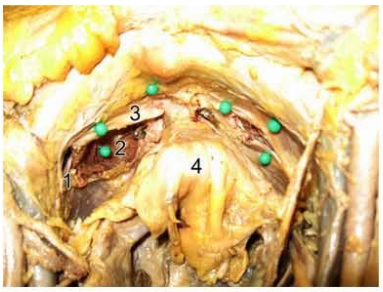

Fig. 2 Correct position of TVT-S inserter in the U position on the *left* and position in lesser pelvis on the *right*. Pins were used for measuring other parameters. *1* Left obturator nerve. *2* Left obturator internus muscle. *3* Fascia of left obturator internus muscle. *4* Urinary bladder

the superior ramus of the pubic bone and to the obturator bundle. The distances are measured again a short time later, in the same way previously described, in order to lower the risk of personal error during measurement. If the tip was not visible right after exploration of the lesser pelvis, it was located by palpation of the obturator internus muscle and the urinary bladder. The thickness of the tissue covering the inserter was measured as follows: A straight cut through the tissue was made until the inserter was reached. After measuring the thickness of the tissue covering the tip during the cut, the tissue covering the inserter was gently dissected to investigate whether veins or nerves ran through the cut or around the inserter. All steps were documented.

Statistical analysis of data was performed as follows: Means from triples of measured distances were calculated. From these data, we estimated mean, variance and standard deviation for the measured distance from obturator bundle at the right and left sides in the group of embalmed bodies and in the group of fresh frozen bodies. Statistical analysis of distance to the obturator nerve was performed based on these factors: difference in position of TVT-S placed in fresh frozen bodies and embalmed bodies. Statistical comparisons were performed using two-sample *t* test for differences between groups and Wilcoxon-paired test for differences between left and right side. All statistical tests were performed by one of the co-authors at the 5% level of significance alpha using statistical system R.

Results

We studied 26 insertions of TVT-S on embalmed bodies and ten insertions on fresh frozen bodies. Table 1 lists the distances from the tip of the TVT-S inserter to the obturator nerve, where the mean distance to the obturator nerve on the left side was 2.83 cm (standard deviation (SD) 0.87 cm) and 2.92 cm (SD 1.24 cm) on the right on embalmed bodies. The mean position towards the top of the superior pubic ramus was 3.90 cm (SD 0.86 cm) on the left and 3.97 cm (SD 0.83 cm) on the right on embalmed bodies.

We obtained fundamentally similar results on fresh frozen bodies: The mean distance to the obturator nerve on the left side was 2.20 cm (SD 1.11 cm) and 2.17 cm (SD 0.97 cm) on the right. The mean position towards the top of superior pubic ramus was 3.67 cm (SD 0.87 cm) on the left and 4.33 cm (SD 0.91 cm) on the right. The *p* values for comparison of fresh frozen and formalin embalmed bodies using *t* test (and Wilcoxon test) are as follows: distance from the top of superior ramus of pubic bone on the left side 0.63 (0.52) and on the right side 0.47 (0.37), and distance from the obturator nerve on the left side 0.29 (0.59) and on the right side 0.21 (0.17).

Once in the group of formalin embalmed bodies, we have found the inserter very near to the obturator nerve (Fig. 3) almost in direct contact. Once in the group of fresh frozen bodies, the inserter was placed very near the obturator nerve.

The correct position was achieved on embalmed bodies only in 13 insertions and the acceptable position in three insertions (a total of 61.5%). The unacceptable position occurred in 13 insertions (38.5%). Results on fresh frozen bodies were as follows: correct position seven, acceptable position zero (a total of 70%). The unacceptable position occurred in three insertions (30%). The localisation of the tape is in Fig. 4. Injury to the urinary bladder by inserting the inserter into the wall of the bladder or by penetrating into the urinary bladder occurred only once in formalin-embalmed bodies.

Discussion

We have established that TVT-S in the U-position might endanger the obturator bundle if the proper procedure is not carried out; however, the position of fixation does not change significantly with changing the position of the legs from 90° to 30°. The site of fixation is easily reached in comparison with the TVT-S in H-position [7]. We succeeded in indicating possible complications, such as bleeding if placement in lesser pelvis occurs or possible threat of injury of obturator nerve.

Since the beginning, there have been indications from independent researchers that the failure rate can be much higher [5, 6, 14 20]. Faced with the lack of anatomical studies of the location of TVT-S, we searched for a possible explanation of this relatively high failure rate.

The advantages of using embalmed bodies include better visualisation of the anatomical structures, easier anatomic dissection, more time for studying pelvic floor and steady

Table 1 Positions of TVT-S in the U position

	Left side			Right side		
	Mean distance of tip of TVT-S from top of superior ramus of pubic bone (cm)	Mean distance of tip of TVT-S to obturator nerve and veins (cm)	Localisation	Mean distance of tip of TVT-S from top of superior ramus of pubic bone (cm)	Mean distance of tip of TVT-S to obturator nerve and veins (cm)	Localisation
FE 1	3.33	2.83	IP	4.00	2.83	IP
FE 2	3.33	4.33	IM	5.17	3.33	IP
FE 3	5.83	4.17	IM	4.00	4.67	IP
FE 4	4.83	3.83	IM	5.33	4.83	IM
FE 5	3.83	2.17	IM	3.83	2.67	IP
FE 6	3.83	2.17	IM	3.67	2.33	IM
FE 7	4.83	2.33	IM	3.67	2.67	SF
FE 8	3.17	2.33	IP	2.67	0.00	IP
FE 9	3.17	2.33	IP	4.83	3.67	IM
FE 10	3.67	2.33	SF	3.33	2.83	IM
FE 11	2.67	1.67	IP	2.83	1.67	IP
FE 12	4.33	3.67	SF	4.67	3.67	IM
FE 13	3.83	2.67	IM	3.67	2.83	IM
Mean FE (SD)	3.90 (0.86)	2.83 (0.87)		3.97 (0.83)	2.92 (1.24)	
FF 1	3.17	3.17	IP	4.83	3.00	IM
FF 2	4.83	2.83	IM	4.67	2.67	IM
FF 3	2.83	0.50	IM	2.83	0.50	IP
FF 4	4.33	2.83	IM	5.17	2.33	IM
FF 5	3.17	1.67	IP	4.17	2.33	IM
Mean FF (SD)	3.67 (0.87)	2.20 (1.11)		4.33 (0.91)	2.17 (0.97)	
Mean total (SD)	3.83 (0.82)	2.25 (0.82)		4.07 (0.84)	2.71 (1.20)	

FE formalin embalmed, *FF* fresh frozen, *IM* intramuscular, *SF* subfascial, *IP* in lesser pelvis

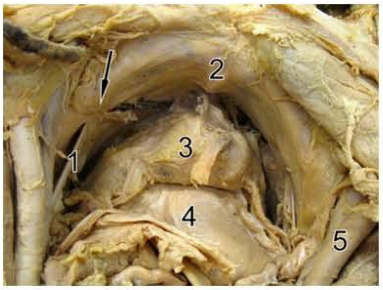

Fig. 3 Very close contact of the inserter with left obturator nerve. *1* Left obturator nerve. *2* Pubic symphysis. *3* Urinary bladder. *4* Uterus. *5* Right external iliac artery and vein

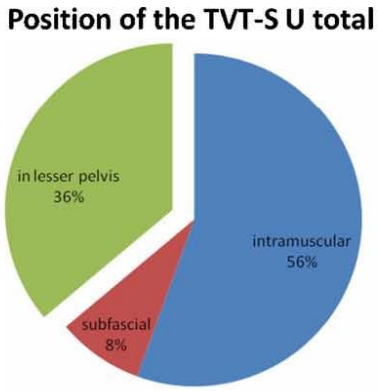

Fig. 4 Localisation of all the TVT-S in the U position (fresh frozen and formalin embalmed)

relative position of the anatomical structures. The disadvantages are rigidity of the body, with movement in the joints virtually impossible, and fixed position of the anatomical structures, which results in more difficult preparation for insertion of the tapes. Despite being unable to provide exactly the same conditions as during real surgery, we established on fresh frozen bodies that the insertion of TVT-S does not significantly change with the position of the legs.

What could be disputed is the immobility of anatomical structures. During real surgery, mobility of structures is possible, and therefore, risk of injury to the important structures such as the nerves and veins, caused by the tip of TVT-S, could be lower. This also prompted us to use fresh frozen bodies.

During some insertions, where the TVT-S inserter penetrated the fascia of the obturator internus muscle, the operating surgeon sensed a loss of resistance. Although we cannot prove that loss of resistance means perforation of the fascia of the obturator internus muscle, in our opinion, this is the most probable explanation for this sensation. Perforation of the fascia of the obturator internus muscle cannot really be evaluated in comparison with our clinical experience due to the low rate of severe complications.

Due to the size of the tip of TVT-S, we feel that the movement of the inserter should be as minimal as possible, so as not to damage the surrounding structures. Excessive movement, shaking or rotation of the tip in case of perforating the fascia would probably tear the crucial fixation point in this case; considering the thin tissue of muscle around it, the tape would probably not hold properly on site. Failure would be the logical outcome.

We cannot agree with the recommendation of the manufacturer to twist, shake or move the inserter tip after positioning it. In cases when the fascia of the obturator internus muscle is perforated, which happened in our study in 38.5% of embalmed bodies and 30% of fresh frozen bodies, excessive movement might enlarge the hole in the fascia, which could in turn reduce fixation; the tip could also tear or puncture veins, as we personally experienced and witnessed during the dissections [21].

Perforation of urinary bladder, which occurred once, seems to be similar to our clinical experience, where, with 100+ patients who underwent TVT-S in the U position in our department, we did not have perforation of the urinary bladder; in other clinical studies, this complication did not occur frequently either. The explanation for this may be that, with formalin-fixated bodies, the urinary bladder, like other tissues, are in steady relative position. In fresh-frozen bodies, no perforation occurred.

The hand preference of the surgeon may explain the different results on the left and right side. We think that a well-experienced surgeon is trained to perform the surgery on both sides with virtually the same outcome. After many operations, the manner of insertion is stable on each side. Statistical analysis also failed to prove significant difference on the right or left side in any of the procedures.

The size of our sample could be questioned; as far as we know, common sizes of similar anatomical studies range from five to ten bodies. We used 13 embalmed bodies and five fresh frozen bodies. Despite using a sample two to four times bigger than usual, for truly valid statistical data, further research needs to be done. Our group is still small, and we would like to investigate further in order to provide more precise statistical data.

In conclusion, we succeeded in providing an explanation for complications during TVT-S surgery. The course of the inserter is less often confined within the body of the obturator internus muscle than anticipated by the manufacturer, and it often penetrates into the lesser pelvis, thus risking visceral injury. The course of the tape does not seem to change much if hip flexion is changed between 30° and 90°.

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Conflicts of interest Professor Martan is a preceptor of Gynecare.

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GENERAL GYNECOLOGY

Anatomical study of position of the TVT-O to the obturator nerve influenced by the position of the legs during the procedure: based upon findings at formalin-embalmed and fresh-frozen bodies

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Abstract
Purpose Groin pain is one of the complications after TVT-O procedure. The aim was to examine the position and safety of the tape after TVT-O procedure.
Methods We inserted TVT-O in 14 formalin-embalmed bodies with legs malpositioned (group 1) and in 5 fresh-frozen bodies with legs malpositioned (group 2) and in 5 fresh-frozen bodies with legs correctly positioned (group 3). After dissection distances from the branches of obturator nerve were measured.
Results In group 1, the mean distance from the anterior branch of the obturator nerve was 8.6 mm on the left, 7.1 mm on the right. Mean distance from the posterior branch of the obturator nerve was 8.4 mm on the left, 8.9 mm on the right. In group 2, the mean distance from the anterior branch of the obturator nerve was 8.0 mm on the left, 8.0 mm on the right. Mean distance from the posterior branch of the obturator nerve was 5.0 mm on the left, 8.00 mm on the right. In group 3, the mean distance from the anterior branch of the obturator nerve was 24 mm on the left, 23 mm on the right. Mean distance from the posterior branch of the obturator nerve was 23 mm on the left, 23 mm on the right. Statistical analysis was performed with confirmation of significant difference between group of bodies with legs positioned correctly and other groups with malpositioned legs.
Conclusions The position of the legs is crucial for correct placement of TVT-O.

Keywords Anatomy · Female stress urinary incontinence · Surgical complications · Tension-free vaginal tape transobturator

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Introduction

Since 1995, when Ulmsten [1] described the tension-free vaginal tape (TVT) method, the surgical treatment of SUI has made great progress. The success of TVT is based on high efficacy rate whilst being less invasive procedure [2, 3] with minimizing total expenses [4]. This procedure has some complications; mild (injury to the urinary bladder and mild haemorrhage) and severe (massive haemorrhage and bowel injury) [5]. This procedure required legs avoiding flexion in the hip joint higher than 60° In response to complications of TVT, in 2001 Delorme [6] described a new procedure called TOT (outside-in), where the retropubic space is avoided and the tape is inserted through the

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obturator foramen from outside into a vaginal incision. This method still involved the risk of urethral and bladder injury; and therefore in 2003 de Leval [7] described the method known as TVT-O (inside-out). During this procedure the tape is passed closer to the obturator nerve [8] and therefore might cause groin pain [9, 10]. The recommended solution is to keep the needle medially [11] and hyperflexion in the hip joint was necessary. However, the incidence of the transient post-operative groin pain is rather low ranging 0.8–3% and resolves fast with help of analgetics. Persistent groin pain is very rare, still in such a case extirpation of the TVT-O tape is only a partial solution [9] which might not lead to complete curation. To explain possible reasons we have performed an anatomical study.

Methods

Our sample consisted of 14 formalin-embalmed bodies at the Institute of Anatomy, 1st Faculty of Medicine, Charles University in Prague. Due to the rigidity of the bodies we also used ten fresh-frozen bodies at the Institute of Pathology, 1st Faculty of Medicine, Charles University in Prague. The study complies with Czech, European and international law on research and was approved by local ethics committee (General Teaching Hospital in Prague). The formalin-embalmed bodies were placed on the back, with the hip joint at flexion of 30° to the horizontal plane and abduction 30° to the sagittal plane (group 1). Due to the rigidity of the formalin-embalmed bodies we also used fresh-frozen bodies that can be positioned as recommended by the manufacturer of the TVT-O, Gynecare TVT™ Obturator System Tension-free Support for Incontinence (Ethicon Inc., NJ, USA). The group of ten fresh-frozen bodies was split into two groups, each with five bodies. In the first group the bodies were placed on the back, with the hip joint at flexion of 30° to the horizontal plane and abduction 30° to the sagittal plane (group 2). In the second group the bodies were positioned on the back, with the hip joint flexed to 90° to the horizontal plane, abducted to 30° to the sagittal plane (group 3). TVT-O was put in place by an experienced surgeon according to the standard procedure [7]—1 cm midline vaginal incision starting 1 cm proximal to the urethral meatus was made. After sharp dissection, continue using "push-spread" technique using pointed curved scissors. The path of the lateral dissection is oriented at the 45° angle from the midline, with the scissors oriented on the horizontal plane. Continuing dissection towards the "junction" between the body of the pubic bone and the inferior pubic ramus, perforation of the obturator membrane was not carried out. Insert the winged guide into the dissected track and towards the obturator membrane, and insert the helical passer into the dissected track following the channel of the winged guide. Push the device inward, traversing and slightly perforating the obturator membrane. Winged guide is then removed. After removal of the winged guide, handle is moved towards the midline to a near-vertical position. Rotate the handle of the helical passer (counterclockwise for patient's right side and clockwise for patient's left side) exiting through skin incisions—2 cm above the urethral meatus, 2 cm lateral to the fold of the thigh, after partial removal of the helical passer plastic tube is pulled completely through skin. After similar procedure on the other side tape is positioned and cut. Skin incisions were not sutures. The deviation from the recommended procedure was flexion of the hip joint as stated above and perforating the obturator membrane with the plastic tube not with the scissors. Afterwards dissection of the lesser pelvis and region of adductors was performed. The following structures were identified: gracilis muscle, adductor brevis muscle, adductor longus muscle, adductor magnus muscle, anterior branch of obturator nerve, posterior branch of obturator nerve.

The distance of the TVT-O tape from both branches of the obturator nerve was measured three times, with a short break to eliminate personal mistakes. Mean distance was calculated for each body. Mean distances and statistical deviation were evaluated for each group. For statistical analysis, program R was used and power analysis was performed by one of the authors. At a 5% level of significance and with the power of the test at 80%, the numbers of fresh-frozen bodies and embalmed female bodies needed to detect the mean difference delta of 0.5 cm, we would need 27 fresh-frozen bodies and 82 embalmed female bodies. In our study, we would be able to detect a mean difference of approximately 1.5 cm. To compare the group of formalin-embalmed bodies and groups of fresh-frozen bodies we used the paired t test and Mann–Whitney test. To compare left and right side of the groups we used Wilcoxon pair test. All tests were performed at a 5% level of significance.

Results

We evaluated the position of TVT-O in a total of 24 bodies. In group 1 the mean distance to the anterior branch was 8.57 mm (SD 6.91 mm) on the left side and 7.14 mm (SD 7.52 mm) on the right side. The mean distance to the posterior branch was 8.36 mm (SD 6.51 mm) on the left side and 8.93 mm (SD 7.12 mm) on the right side. In six cases the inserter was in direct contact with the anterior branch of the obturator nerve. Furthermore, also in six cases there was direct contact with the posterior branch of the obturator nerve.

Results for group 2 were similar to the group 1. The mean distance to the anterior branch of the obturator nerve was 8.00 mm (SD 2.74 mm) on the left and 8.00 mm (SD 5.70 mm) on the right. The mean distance to the posterior branch of obturator nerve was 5.00 mm (SD 5.00 mm) on the left and 8.00 mm (SD 2.74 mm) on the right. Direct contact occurred twice with the anterior branch and once with the posterior branch.

Results for the group 3 were quite different. The mean distance to the anterior branch of the obturator nerve was 24.00 mm (SD 4.18 mm) on the left and 23.00 mm (SD 5.70 mm) on the right. The mean distance to the posterior branch of obturator nerve was 23.00 mm (SD 5.70 mm) on the left and 23.00 mm (SD 4.47 mm) on the right. No direct contact with either anterior or posterior branch occurred. Detailed results are in Table 1.

In all the groups the inserter did not penetrate into the lesser pelvis, which means the inserter did not penetrate through the fascia of obturator internus muscle into abdominal cavity.

There was a statistically significant difference (p value less than 0.005) between the distance of the inserter from the anterior and posterior branch of the obturator nerve when comparing the group 1 and group 3, same as when comparing group 2 and group 3. No statistically significant difference was found when comparing group 1 and group 2 (p value higher than 0.005).

Discussion

The use of formalin-embalmed bodies to study anatomy and placement of the tape has some advantages and some disadvantages. The advantages are more time for dissection, better visualization and rigidity of anatomical structures. The rigidity of anatomical structures can cause

Table 1 Distance of TVT-O to obturator nerve in adductor region (mm)

	Distance to the anterior branch of the left obturator nerve (mm)	Distance to the posterior branch of the left obturator nerve (mm)	Distance to the anterior branch of the right obturator nerve (mm)	Distance to the posterior branch of the right obturator nerve (mm)
Formalin embalmed 1	5	0	5	10
Formalin embalmed 2	0	2	5	0
Formalin embalmed 3	15	10	5	10
Formalin embalmed 4	0	0	5	5
Formalin embalmed 5	15	5	5	10
Formalin embalmed 6	15	15	0	25
Formalin embalmed 7	0	15	5	10
Formalin embalmed 8	5	10	0	0
Formalin embalmed 9	20	20	0	10
Formalin embalmed 10	0	10	10	5
Formalin embalmed 11	15	10	10	10
Formalin embalmed 12	10	5	30	20
Formalin embalmed 13	10	15	10	0
Formalin embalmed 14	10	0	10	10
Mean (SD)	8.6 (6.9)	8.4 (6.5)	7.1 (7.5)	8.9 (7.1)
Fresh frozen correct 1	25	25	25	20
Fresh frozen correct 2	25	30	25	25
Fresh frozen correct 3	20	20	15	20
Fresh frozen correct 4	30	25	30	30
Fresh frozen correct 5	20	15	20	20
Mean (SD)	24.0 (4.2)	23.0 (5.7)	23.0 (5.7)	23.0 (4.5)
Fresh frozen malpositioned 1	5	10	0	10
Fresh frozen malpositioned 2	5	10	5	10
Fresh frozen malpositioned 3	10	0	15	10
Fresh frozen malpositioned 4	10	0	10	5
Fresh frozen malpositioned 5	10	5	10	5
Mean (SD)	8.0 (2.7)	5.0 (5.0)	8.0 (5.7)	8.0 (2.7)

problems if the legs need to be placed into certain position. For this reason we also used fresh-frozen bodies. The possibility to position the legs is traded for worse visualization and the need for fast dissection. To confirm our hypothesis that it is the position of the legs we have also included fresh-frozen bodies with the legs positioned same as in the group of formalin-embalmed bodies. As receiving similar results, also statistical analysis confirmed that the group of fresh-frozen correctly positioned bodies differs from other groups and that there is no difference between group of formalin-embalmed bodies and fresh-frozen malpositioned bodies.

Surely, one can object, that living body is different from formalin-embalmed body. The anatomy of the nerves and their position which is the topic of this paper does not change during the embalming procedure; therefore, it is a good method of checking the safety of the procedure. Fresh-frozen body can be considered similar to the living body, especially nowadays when mean age at the point of surgery still rises. Based on our experience and the fact that some manufacturers use fresh-frozen bodies for lecturing insertion technique, we believe that the insertion procedure is similar. Unfortunately, efficacy could be judged hardly by anatomical study based on cadavers. Still, there are numerous papers describing clinical efficacy and results of different questionnaires about the surgery.

Our findings match those of Hinoul [11] relating to the influence of the position of the legs on the position of the TVT-O. In the above-mentioned study the position of the tape was described based on result on a single body with malpositioned legs. Due to the fact that complications of TVT-O such as groin pain [9, 12–14] continue to be mentioned frequently, we feel that this issue is still relevant. As was already stated in "Introduction" the groin pain is quite rare even in early post-operative period and usually is resolved by itself or with help of analgetics. The persistent groin pain is very rare. Unfortunately, partial resection of the TVT-O does not provide complete solution [9].

The anterior branch of the obturator nerve is responsible for the innervation of the pectineus muscle, adductor longus muscle, adductor brevis muscle, gracilis muscle and in some cases for partial sensitive innervation of the inner thigh. The posterior branch of the obturator muscle is responsible for the innervation of adductor brevis muscle, adductor magnus muscle and usually the knee-joint. Due to duplex innervation of some muscles, injury of one branch might be without clinical symptoms. It is also important to stress that mere contact with the nerve does not have to cause loss of innervation. We have not witnessed direct damage of the obturator nerve. It is more probable that contact with the nerve will cause dysesthesia or paraesthesia. Close contact with both branches of the obturator nerve can be seen in Fig. 1.

Fig. 1 Close relation of the branches of obturator nerve to TVT-O (in forceps adductor brevis muscle). *1* Adductor longus muscle, *2* anterior branch of the obturator nerve, *3* adductor brevis muscle and *4* Posterior branch of the obturator nerve

In conclusion, TVT-O is dependent on the position of the legs, and the peripheral branches of the obturator nerve are endangered if there is any deviation from the standard procedure regarding positioning and method of insertion. However, following the procedure the obturator nerve should be in safe distance.

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Conflict of interest Martan A. is perceptor of Gynecare.

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