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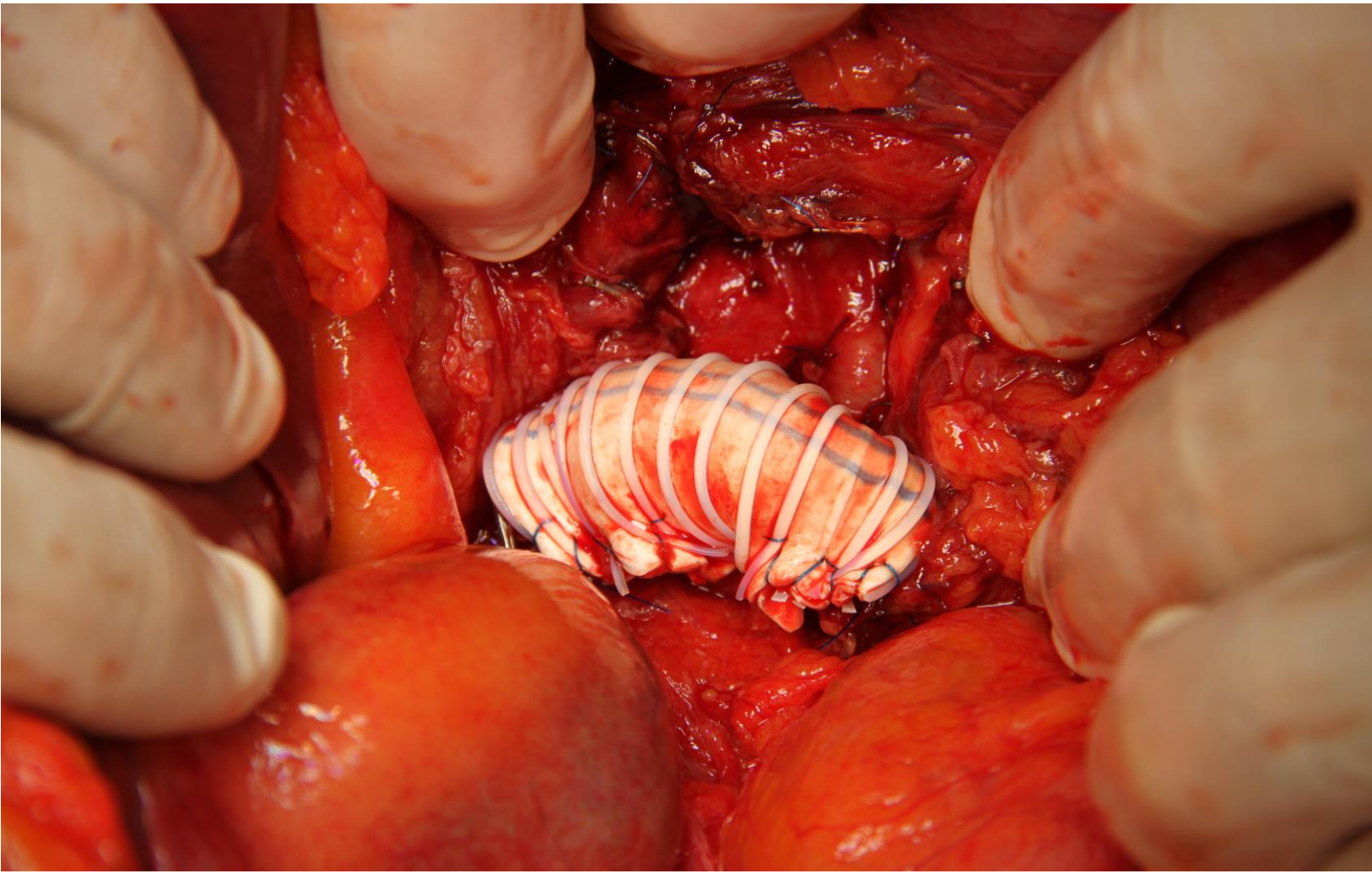

- **Antibacterial Activity of Laurus nobilis: A review of literature**
- **Epidural blood patch for the treatment of post dural puncture headache in pregnant women**
- **Pancreaticoduodenal artery aneurysm: Treatment outcomes of a rare disorder**
- **Types of herniated discs and outcomes of lumbar microsurgical discectomy with extended foraminotomy**

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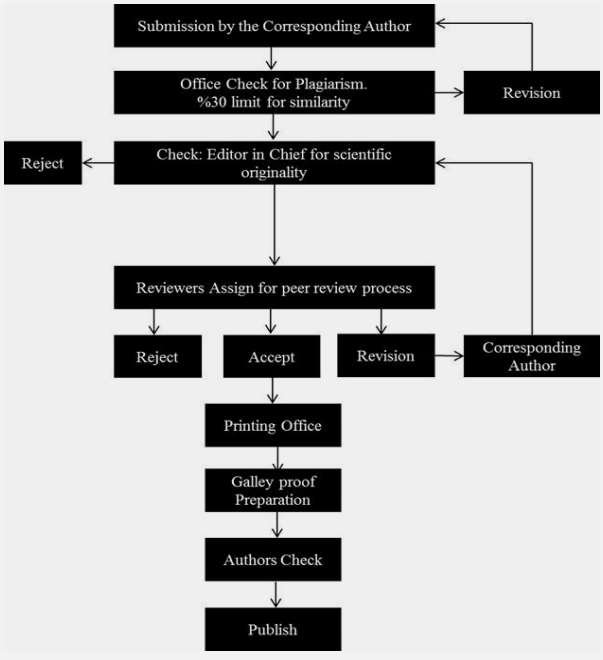

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Antibacterial Activity of Laurus nobilis: A review of literature

Belgin Sırıken[1], Ceren Yavuz[2], Ayhan Güler[3]*

Abstract

The presence of phenolic compounds in spices and herbs, along with the essential oils, has been gaining attention due to their various functions like antioxidant capacity, antimicrobial properties, and flavoring properties. The Bay leaf belongs to Lauraceae family and is endemic in the Mediterranean region. *Lauraceae*, is an aromatic plant frequently used as a spice in Mediterranean cookery and as a traditional medicine for the treatment of several infectious disease. *L. nobilis* also belongs to *Lauraceae*. *L. nobilis* is aromatic tree, and is 2 m to 10 m high. *L. nobilis* contains about 1.3% essential oils and polar flavonoids mono, sesquiterpenes, alkoloids, glycosylated flavor-noids, megastigmane and phenolic components. It is known to have various pharmacological effects, including antimicrobial, cytotoxic and immune modulating. Its' essential oil containg eucalyptol, α-terpinyl acetate, linalool, methyl eugenol, sabinene and carvacrol. The property of every essential oil varies according to the harvest country, altitude, period of sunshine, conditions of harvest. These essential oil contents of *L. nobilis* are strong antibacterial activity against Gram negative and Gram positive foodorne pathogens (*Salmonella, Staphylococcus aureus, Esherichia coli, Listeria* monocytogenes like that), spoilage bacteria (*Pseudomonas aeroginosa*) as well as antifungal effects. The synergy between terpenes (linalool), lactones, oxides (1,8 cineole) and monoterpenes (camphene, alpa-pinene) gives to the essential oil of Laurel a good antibacterial activity. Its essential oils' various or single chemical compositions at different concentrations have different inhibition mechanisms that can affect a variety of pathogens by changing membrane permeability, denaturing proteins and inhibiting enzymes. The oils are not affecting on existing beneficial intestinal bacteria.

Key words: Essential oils, *Laurus nobilis*, Antibacterial Activity, Review

Introduction

Antibiotic or multiple antibiotic resistance (MDR) microorganism particularly pathogen bacteria has dramatically increased in human and animal. Therefore, resistance microorganism caused diseases have posed a risk in human and treated public health. Due to these resistance properties of microorganism, researchers started looking for alternative way for treatment or for preventing diseases. Nowadays, ingredients obtained from plants, like essential oil, can be used as alternatives to antibiotics. Bay laurel, cinnamon, oregano and clove like plants have antimicrobial activity against both some Gram negative and positive microorganisms (1). In this review, L. nobilis (bay leaf) and its effects as antimicrobial properties against some microorganism are highlighted.

Laurel (L.) nobilis (bay leaf) is an aromatic plant and evergreen tree which belongs to the family of Lauraceae, it is one of the most widely used culinary spices in all Western countries and Asian countries.

It is cultivated and endemic in the Mediterranean countries of Turkey, Spain, Morocco, Greece, Portugal, as well as in Mexico and other temperate and warm parts of the world. This aromatic tree is 2 m to 10 m high (2). The plants inherently cultivated in coastal areas to an altitude of 600-800 meters. The plant's leaves and berries are commonly used as a spice aroma and enhancer for foods especially for meats, sauces and soups (3). Besides its special aroma, it is also used to cure diseases all over the world. Some compounds of this plant such as essential oils and organic acids have shown strong antibacterial activity against some foodborne pathogen microorganism besides spoilage bacteria (4, 3,5,6).

Essential oil is a hydrophobic liquid compartment obtained from various parts of plant such as flowers, seeds and stems. Because of its aromatic characteristic, essential oil is used in as a flavoring agent in cosmetic and food industries

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It has also biologic effects such as antimicrobial, antidiabetic and anticancer activities (4). The plant's essential oils have antimicrobial activity (1). Therefore, essential oils have been shown to have advantages as natural antimicrobials. These oils' various chemical compositions or single components at different concentrations have different inhibition mechanisms that can affect a variety of pathogens by changing membrane permeability, denaturing proteins and inhibiting enzymes. It has also shown effective antimicrobial activity against drug-resistant strains (7).

Essential oil of bay leaves

The property of every essential oil varies according to the country of harvest, period of sunshine, conditions of harvest, quality of the distillation, storage and usage (8). However, it is generally reported that the basic components of the essential oil of bay leaves are 1.8-cineole, linalool and a-terpinyl acetate (9).

In addition, it has also some phenolic components such as epicate-chin, procyanidin dimer, procyanidin trimer, flavonol and flavonederivatives and many volatile active components such as a-pinene, ß-pinene, myrcene, limonene, linalool, methyl chavicol, a-terpineol, geranyl acetate, eugenol and chavicol. All these compounds are known as antimicrobial (3,6), anti-oxidant (6), digestive and anti-cancer and immune modulating (10).

There have been detailed analyses on of essential oil of obtained from bay leaf. For instance, the GC/MS analysis reports that, the main components of oil are: an ether-oxide of terpenic nature: 1.8 cineole or eucalyptol (35.31%), which is the main component of the essential oil of Bay leaf, and considered as drug and phenologic stadium of the Bay leaf. Linalool and camphene are present as monoterpenes. Sesquiterpenes represented by sesquiterpenic lactones (cadinene and caryophyllene) constitute 22% of the oil. Terpinol (3.18%) is predominant alcohol.

From Turkey, (5) it was reported that the major components detected in bay laurel essential oil were eucalyptol (27.2%), α-terpinyl acetate (10.2%), linalool (8.4%), methyl eugenol (5.4%), sabinene (4.0%) and carvacrol (3.2%). In Table 1, chemical composition of L. nobilis essential oil is shown.

Table 1. Chemical compositions of *L. nobilis* essential oil (3)

	Compounds	RT	Composition (%)
1.	α-Thujene	9.4	0.2
2.	α-Pinene	9.7	3.7
3.	Sabinene	12	10.1
4.	β-Pinene	12.1	2.8
5.	Myrcene	13.1	0.9
6.	α-Phellandrene	13.8	0.5
7.	1,8-Cineole	15.7	51.8
8.	γ-Terpinene	17.3	0.5
9.	trans-Sabinene hydrate	17.8	0.6
10.	cis-Sabinene hydrate	19.9	0.4
11.	Linalool	20.2	1.9
12.	Pinacarvone	24.1	0.1
13.	Terpinen-4-ol	25.3	3.1
14.	α-Terpinenol	26.2	5.2
15.	Bornyl acetate	30.7	0.1
16.	Pseudolimonene	31.9	0.4
17.	α-Terpinyl acetate	33.1	11.2
18.	Eugenol	33.3	0.4
19.	Neryl acetate	33.6	0.3
20.	β-Elemene	34.4	0.4
21.	Methyl eugenol	34.8	0.8
22.	Germacrene	37	0.1
23.	Bicyclogermacrene	37.4	0.2
24.	β-Eudesmol	41.3	0.3
25.	Elemol	41.3	0.1
26.	Eremanthin	48.7	0.1
27.	1,2 Benzenedicarboxylic acid	70.0	0.4
	Total		96.6

RT: Retention time

Antibacterial effects of essential oil of bay leaves

One of the important properties of essential oils and their components is their hydrophobicity, which allows them to partition the lipids of the bacterial cell membrane and mitochondria, disturbing the cell structures and making them more permeable (11). The antimicrobial activity depends on not only the chemical composition of the essential oil, but also on lipophilic properties and power of functional groups or aqueous solubility. The mixture of compounds with different biochemical properties can improve the effectiveness of essential oils (1).

Commonly, essential oil of bay leaves is more effective against Gram negative bacteria than Gram positive bacteria (12). This resistance is due to bacterial cellular membranes' nature group. Hence, their external structures make them to highly hydrophobic surface 13).

There are some studies according to essential oils of L. nobilis' antimicrobial activities. One of them, (13)'s studies. They report that the essential oil of L. nobilis L. had demonstrated a strong activity on the majority of tested 22 strains; the highest sensitivity was in Enterobacter species having an inhibition diameter of 22.4 mm, 16.8 mm pure oil and 1/8 dilution. The most resistant strain was P. aeruginosa. They also reported that 1.8 cineole had a part in this activity having antimicrobial activity against E. coli, P. aeruginosa and Staphylococcus aureus. Laurel's essential oil contains terpenes (linalool), lactones, oxides (1,8 cineole) and monoterpenes (camphene, alpha-pinene). There is a good synergy among the substances for antimicrobial activity.

In another study, (14) reported that ampicillin resistant E. coli was sensitive to the pure oil and diluted at ½, on the other hand, it was of a weak sensitiveness to the essential oil diluted at ¼, 1/8, and 1/16. Proteus spp. was resistant to ampicillin, ticarcillin, cotrimoxazol and chloramphenicol. This strain showed a very big sensitiveness towards the pure essential oil but it was resistant to the different used dilutions. Serratia was resistant to ampicillin, ticarcillin, ofloxacine and cotrimoxazol. This strain was rather sensitive to both pure essential oil and different used dilutions. Klebsiella pneumoniae, Staphylococcus aureus, Streptococcus D, Pseudomonas aeruginosa and Acinetobacter, which are resistant to at least one of antibiotics such as kanamycin, penicillin, nalidixic acid, lincomicin, cefazolin, imipenem, gentamicin, pefloxacin, phosphomycin and piperacillin. But They are susceptible to essential fatty acids diluted 1/2 and at 1/4 (6)'s study aimed to evaluate the antimicrobial and antioxidant activities of essential oils obtained from bay laurel, white wormwood and rose-scented geranium against Salmonella typhimurium and Escherichia coli O157:H7 on fresh produce and to examine consumer acceptability of fresh produce treated with these essential oils. Bay laurel's essential oil consisted of 30-50% 1.8-cineol, 10-20% linalool, 2.13% methyl eugenol and 0.01% eugenol. They found that while essential oil derived from rose-scented granium exhibited the most effective antimicrobial activity, the highest activity was occurred in bay laurel essential oil.

From Turkey, (3) has obtained essential oil from leaves of Laurus nobilis using extraction technique. After extraction, they found that the main components of oil were 51.8% 1,8-cineole, 11.2% α-terpinyl acetate, and 10.1% sabinene. They also found that the L. nobilis essential oil was of the high antibacterial, antifungal and antioxidant potential.

(5) reported that natural extracts from myrtle and laurel can be used by the food industry to extent the shelf life of seafood because they exhibited promising antioxidant and antimicrobial effects. (15)'s study results also showed that 1% thyme essential oil treatment was effective in inhibiting spoilage bacteria growth in the iced storage fish. They also obtained same results in treatment of laurel essential oil. In addition, two plant's essention oil had positive effects on shelf life of iced stored fish samples.

Nano- particules of Laurus nobilis (Ln-ZnO NPs) and antimicrobial effects

Nanoparticles have widely emerged as an anti-bacterial agent in the last decade. It has particularly showed specific targeting and minimum toxicity. They have proven useful for inhibiting antibiotic-resistant bacteria particularly Nanoparticles are in the size ranges from 10-100 nm. The appearance and usefulness of nanoparticles brings many advantages and opportunities. These nanoparticles can be synthesized by physical, chemical and biological methods. In the course of time several groups have achieved success in the synthesis of silver, titanium oxide, copper oxide, iron oxide, zinc oxide (ZnO) and gold etc. Because of the fact that nano particles significatly inhibit growth of many type microorganisms, many researchers have been interested to develop many applications. There are very kinds of nanoparticles. Among them, silver nanoparticules are more common than others. Silver and their compounds have highly antmicrobial effects on microorgaisms such as Escherichia coli and Staphylococcus aureus (16). It has long-lasting biocide and low volatility. In contrast, it has low toxicity to human cells (17). Beside silver, zinc oxide nanoparticules have more inhibitory effects on micriorganisms than silver nanoparticules. Hence, its small size and high surface-to-volume ratio of zinc oxide nanoparticles allow for better interaction with bacteria (18)., So zinc oxide nanoparticle is highly biocompatible and its electron transport kinetics rate is fast and, it's it is suitable to be used as a biological membrane or for other biological applications (19). The nanoparticles have selective toxicity to both Gram-positive and Gram-negative bacteria such as E. coli O157:H7, Salmonella, Listeria monocytogenes, and Staphylococcus aureus and Streptococcus pyogenes, Escherichia coli, Klebsiella aerogenes, Pseudomonas aeruginosa, Proteus mirabilis, Mycobacterium tuberculosis and Bacillus subtilis (figure 1). For reduction and stabilization of nanoparticle, phytochemicals are used. These phytochemicals may contribute to the anti-bacterial activity of nanoparticles by starting a cascade of events like ROS generation, disrupting the bio film formation, cell membrane integrity disruption, enzyme inhibition, protein denaturation, or by accelerating the process (Figure 2) (20, 19).

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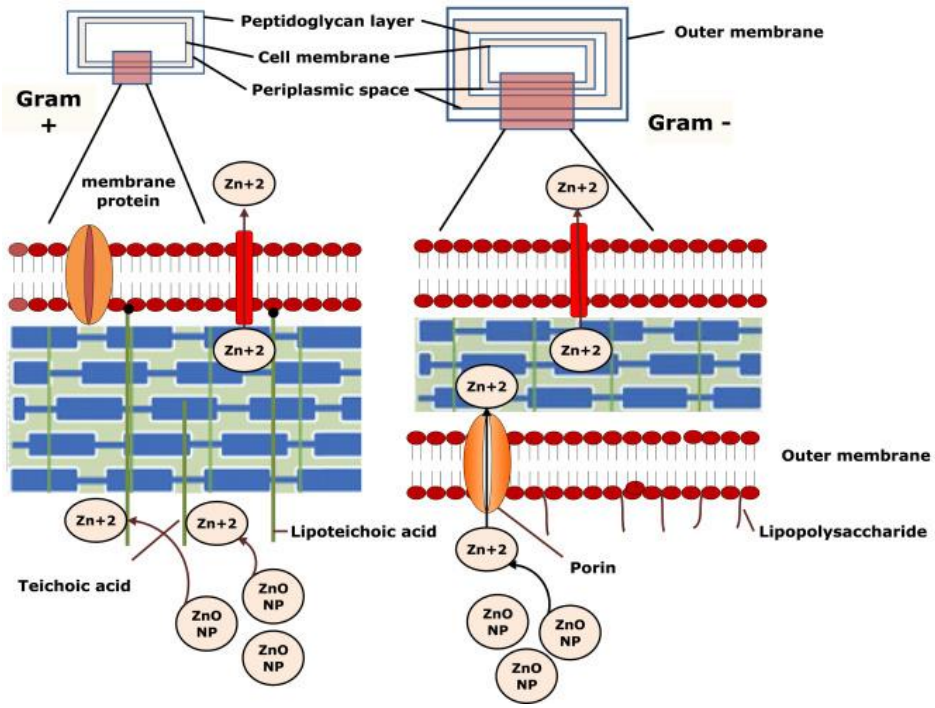

Figure 1. ZnO- NPs interaction with Gram positive and negative cell (19).

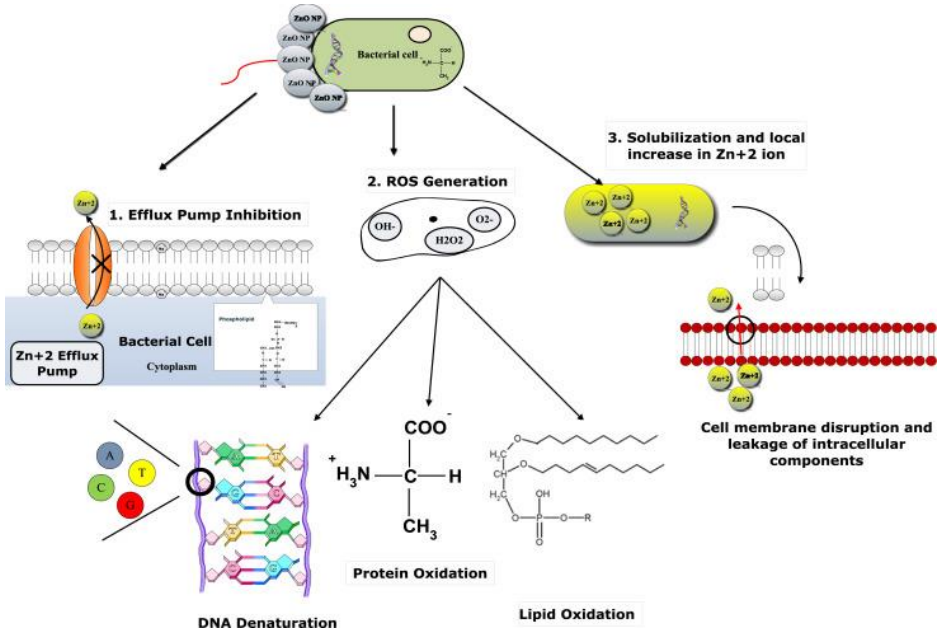

Figure 2. Anti-bacterial mechanisms of ZnO- NPs (19)

Silver, zinc oxide, gold and palladium nanoparticles using extracts obtained from unicellular organisms like bacteria (21,25) and fungi, as well as extracts from plant parts, e.g., geranium leaves, Bay leaf (Laurus nobilis), neem leaves, lemon grass, aloe Vera and several others (22). Green synthesized nanoparticles surround themselves with a large group of organic phytochemicals which helps in ligand-based complexation with various receptors like proteins, lipid, phospholipid, lipoteichoic acid at the microbial surface.

This complexation of nanoparticle with bacteria prevents biofilm formation and their growth (23).

Nanoparticles synthesized by green route tend to exhibit better anti-bacterial activity than physical or chemical method derived nanoparticles due to the coating of various pharmacologically active biomolecules on their surface which allows multiple ligands based conjugation of nanoparticle with receptors on bacterial membranes.

These biomolecules are mainly organic acids, flavones, aldehyde, ketone, amides, polysaccharides, and quinones and known to have significant therapeutic effect against a wide range of human pathogen (24).

Nanoparticuls obtained from L. nobilis have antibacterial activity against microorganisms. (22) conducted a study. In this study, they obtained the green synthesis of zinc oxide (nanoparticles using the aqueous leaf extract of Laurus nobilis (Ln-ZnO NPs) by co-precipitation method. They found that the antibacterial activity of Ln-ZnO NPs was greater against Gram positive (Staphylococcus aureus) bacteria than Gram negative (Pseudomonas aeruginosa) bacteria. In addition to this, the light and confocal laser scanning microscopic images gave evidence that Ln-ZnO NPs effectively inhibited the biofilm growth of S. aureus and P. aeruginosa at 75mg mL1.

Conclusion

Mainly essential oil of Laurus nobilis has strong antibacterial activity against Gram negative and Gram positive foodorne pathogens, spoilage bacteria as well as antifungal effects. Use of nanoparticles as an antibacterial agent in current studies with metal nanoparticles like silver, gold, copper, iron and metal oxide nanoparticles like zinc oxide etc, it has not been common. Laurus nobilis origin zinc oxide nanoparticules (Ln-ZnO NPs) have antibacterial activity especially against Gram positive bacteria. Drug made from plants and nanoparticles are alternative approaches to spoilage due to potoogens and microorganisms.

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Ethical issues: All Authors declare, Originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the Authors responsibilities.

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Epidural blood patch for the treatment of post dural puncture headache in pregnant women

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Abstract

Objective: Postdural puncture headache (PDPH) is still a considerable problem and it is one of the most common complications of neuro axial anesthesia. Efficiency of the blood patch performed for the patients who developed postdural headache following spinal and combined spinal-epidural anesthesia carried out in our hospital was retrospectively investigated.

Material and Methods: Postdural puncture headache (PDPH) is one of the complications commonly encountered after epidural anesthesia and analgesia with occurring of dural penetration. In this study, efficiency of the epidural blood patch (EBP) was discussed in the patients with postdural puncture headache who did not give response to medical therapy. A total of 55 patients who developed PDPH following caesarean section performed under spinal and combined spinal-epidural anesthesia between January 2009 and January 2014 in Erzincan State Hospital and Erzincan Mengücek Gazi Training and Research Hospital was included in the study.

Results: Among the 1,110 undergone spinal and 1,749 combined regional anesthesia patient, 55 patients have been developed PDHA and 34 patients who did not give response to medical therapy who applied epidural blood patch.

Conclusions: In the cases of PDPHs which don't give response to medical therapy within 24 hours, EBP should be administered, considering not only the mothers, but also the infants.

Key words: Postdural puncture headache, epidural blood patch, caesarean section

Introduction

Risk of post dural pain headache (PDPH) is present in all the patients undergone dural puncture (1). The most important disadvantage for dural tears development for the patients is postdural puncture headache that may commonly develop (2).

The International Headache Society (IHS) has defined a PDPH as a bilateral headache that develops within 7 days after lumbar puncture and disappears within 14 days after the lumbar puncture (1).

PDPH is a crucial condition which develops due to a reduction in cerebrospinal fluid (CSF) pressure resulted from the loss of CSF through leakage from the hole opened by the used needle in the dura membrane (3).

A sudden reduction in cerebrospinal fluid (CSF) lead to stress in the pain sensitive structures such as dura mater, cerebral arteries and venous sinuses, resulting headache to clinically emerge (4, 5).

Today cesarean section attempts are mostly performed under epidural or spinal anesthesia (6,).

Frequently use of regional anesthesia in cesarean attempts increases risk of PDPH; Postpoperative pain management is important not only for mother but also for infant because of the breast milk.

Objective of the present study is to share our experiments about epidural blood patch which is used as a therapy method in PDPH patients following cesarean section attempts.

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Materials and Methods

This retrospective study was approved by Erzincan University Medical Faculty Ethics Committee. A total of 2,859 patients administered central block and operated in Erzincan State Hospital and Erzincan Mengücek Gazi Training and Research Hospital between January 2009 and January 2014 were included in the study. Patients who developed PDPH after the applied central block were advised bed-rest, oral or IV (intravenous) fluid therapy and caffeinated analgesics for 24 hours. Thirty-four patients who did not give response to conservative medical treatment and have a Visual Analogue Scale (VAS) of 4 or higher were administered epidural blood patch. Sixteen of the patients who receive EBP had been administered spinal and 18 combined regional anesthesia. EBP was carried out in the hospital to all the patients. Patients were taken to the operating room and monitored, while the vascular access was achieved with a 18 G branule from the antecubital region and 500 ml of crystalloid fluid was given. After the patients were given a sitting position, skin was sterilized with povidone iodine. Following local anesthesia, operation was introduced with a 18 G Tuohy end epidural needle entered from a lower level of previous regional anesthesia region using loss of resistance with saline. After the loss of resistance was felt and epidural space was observed; antecubital region of the patient was cleaned under sterile conditions with povidone iodine solution. Autologous blood was drawn and 20 ml of it was given into epidural space.

Success of the EBP implementation was measured as complete relieve (resolving of all the symptoms), partial relieve (ability to clinically fulfill daily activities) or failure (persistence of the severe symptoms).

Results

Of the 2,859 cesarean section with 1,110 undergone spinal and 1,749 combined regional anethesia, 55 patients developed PDHA. EBP was administered in 34 patients who did not give response to the conservative medical therapy and in PDPH was not resolved. While 27 G pencil-pointspinal needle was used in all 18 patients undergone combined regional anesthesia, 25 G Quincke needle was used in 16 patients undergone spinal anesthesia (Table 1).

In addition to the post-dural headache, nausea and vomiting were seen in 2 patients and, dizziness and neck pain in 3 patients, while no any additional symptoms were seen in 11 patients (Table 2). Complaints of PDPH were resolved in 34 patients within minutes after the first EBP administration. However, a second injection was carried out in one patient after the 24 hours of EBP due to the recurrent complaints despite the resolve of the complaints following the first operation. The complaints were resolved within minutes in this patient following the second EBP administration. No complication was observed in these patients. Patients who underwent EBP were monitored for an additional 2-3 hours and discharged since there was not seen any problem.

Table 1: PDPH and Epidural Blood Patch applied patient statistics

	Epidural Blood Patch (n:34)	PDPH (n:55)
Combined Spinal-Epidural Anesthesia	18	24
Spinal Anesthesia	16	31
27 G pencil-point	18	24
25 G Quincke	16	31

Table 2: Sypmtoms for Epidural Blood Patch

Symptoms	Epidural Blood Patch (n:34)
No	11
Nausea	5
Vomiting	2
Dizziness	4
Backache	2
Tinnitus	1
Neck-shoulder pain	14

Discussion

PDPH is an important complication disturbing the patients which is accepted to develop due to a reduction in cerebrospinal fluid CSF pressure resulted from the loss of CSF through leakage from the hole opened by the used needle in the dura membrane. The most important factors in its occurrence are accepted to be multiple interventions and the type and thickness of the used needle (5). In this study, 55 of 2,859 cesarean section patients undergone spinal-epidural anesthesia developed postdural headache, while 34 of them were administered EBP since they did not give response to conservative medical therapy. The blood given to epidural region was demonstrated to diffuse toward 6 segment cephal and 3 segment caudal (7). It is reported that success rate of EBP is related to the proximity of the dural puncture, and therefore EBP is suggested to be performed to be carried out from a high, same or a low-level (8). In this study, we performed EBP from one level lower of a regional administration level of EBP. In a study, success rate of EPD was reported as 85% after the first and 98% after the second epidural blood patch administered (9). In our study, second EBP was applied after 24 hours in only one patient since PDPH did not resolve. It was suggested in the literature that epidural blood patch should be applied after 24 hours of the dural punction (10). Loesner et al. (11) reported that EBP performed within the first 24 hours of the dural puncture resulted in failure by 71%, while EBP performed after 24 hours of the puncture resulted in failure only by 4%. In a study by Van Kooten F et al. (12) the authors reported that EBP was superior to the conservative medical therapy in the treatment of PDPH. In our study, EBP was administered after 24 hours of conservative medical therapy and only 2% of EBP administration was observed to be failed. There is still no complete certainty about when to apply EBP postoperatively. There are studies proposing the use of EBP within 3-4 days of unresponsive period to the conservative medical treatment (13).

In our study, EBP was found to be superior to the conservative medical therapy since the success rate of medical therapy was found as 38% with the conservative medical therapy and 97% with the first performed EBP. There is no any consensus on the most suitable blood volume advised for EBP. There is a wide range between 2 and 20 ml of volume suggested in the literature (14-15). Jung et al. (16), suggested use of 12-40 ml in the lumbar region, 11-20 ml for the thoracic region and 6-13 ml in the cervico-thoracic junction. Whereas we injected an autologous blood of 20 ml in our patients when EBP was administered and did not encounter with a symptom of back or leg pain. In our study besides headache, complaints were stated such as nausea, vomiting, neck-shoulder pain and tinnitus. Neck-shoulder pain was the most common complaints among the complaints followed by nausea. These complaints were reported as the symptoms to be seen together with PDPH (7-17). Incidence of PDPH differs according to the type and size to the needle between 0% and 37% (18). In this study incidence of PDPH was found as 1.9%. In the literature, there are numerous studies, indicating that pencil-point and small diameter needles decrease the incidence of PDPH (19-20). In a study by Westbrook et al. (21) less CSF loss was shown with pencil-point needles and this was related to the design of the needles. In a study (Ready et al (22)) which conducted with pencil-pointed and sharp-pointed needles which have equal external diameters, less loss of CSF was found using pencil-point needles and needle design has been found to have important effect in headache. In their study with Quincke (sharp-point) and Whitcare (pencil- point) 27 gauge needles, Santanen et al. found the incidence of headache as 2.7% in the Quincke group (23). In our study, incidence of PDPH was found as 1.3% with 27 G pencil-point needles, while this rate was 2.7% in the patients in whom 25 G Quincke needles were used. Consistently with the literature, incidence of PDPH was found to be lower in thepencil-point needle used patients.

In conclusion; development of PDPH following the administered anesthesia is a distressing condition for patients. Postoperative pain management is a crucial condition not only for mothers, but also for infants since it increases morbidity and negatively affect the breast feed of mother in obstetrics. Although there is no certainty about when to use EBP following the PDPH, thinking about the baby's health, EBP should immediately be applied after 24 hours to the patients who do not respond to the conservative treatment after caesarean procedure. We believe that further controlled studies are needed in order to use this method more safely and more frequently.

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Ethical issues: All Authors declare, Originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the Authors responsibilities. The study was conducted under defined rules by the Local Ethics Commission guidelines and audits.

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The effect of gel foam mattress use during total hip replacement surgeries on the development of pressure ulcers in the recovery unit: a quasi-experimental study

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Abstract

Objective: This study was conducted on patients undergoing total hip replacements in order to examine the effect of the use of a gel foam mattress during surgery on preventing the development of pressure ulcers.

Material and Method: A quasi-experimental design, with a pretest-posttest control group, was used for this study, which was carried out in the Orthopedics and Traumatology Clinic of the Adnan Menderes University Research and Treatment Hospital between July 2015 with 80 patients who were to undergo total hip replacement surgery (40 in the experimental group and 40 in the control group who were to undergo total hip replacement surgery and April 2016.

Results: According to the research results, 30% of the patients in the experimental group and 60% of the patients in the experimental group developed pressure ulcers in the recovery unit (p=0.013). It was further observed, according to the results of Braden Pressure Ulcer Risk Assessment Scale (BPURAS), that the type of pressure ulcers in the patients who developed them was stage 1 and located in the gluteal region.

Conclusion: Our results have been shown that the development of pressure ulcers in patients from both the experimental group and the control group in the recovery unit was related to age, operating time (min), anesthesia type, while height, weight, gender, diagnosis, temperature of operating theater. However, movement restrictions before surgery have not an impact on the development of pressure ulcers.

Keywords: pressure ulcer, total hip replacement, nursing care

Introduction

Total hip arthroplasty is a major surgery that is performed as a result of pain caused by avascular necrosis, ankylosing spondylitis, and proximal femoral fractures. During this operation, the risk of pressure ulcers developing is high due to the long period of time patients remain on the operating table (1). For patients who are at risk of developing pressure ulcers, the American Nurses Association recommends the use of a support surface that provides a balanced distribution of body weight on the operating table during surgery (2, 3, 4). As the use of gel positioners is one of the methods that can be used to prevent this risk, it is important to conduct research on the effectiveness of gel positioners in preventing the risk of pressure ulcers from developing after lengthy surgical procedures, such as total hip arthroplasties.

The Minnesota Hospital Association (2013) recommends that evaluations on the development of pressure ulcers in the operating theater be conducted by focusing on the following factors: operations that last longer than two hours (such as cardiac, vascular, trauma and transplantation surgeries), patients who have a body mass index of less than 19 or greater than 40, patients who are confined to bed or wheelchair or otherwise unable to change position, patients who previously experienced pressure ulcers, and patients who develop a skin rash.

The development of pressure ulcers in the operating theater is often caused by improper positioning, incomplete support, insufficient protection, the wrong use of positioning tools, or prolonged bodily pressure placed on patients when they are on the operating table for a long time (5).

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The incidence of pressure ulcers in patients who have had surgery varies between 4 and 38% (6, 7). According to research in Turkey, the frequency of pressure ulcers developing in patients who have had surgery is 54.8%, while the overall rate of pressure ulcers is 7.8% (8). The occurrence of pressure ulcers in hospital may cause prolonged hospitalization and patient care and higher treatment and care costs, and lead to increased mortality (8, 9, 10, 11).

There are various studies in the literature on the use of gel positioners during major operations. It has been shown that using gel positioners is more effective than using other support surfaces (12, 13, 14). However, further research is still needed on the use of gel foam mattresses and other support surfaces used to prevent the development of pressure ulcers from occurring after undergoing surgical procedures in operating theaters. The aim of this research was thus to investigate the effect of gel mattresses during total hip replacement surgery on the prevention of pressure ulcer development.

Materials and Methods

This study was conducted using a quasi-experimental design and included a pretest-posttest control group. The research was carried out on patients undergoing total hip replacement surgery by an orthopedic surgeon in the Orthopedic Trauma Operating Room of the Orthopedics and Traumatology Clinic of the Adnan Menderes University Research and Treatment Hospital in Aydın, Turkey between July 2015 and April 2016.

Participants

The study sample included a total of 80 patients, 40 of whom were placed in the experimental group and 40 in the control group. This study sample was derived from a patient population of 112, which included those who were older than 45 and who had a body mass index of between 18 and 40. It was originally determined that 45 patients, whose operations had already been scheduled, would be placed in the control group and 67 in the experimental group (Figure 1). Informed consent forms to participate in the study were obtained from all patients constituting the population. To determine the sample for the study, the minimum number of individuals to investigate was calculated using the G-Power program, based on the criteria specified by Defloor et al. (2000). The following results were obtained: domain size=0.637, margin of error (α)= 0.05, and power (1-β) = 0.80. Owing to the fact that this research was a master thesis and that gel positioners were purchased at a late date, the control group's data were collected some time before the experimental group's, and the groups were not able to be randomized.

Data Collection Tools

For the total hip replacement operations performed on the experimental group patients, gel positioners (183x51 cm in size) were placed onto a standard operating table. The American brand, ACTION gel positioners, which have optimal sensibility and are designed to reduce friction, were used. The gel positioner features a base supported with gel layers and filled with viscous foam, and it has concave corners and sides.

Standard operating tables without gel positioners were used for the control group patients. The standard operating table features a polyurethane molded cushion atop a stable, compact bed.

Research data were collected using the Braden Pressure Ulcer Risk Assessment Scale (BPURAS) and the Pressure Areas Risk Assessment Form (PARAF). Age, gender, height before surgery, weight, diagnosis, duration of hospitalization before surgery, nutrition and mobility before surgery, period of not eating before surgery, fecal or urinary incontinence, dehydration or edema, laboratory tests, and medication taken for chronic diseases were determined by a question form prepared by the researchers after examining the literature(15, 16, 17, 18).

The BPURAS has six sub-dimensions: detection of stimulus, humidity, activity, motion, nutrition, and friction and irritation. The sum of the sub-dimension scores is the total score, which ranges between 6 and 23. A total score of 12 points or below is evaluated as high-risk, 13-14 points as moderate risk, and 15-16 points as low-risk. In people older than 75, a score of have 15-18 indicates to low risk (19).

Body pressure areas in the lateral, supine, and sitting positions were identified with PARAF. Assessments of pressure areas according to body position were made and then marked on the form (20).

To confirm content coverage and face validity of the questionnaire, expert opinions of 8 faculty members working in the field of Surgical Nursing were taken, and the structure of the questionnaire was rearranged in line with their suggestions. In addition, to improve the intelligibility and applicability of the questionnaire, a pilot study of the questionnaire was conducted with 10 patients who had total hip prosthesis to identify questions that were difficult to understand. Based on the results of this pilot study, the questions identified to be confusing were edited to improve their comprehension. The PARAF form was filled out through face-to-face interviews conducted with the participants.

Study Design and Data Collection Procedures

The research had to begin with the selection of patients for the control group, as there was an unexpected delay in the purchase of gel mattresses. This delay prevented randomized selection of experimental and control group patients.

For the operations performed on the experimental group patients, gel positioners were placed on standard operating tables for the entire duration of the surgery. Once the operation was completed, the patients were transferred to a recovery unit, where they were placed in a supine position. The body areas – according to the location (right-left lateral) of the area operated on – touching the operating table were then examined for pressure ulcers by observation and palpation. In cases of any signs of pressure ulcers in the pressure areas, the areas where these signs were seen were marked on the PARAF. If any pressure

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ulcers had in fact developed, where and what stage they were at were indicated on both the BPURAS and the PARAF (19).

Body pressure areas in the lateral, supine and sitting positions were identified with PARAF. Assessments of pressure areas according to body position were made and marked on the form (20).

Ethical Considerations

Permission to conduct the research was obtained from the Aydın Adnan Menderes University Research and Treatment Hospital in August 2015. The research protocol was approved by the Ethics Committee for Clinical Research and Counseling of the Adnan Menderes University Medical Faculty. Prior to the study, information about the study, including the freedom to withdraw from the study at any time, was given to all participating patients, and their verbal and written consent to participate in the study was received.

Statistical Analyses

Research data were analyzed via the SPSS (Statistical Package for Social Sciences) program for Windows 18 SPSS (Inc., Chicago, IL, USA). Descriptive statistics, the Mann Whitney U test, Chi Square test, Kruskal-Wallis test, and Wilcoxon test were used to evaluate the research data. Normal distribution of variables was tested with the Kolmogorov-Smirnov test. The significance level of the results was set at the $p<0.05$ level, with a 95% confidence interval. The dependent variables of the research were the recovery unit and the development of pressure ulcers after surgery, while the independent variable was the gel positioner (15, 16, 17, 18) .

Strengths and Limitations

The fact that only volunteer patients were involved in the study and that the research was conducted at only one hospital, within a specific period of time, were the primary limitations of this study. Secondly, as another limitation, data were restricted to being collected within the period of time set for the master's thesis.

Lastly, some of the experimental patients in the study were hesitant to participate, as they expressed concern over the cost of using gel positioners and were worried that the gel foam mattress could be harmful for them.

Results

The socio-demographic and surgical characteristics of the patients in the study are given in Tables 1 and 2, respectively. Patients in the experimental and control groups were determined to have similar characteristics.

In 30% of the patients in the experimental group and in 60% of the patients in the control group, pressure ulcers developed in the recovery unit. Patients in the experimental and control groups who developed pressure ulcers had Stage I pressure ulcers in the gluteal region (Table 3).

According to the results of the study, there was a significant difference in the BPURAS mean scores of all subdimensions in the preoperative and postoperative periods. More specifically, the mean postoperative BPURAS scores were observed to have decreased for both the control and experimental groups (Table 4).

When the results were examined, a statistically significant difference was found in the average ages of patients who had developed and those who had not developed pressure ulcers ($p=0.002$). The average age of the patients who developed pressure ulcers in the recovery unit was higher than that of the patients who did not develop pressure ulcers (Table 5).

Furthermore, the results of the study showed that there was a statistically significant difference in pressure ulcer development based on operating time, type of anesthesia, and presence or absence of a rash ($p=0.026$). Patients with a longer operating time were determined to have a higher rate of developing pressure ulcers. Patients who received epidural anesthesia were observed to have developed pressure ulcers 58.3% more of the time in the recovery unit. Other categorical variables used in the study were not found to be statistically significant ($p>0.05$) (Table 5).

Table 1. Descriptive Characteristics of Patients in the Control and Experimental Groups

Characteristics	Experimental (n=40)	Control (n=40)	p
Age/Range	65.5/48.75-69	62/49.25-68.75	-0.535/0.593
BMI(Body Mass Index), n (%)			
18.5-24.9 kg/m^2	5 (12.5)	12 (30)	3.660/0.160
25-29.9 kg/m^2	25 (62.5)	20 (50)	
30-39.9.kg/m^2	10 (25)	8 (20)	
***Gender, n* (%)**			
Female	18 (45)	21 (52.5)	
Male	22 (55)	19 (47.5)	0.655
Have Chronic Disease, n (%)	11 (27.5)	7 (17.5)	0.645/0.422
Have Anemia, n (%)	11 (27.5)	7 (17.5)	0.000/1.000
Smoking Cigarettes, n (%)	1(2.5)	5(12.5)	0.3230.201

Table 2. Characteristics of Control and Experimental Group Patients in Surgical Period

Characteristics	Experimental (n=40) X±SD	Experimental (n=40) Range	Control (n=40) X±SD	Control (n=40) Range	p
Preoperative Hospitalization Duration (days)	1	1-2	1	1-7	-2.037/**0.042**
Operating Time (min)	150	140-170	170	150-189	-2.895/**0.004**
Average Temperature of Operating Theater (°C)	19.2	18.6-19.75	19.3	18.4-19.8	-0.270/0.787
Operating Humidity (%)	65	65-75.5	67.5	65-71.5	-0.991/0.322
Type of Anesthesia					
Spinal, n (%)	14(35)		5(12.5)		
Epidural and Spinal, n (%)	24(60)		27(67.5)		**0.018**
General	2(5)		8(20)		

Table 3. Diagnosis of Pressure Ulcer in Post-Operative Recovery Unit

Diagnosis of Pressure Ulcer in Post-Operative Recovery Unit	Experimental (n=40)	Control (n=40)	p
Positive, n (%)	12 (30)	24 (60)	6.111/ 0.013
Negative, n (%)	28 (70)	16 (40)	

Table 4. Comparison of BPURAS Scores Obtained by Patients in the Experimental and Control Groups in Pre-Operative and Post-Operative Periods

	BPURAS Preoperative Mean Score (X±SS)	BPURAS Postoperative Mean Scores (X±SS)	p
Control Group (n=40)	20 ±19.425	18±17.825	-4.573 <**0.001**
Experimental Group (n=40)	20 ± 19.400	18±17.925	-3.807 <**0.001**

Table 5. Relationship between Socio-demographic data and Surgical Period Characteristics of Patients who Developed Pressure Ulcers in the Experimental and Control Groups

Sociodemographic Characteristics		Patients Who Developed Pressure Ulcers in the Recovery Unit (n=36)	p
Average Age, n (range)		67 (59.25-73)	-3.060/**0.002**
Height(cm), n (range)		161.5 (157-170)	-1.367/0.172
Weight(kg), n (range)		73.5 (67-85.75)	-0.504/0.614
Gender			
Female, n (%)		21 (58.3)	1.759/ 0.185
Male, n (%)		15 (41.7)	
Preoperative Hospitalization Duration (days), n (range)		67.5 (65-75.75)	-0.864/0.387
Operating Time (min), n (range)		170 (150-192.75)	-2.603/**0.009**
Average Temperature of Operating Theater (°C), **n (range)**		19 (18.4-19.6)	-1.358/0.174
Operating Humidity (%), n (range)		67.5 (65-75.75)	-0.864/0.387
Restriction of Movement Before Surgery, n (%)	Positive	18 (50)	
	Negative	18 (50)	0.147/ 0.702
Type of Anesthesia, n (%)	Spinal	6 (16.7)	
	Epidural+Spinal	21 (58.3)	9.866/**0.007**
	General	9 (25)	
Smoking Cigarettes, n (%)		1 (2.8)	0.168/0.215
Have Chronic Disease, n (%)		8 (22.2)	0.000/1.000
Anemia, n(%)		10 (27.8)	4.944/**0.026**
Body Mass Index (BMI), n (%)	18.5-24.9 kg/m^2	12(30)	
	25-29.9 kg/m^2	20(50)	-0.523/ 0.601
	30-39.9 kg/m^2	8(20)	

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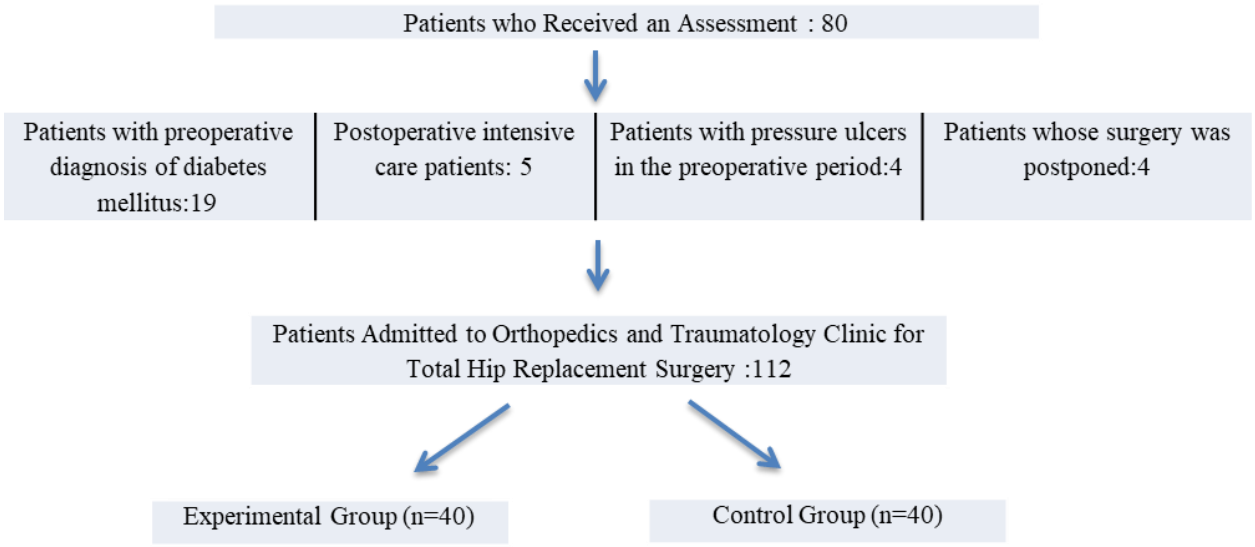

Figure 1. Flow Diagram of the Patients

Discussion

This research, which was conducted to examine the effect that the use of gel foam mattresses has on the development of pressure ulcers during hip replacement surgery, concluded that the use of gel foam mattresses decreases the risk of pressure ulcers after operations. This conclusion is important insofar as it shows that the development of post-surgical pressure ulcers, which extends the period of hospitalization and care required, increases the cost of treatment and care, and also increases mortality, is a problem that can be mitigated through the use of gel positioners.

The factors responsible for increasing the risk of patients developing pressure ulcers following surgery should be examined in detail and precautions should be taken to address them (14, 21).

There are studies in the literature that have focused on the use of gel pads to prevent pressure ulcers in the preoperative and postoperative period (2, 3, -13, 14, 21). However, only a limited number of studies have been conducted on the use of gel positioners during operations and its effect on pressure ulcer development.

According to the study results, a statistically significant relationship exists between patients who developed pressure ulcers in the recovery unit and patients who had anemia (p=0.026). Among the patients who contracted a skin rash in the recovery unit, 28% developed anemia. In the results reported by Jerusum et al. (1996) in their study evaluating patients who had cardiac surgery, using BPURAS, anemia and the inability to change position after the surgery were related to the development of pressure ulcers. A similar study by Totur (2006), which also used BPURAS, reported that 100% of the experimental group patients and 20% of the control group patients who developed pressure ulcers had anemia (22, 23).

When the relationship between the factor of operating time and incidences of pressure ulcers for patients in the control and experimental groups was analyzed, it was observed that the average operating time for patients with pressure ulcers was 170 (150-192.75) min, while the average operating time for patients who did not develop pressure ulcers was 150 (140-170) min (Table 5). In the study conducted by Hoshowsky and Schramm (1994), it was reported that patients whose surgical operation duration was between 150-240 min developed tissue damage. Schultz et al. (2005), in their study on patients undergoing surgical procedures, the prevalence of pressure ulcers was determined to be 26.6%. Furthermore, Chalian and Kagan (2001) indicated in their study, which involved 39 patients who were separated into an experimental and control group, that the patients who developed pressure ulcers had longer operating times; the study by Schoonhoven et al. (2002) involving patients who were undergoing surgery indicated that as operating time extended, the risk of developing pressure ulcers increased; and finally, Karadağ and Gümüşkaya (2005) reported in their study that patients with an operating time of 180 min or longer had a higher risk of developing pressure ulcers than that of patients with an operating time of between 120-180 min (7, 24, 25, 26, 27). From these results, including those found in the present study, it can be concluded that as operating time extends, the risk of developing pressure ulcers becomes greater, owing to the prolonged period of time patients are unable to change their position and the higher amount of time their body parts are exposed to pressure.

The results of the present study found that 60% of the control group patients and 30% of the experimental group patients developed pressure ulcers in the recovery unit. This suggests that the gel positioner-supported operating tables, as compared to standard operating tables, resulted in the reduced number of pressure ulcers seen in the experimental group patients. A number of studies in the literature support

this finding, in suggesting that the use of support surfaces in the operating theater decreases the risk of developing pressure ulcers (28, 29, 30, 31, 32).

Conclusion

The results of the present research showed that pressure ulcers developed less often in the experimental group, and that compared to the standard operating table, the gel positioner-supported operating tables were more effective in decreasing pressure ulcer development. It is recommended that further studies, similar to that of the present, be performed with larger sample groups in order for the results to be generalizable.

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Author's Contributions: Planning the research: **BS, RC;** collecting data: **BS;** analyzing data: Can Türkiş; preparing the research report: **BS, RC**.

Ethical issues: All Authors declare, Originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the Authors responsibilities.

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Pancreaticoduodenal artery aneurysm: Treatment outcomes of a rare disorder

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Abstract

Objective: Pancreaticoduodenal artery aneurysm is a rare vascular disorder that manifests with a clinical presentation ranging from asymptomatic cases to hemorrhagic shock due to aneurysm rupture. In this study, we aimed to evaluate the outcomes of patients treated with different methods for pancreaticoduodenal artery aneurysm.

Material and Methods: A total of 5 patients who were treated and followed for pancreaticoduodenal artery aneurysm between January 2011 and January 2018 were enrolled in the study. Standard endovascular embolization and surgical resection were performed. The demographic findings and treatment outcomes were compared.

Results: All patients were shown to have a pancreaticoduodenal artery aneurysm by radiological methods. The most common complaint was abdominal pain. The mean aneurysm size was 2.8 cm. Two patients had coeliac axis stenosis and occlusion, one had hypertension, one had Marfan syndrome, and one had chronic pancreatitis as the possible etiological cause. One patient with occlusion of the coeliac axis had thrombus, one patient with coeliac axis stenosis had median arcuate ligament compression. Three patients were treated with embolization, one with surgery, and one with low-molecular weight heparin.

Conclusion: Different etiological factors and multiple vascular problems accompanying the disorder create difficulties for establishing a treatment algorithm. Due to the rare nature of the disease, studies available in the literature involve limited numbers of patients, as was also the case in our study. There appeared to be no significant differences between the treatment and follow-up duration among the different treatment methods we applied for our patients.

Key words: pancreaticoduodenal artery aneurysm, endovascular treatment, surgical treatment

Introduction

Pancreaticoduodenal artery (PDA) aneurysm is a rare condition. Its incidence has been reported as 2% of all splanchnic area aneurysms. Pseudo whoaneurysms may occur as a result of trauma, congenital malformations, pancreatitis, collagen tissue disorders, and systemic vasculitis (1). It is considered that all true aneurysms develop from coeliac axis stenosis (2). Seventy percent of these patients have coeliac axis stenosis as a result of median arcuate ligament compression (3). Moreover, stenosis of common hepatic artery may accompany this condition (4). It is considered that PDA aneurysms develop due to increased retrograde blood flow in the pancreaticoduodenal arcuate as a result of coeliac axis or hepatic artery stenosis. Today, with advances in imaging methods, the number of diagnosed PDA aneurysms has seen an increase.

While asymptomatic cases are incidentally diagnosed, the diagnosis may also be made as a result of chronic abdominal pain, chronic intestinal angina, gastrointestinal bleeding, and acute abdomen. In more than half of reported cases there may exist hemorrhagic shock secondary to aneurysm rupture (5). There is no established definitive treatment algorithm and different treatment methods are recommended, including endovascular interventions and surgical procedures.

The rare nature of the disease results in available studies in the literature being in the form of case reports or reports of small patient groups. Therefore, new studies are needed on possible etiological factors and treatment modalities. Our study aimed to compare etiological factors and to assess the outcomes of patients treated with different treatment methods for PDA aneurysms.

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Material and Methods

Five patients who treated for PDA aneurysm between January 2011 and June 2018 were included in the study. This study was approved by Baskent University Institutional Review Board (Project no: KA 18/250) and supported by Baskent University Research Fund. Each patient signed an approved informed consent before the treatment. The retrospective analysis of personal health data of study patients was in accordance with the Declaration of Helsinki. Patients' age, sex, symptoms at diagnosis, size of aneurysm, presence or absence of coeliac axis stenosis and median arcuate ligament compression, type of treatment, and result of the treatments were evaluated. Endovascular treatment was performed via a single-sided femoral approach using a 4F introducer sheath, first with the coeliac axis (where possible), followed by the superior mesenteric artery (SMA). A trapping embolization technique was used (i.e. passage via aneurysm and embolization of the afferent and efferent arteries). A mixture of lipiodol and N-butyl cyanoacrylate was used for embolization (ratio, 1: 1). If this was not feasible, the aneurysm and the afferent artery were occluded with micro coils. Technical success was defined as the absence of any visible aneurysm in the completion angiography.

In patient undergoing surgery, the kocher maneuver was followed by the dissection of the adhesion between the pancreas' uncinate process and the aneurysm. The origin of the SMA was freed proximal to the aneurysm and the origin of the PDA was suspended. The distal part of the aneurysm was freed until the gastroduodenal artery and the aneurysm were isolated (Figure 1). After the aneurysmectomy, the vascular defect was repaired with the "shoemaker" technique using 6/0 polypropylene suture (Figure 2). In order to prevent any future recurrence, a 2.5 cm wide and 5 cm long PTFE graft was wrapped around the PDA (Figure 3).

Statistical analysis was performed using the SPSS version 19 software program (IBM Corp., Armonk, NY, USA). The results were expressed as percentages and mean with minimum and maximum values.

Results

A total of 5 patients with PDA, of which 2 (40%) were male, were evaluated. The mean age of the patients was 58.4 years (range, 16-82 years); the most common complaint was abdominal pain.All patients had a PDA aneurysm demonstrated by a computerized tomography (CT) or conventional angiography. The mean aneurysm size was 2.7 cm (range, 1.8-4.5 cm). The mean duration of symptom onset was 35.6 days (range, 3-114 days). None of the patients had documented systemic vasculitis or coagulation disorder. The 16-year-old patient, who was the youngest, was being treated for Marfan syndrome. One patient was being followed-up for chronic pancreatitis since 2 years. One patient with coeliac axis occlusion had thrombus while 1 patient with coeliac axis stenosis had median arcuate ligament compression. In these patients the common hepatic artery filled via collateral circulation from the branches of SMA.

Possible risk factors for PDA aneurysm in patients were coeliac trunk stenosis due to arcuate ligament compression, coeliac trunk occlusion due to thrombus, hypertension, Marfan syndrome, and chronic pancreatitis.

Patient number one, 55-year-old male with right upper quadrant pain, had a fusiform aneurysm with 4.5 cm width caused by PDA (Figure 4). This patient underwent aneurysmectomy due to coeliac stenosis, collateral filling of the common hepatic artery, and an aneurysm size of 4.5 cm. Patient number two, 74-year-old female patient had 2.2 cm PDA aneurysm which was discovered incidentally during a routine check-up. The patient, refused the recommended interventional treatment techniques, and was therefore prescribed with enoxaparin 40 mg/day for 12 months for embolism prophylaxis. The patient did not suffer aneurysm expansion or any complication during a 2-year follow-up. Patient number three, four and five were treated with embolization. Patient number three, a 16-year-old female patient who was being treated for Marfan syndrome had a 2.5 cm PDA aneurysm. Patient number four, an 84-year-old female being followed-up for chronic pancreatitis, presented at the hospital with sudden abdominal pain and following examination was found to have a 2.4 cm PDA aneurysm. An angiography confirmed the aneurysm had ruptured, and she was treated with endovascular embolization. Patient number five, a 65-year-old man, died due to acute myocardial infarction after the embolization of a 1.8-cm aneurysm. Table 1 summarizes the clinical properties and treatment methods of the study patients.

Discussion

PDA aneurysms are pseudoaneurysms that form as a result of trauma, congenital malformations, pancreatitis, connective tissue disorders, or systemic vasculitis. True aneurysms are rarer and are reported to occur as a result of coeliac axis stenosis (6). The disorder may be asymptomatic, but may also manifest with a clinical presentation ranging from abdominal pain to hemorrhagic shock due to aneurysm rupture. One of our patients was diagnosed while she was in hemorrhagic shock due to PDA aneurysm rupture, while the other patients were diagnosed following chronic abdominal pain. Although sex predilection of the disease is not clear, men are reportedly more commonly affected (7). However, while PDA aneurysm rupture is reported among young, female patients with large aneurysms in Western Europe, it is more commonly reported among elderly men, and those with small aneurysms in Eastern Asia (8,9). Two of our patients were male. Whereas none of our male patients had aneurysm rupture, the only patient with aneurysm rupture was a woman who was treated with embolization.

The exact mechanism of PDA aneurysm development has not been fully explained. It is considered that arterial hypertension and increased blood flow to small vessels result in true aneurysm development (10). In the majority of patients there exists coeliac axis stenosis, and 10-30% of patients have median arcuate ligament compression (11).

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Table 1: Details of the patients treated for pancreaticoduodenal artery aneurysm.

Patient	1	2	3	4	5
Age (y)/Sex	55/M	74/F	16/F	82/F	65/M
Etiology	Coeliac stenosis	Coeliac occlusion	Marfan syndrome	Chronic pancreatitis	Hypertension
Size of aneurysm (cm)	4.5	2.2	2.5	2.4	1.8
MAL compression	Y	N	N	N	N
Coeliac stenosis/occlusion	Y	Y	N	N	N
Hepatic artery circulation	Collateral	Collateral	Coeliac	Coeliac	Coeliac
Treatment	Surgery	LMWH	Embolization	Embolization	Embolization
Follow up (mo)	6	10	10	14	None
Result	Favorable	Favorable	Favorable	Favorable	Exitus

F, female; LMWH, low molecular weight heparin; M, male; MAL: median arcuate ligament

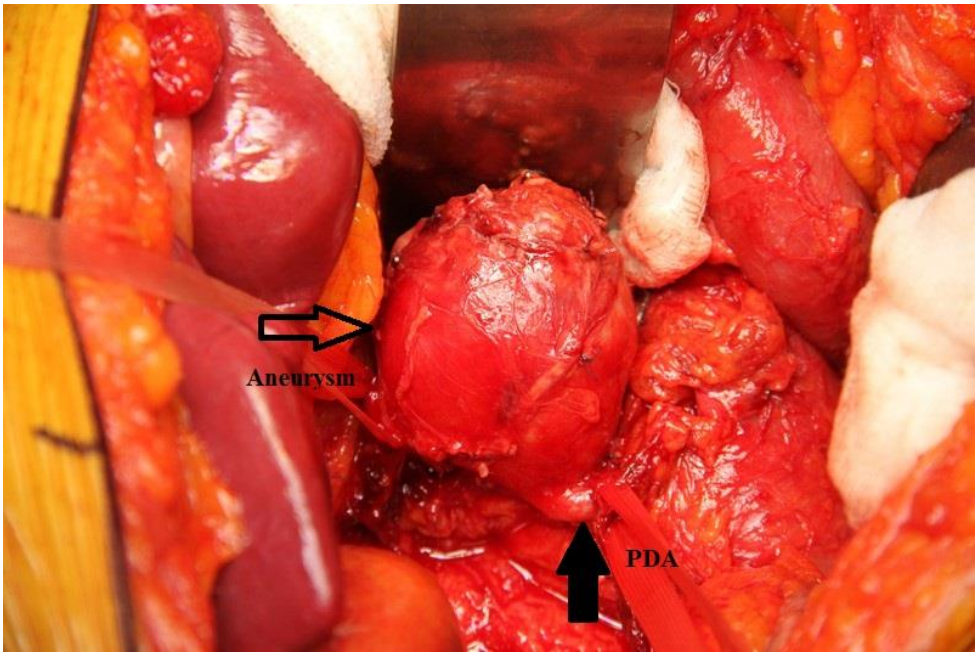

Figure 1: Dissected aneurysm. Black arrow shows the origin of PDA, the hollow arrow shows the aneurysm.

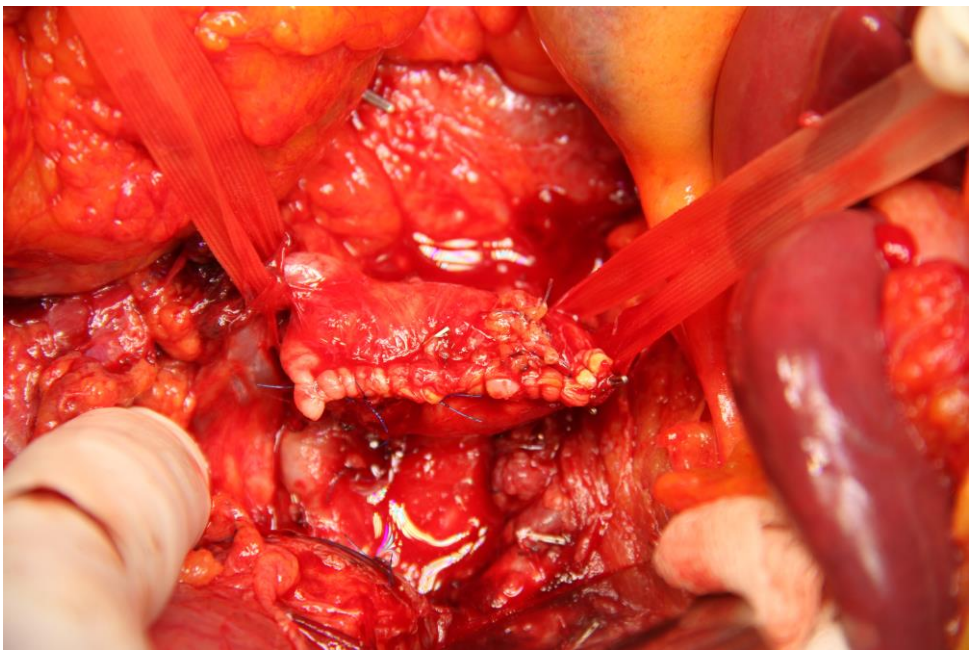

Figure 2: Repaired vascular defect.

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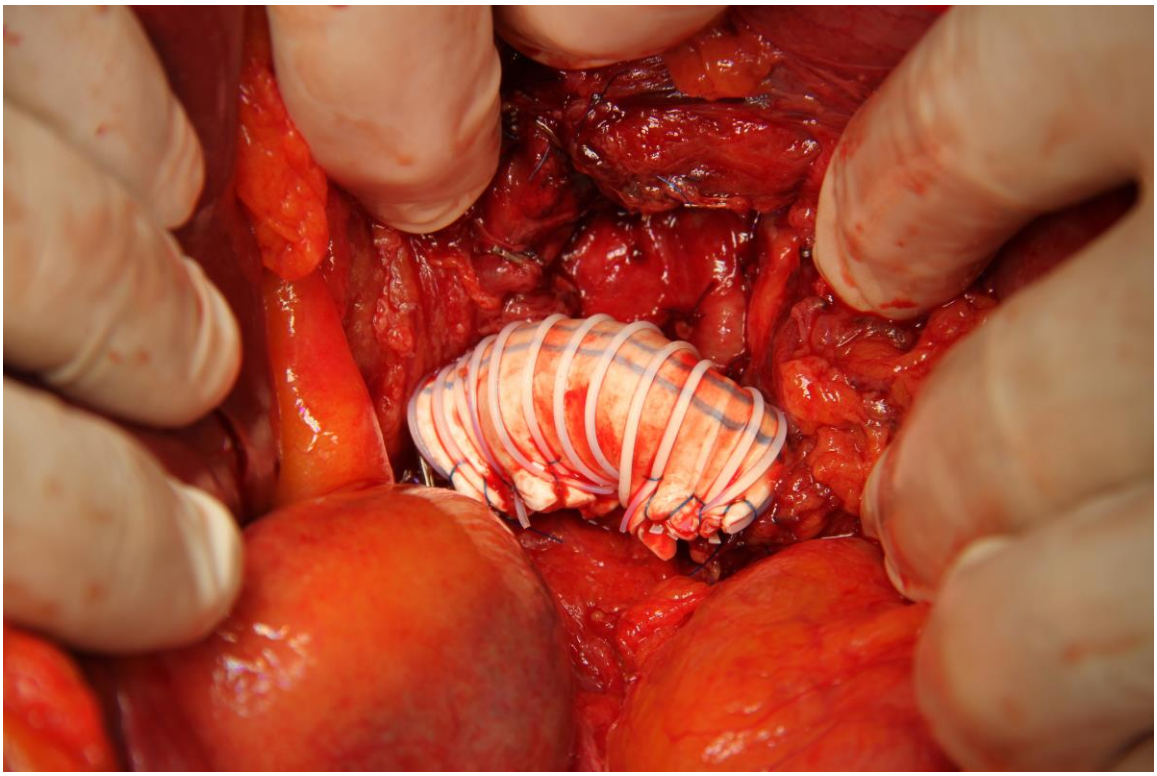

Figure 3: Supporting with PTFE graft.

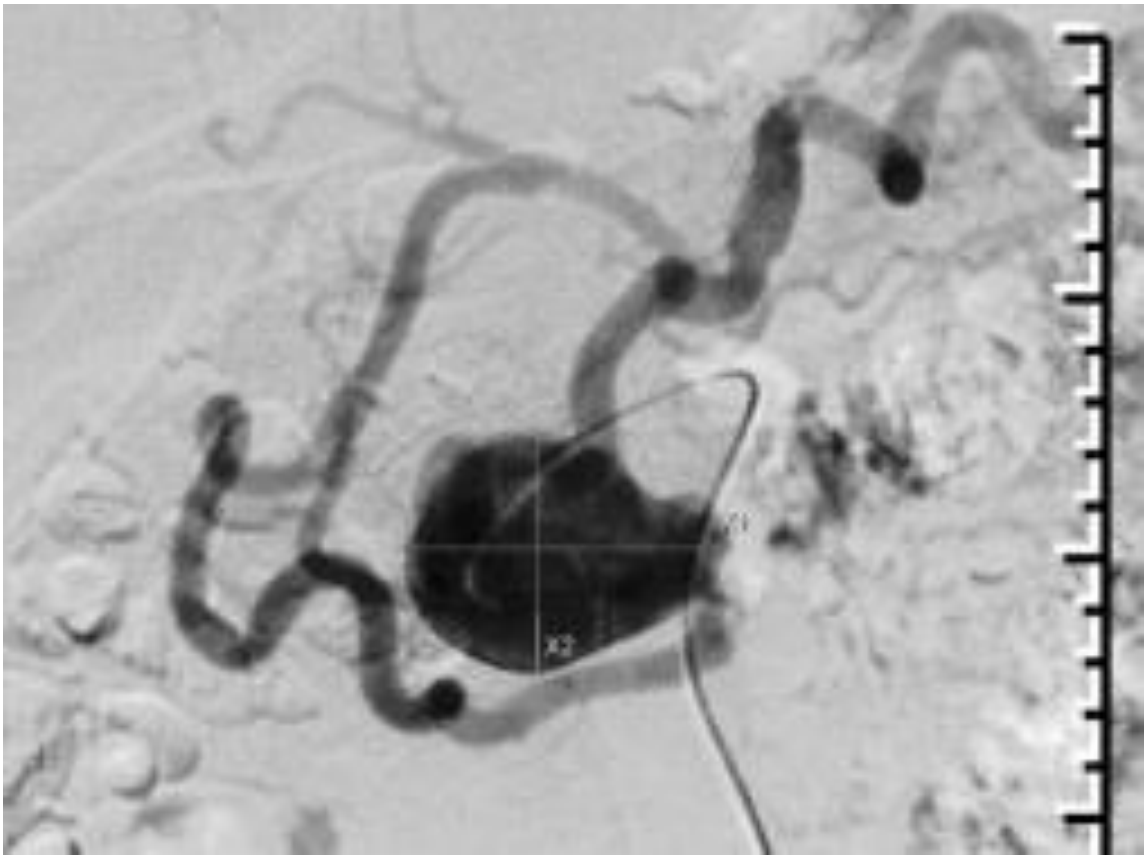

Figure 4: Angiography image of aneurysm

We had 2 patients with coeliac stenosis or occlusion and one of them had median arcuate ligament compression.

Our youngest patient had Marfan syndrome. It is hypothesized that vascular disease in the Marfan syndrome occurs when FBN1 mutations prevent elastic fiber maturation by disrupting microfibrillar array. As a result, increase in inflammation and recurrent pressure creates weak regions in the adventitia layer, which is predisposed to aneurysm development (12). Since it has been demonstrated that PDA aneurysms may develop among patients without median arcuate ligament compression, abnormal coeliac axis flow, or hypertension at the pancreaticoduodenal arch, the pathophysiology of the disease has not been fully explained.

As for the treatment of the disease, trans-arterial embolization (TAE) is reported to confer a lower mortality compared to surgical therapy. The mortality rate among patients with a patent hepatic artery flow that undergo TAE has been reported as 0-2.1% (13). It was shown that PDA aneurysm rupture in patients with an aneurysm size below 10 mm can be safely treated with TAE and that the lipiodol mixture used for embolization is safe (11). One of our patients who had been treated with endovascular technique died due to myocardial infarction after the procedure. Coeliac devascularization is recommended during endovascular treatment of PDA aneurysm in patients with co-existing coeliac stenosis. This has been reported to lead to a reduction of arterial pressure on PDA and to reduce recurrence rates (14). Similar results have been reported for patients that did not undergo coeliac devascularization (15). In our patient group, on the other hand, coeliac devascularization was not applied and no additional problems were seen during follow-up.

Surgical treatment is applied for ruptured or large aneurysms for which endovascular intervention is not feasible. Surgical outcomes depend on surgical expertise and the patient's clinical condition. The mortality rate of surgical treatment has been reported between 13% and 20% (13). Since the aneurysm may be embedded in the deep pancreatic tissue in close to 70% of patients, the morbidity of surgical therapy is high (16). In our patient who was treated surgically, the aneurysm was embedded in the uncinate process of the pancreas. In this patient, surgery involved pancreatic tissue dissection followed by aneurysmectomy and supported with a PTFE graft; he developed no postoperative complications. Preservation of the native arterial tissue and external reinforcement was reported in 1982 by Egloff (17). It is reported that morbidity and mortality rates in this technique are comparable to open graft replacement (18). In addition, it has been argued in the literature that the wrapping technique is safer than conventional treatment methods when performed in suitable patients (19). In our patient, we preferred wrapping technique in order not to create hepatic artery ischemia with collateral filling from PDA. Apart from all these treatment options, conservative management has also been reported to cause no complications, as was the case for our medically-treated patient (14). It is recommended that the treatment method applied should be selected on the basis of the rupture rate of the aneurysm, mortality rate of the applied treatment, and patient age (20).

Conclusion

The rare nature of the disease, different etiological factors, and multiple vascular problems accompanying the disorder creates difficulties for establishing a treatment algorithm. In this study, treatment standardization could not be achieved due to the retrospective design of the study, and each patient having a different clinical presentation. Previous studies in the literature involve small numbers of patients as does our study. We observed no significant differences between our patients treated with different treatment modalities with respect to outcome and follow-up duration. Still, there is a need for prospective multi-center studies for establishing diagnostic and therapeutic algorithms.

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Ethical issues: All Authors declare, Originality and ethical approval of research. Responsibilities of research, responsibilities against local ethics commission are under the Authors responsibilities.

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Types of herniated discs and outcomes of lumbar microsurgical discectomy with extended foraminotomy among young Turkish army personnel

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Abstract

Objective: The present study is conducted to evaluate the findings of lumbar disc disease among the young adults who are under hard physical conditions in military service.

Materials and Methods: Data of 454 lumbar disc hernia patients who underwent microsurgical discectomy have been analyzed retrospectively. Patients' age, predisposing factors, duration of symptoms, levels of disc hernia, intraoperative findings, Visual Analog Scores (VAS), and Oswestry Low Back Pain Disability Questionnaire (ODI) data were reviewed from hospital records.

Results: All patients had severe radiculopathy. The 78% of the patients were smokers. Nevertheless, all recurrent disc patients (100%, n = 14) were heavy smokers. Majority of the patients (n = 424, 95%) had problem in just one vertebral point and the most common affected vertebral section was L4-L5 (n = 287, 59%). Disc herniation was centrolaterally placed in 94% (n = 425) patients. The mean VAS and ODI scores at final follow-up were 1.52 and 13.25 points with a reduction from a mean preoperative 7.08 and 60.45 points, (P < 0.001).

Conclusion: Posterior longitudinal ligaments were intact and mostly centrolateral and subligamentous disc herniation were shown in young adult army personals. The comparable effect of smoking on microvascular circulation at the operation site may be effective on recurrence.

Key words: Foraminotomy, lumbar disc herniation, microsurgery, young adults

Introduction

There are many potential causes for low back pain and disc hernia in adolescents. Low back pain may reasoned by muscular, ligamentous, infectious or congenital pathologies of the lumbar spinal column (1-3). Sedentary life conditions and minimal sportive activity may cause muscular and ligamentous weakness. Patients with back pain, radicular pain and subsequently with neurological deficit due to nerve root and/or dural sac compression are commonly referred to medical services.

Lumbar disc herniation is mainly problem for adults and elderly people as degenerative changes progress with age. Most patients over fifth decade present with degenerative changes in discs, vertebral end plates, and facet joints. Although lumbar disc hernia is the most common entity of the spinal diseases in the elderly population, this is rare in paediatric ages and young adults (4, 5).

Military personnel are young and motivated groups, whom physical conditions are superior to that of the general public. The presented study was conducted to evaluate the findings of lumbar disc disease among the young and active population who are under hard physical conditions in military service.

Materials and methods

Data of 454 lumbar disc hernia patients who underwent microsurgical discectomy and extended foraminotomy was analyzed retrospectively at the departments of Neurosurgery. Patients' age, predisposing factors (sport activity, smoke, familial predisposition, obesity), duration of symptoms, levels of operated disc hernia, operation findings, Visual Analog Scores (VAS), and Oswestry Low Back Pain Disability Questionnaire (ODI) data were reviewed using hospital records.

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Physical examination, X-ray graphs and magnetic resonance imaging (MRI) were applied to all patients. Patients with accompanying diseases such as spondylolisthesis, congenital malformation, infection and/or inflammation of the spine, and previous surgeries in the past were not included in the study.

Patients were classified into four groups according to the duration of symptoms before admission. Patients in the Group I (duration of symptoms: 0-3 months), Group II (duration of symptoms: 4-6 months), Group III (duration of symptoms: 7-9 months), and Group IV (duration of symptoms: 10-12 months) admitted our department during their military services. All of the patients received conservative treatment according to physical therapists' order prior to surgery. Each individual underwent C-Arm fluoroscopic level control and microsurgical discectomy with extended foraminotomy (6). Patients who were not doing well clinically enough to return to full duty were checked up with MRI or computed tomography scan and/or flexion-extension radiographs.

VAS and ODI scores were recorded from the database of the departments (Standard clinical follow-up protocol: 3rd, 6th, and 12th month follow-up during the first year of postoperative period).

Results

All patients were male, private soldier and their ages varied between 20 and 26 years. The patients had low back pain and severe radicular pain that were resistant to either medication or physiotherapy; 87.6% (n = 398) of the patients had severe disability.

Most of our patient population 80.2% (n = 364) had history of sedentary life conditions before joining to military service. The 19.8% (n = 90) of patients had habit as a regular sport activity (body building and running everyday, playing football and swimming weekly) in their civilian circle. However, all of the patients had severe radicular pain rather than low back pain after sports practice during their military service.

The 78% (n = 354) of patients were smokers and all recurrent disc herniated patients (n = 14) were heavy smokers. The 27.7% (n = 126) of patients had disc hernia history in their families. None of the patients was obese. The data of the patients is summarized in the Table 1.

Out of 484 operated levels, 59% (n = 287) of levels were L4-L5 and 37% (n = 180) of levels were L5-S1. Limited number of patients had L3–L4 level herniations 3% (n = 14) and L1-L2 level herniations 1% (n = 3). 80% (n = 364) of patients underwent surgery at the admission of first 6 months period (in Group I and II) (Table 2).

Herniated discs were not degenerative (they were observed as soft, hydrated, and rubbery intraoperatively) in 84% (n = 382) and were degenerative in 16% (n = 72) of patients. Disc herniations were contained and subligamentous in 85% (n = 386), and extruded in 15% (n = 68) of patients. It was centrolaterally placed in 94% (n = 425) and centrally placed in 6% (n = 29) of patients.

The patients without complications were satisfied with their outcome. Although the levels evaluated with fluoroscopic level control intraoperatively, two of them were operated for wrong levels but not developed additional neurological deficits postoperatively. There were 15 complications including 14 recurrent disc herniations and 1 discitis. The 14 patients suffered recurrent disc herniation in mean 8.5 (range, 4 – 16) weeks after initial surgery. By disc type, recurrence occurred from the 5.8% (n = 4) of extruded, 2.5% (n = 10) of contained disc herniations. By level, 3 recurrences were at L5–S1 level and 11 at L4–L5 level.

The 2.5% (n = 14) of patients underwent repeated discectomy, and 7% (n = 1) of recurrent disc hernia patients were treated with posterior transpedicular screw fixation due to instability. One of the patients who developed discitis, treated with antibiotic and hyperbaric oxygen therapy according to the protocol was suggested by Kutlay et al. 2.8% (n = 13) of patients with complications returned to full military duty within 6 months (7).

The mean VAS leg pain score at final follow-up was 1.52 points (range, 0 – 5), ($P < 0.001$), with a reduction from a mean preoperative 7.08 points (range, 0 – 10), ($P < 0.001$) (Paired Samples t-test) (Table 3). A decrease greater than 4 points on the VAS was observed in 368 (81%) of the patients. The mean ODI score demonstrated improvement from a mean score of 60.45 (range, 10 – 100), ($P < 0.001$), before surgery to 13.25 (range, 00 – 35), ($P < 0.001$) at final follow-up (Paired Samples t-test) (Table 3). 359 of all patients (79%) had a decrease in ODI score at least 20%. There was a positive significant correlation between patient satisfaction and outcome measures ($P < 0.001$) (Figure 1).

Table 1: Data of 454 young male patient Lumbar Disc Hernis (LDH) sections.

Levels of disc herniation	Uni L. L1-L2	Uni L. L3-L4	Uni L. L4-L5	Uni L. L5-S1	Bi L. L4-L5	Bi L. L5-S1	Ipsi L. L3-L4, L4-L5	Ipsi L. L4-L5, L5-S1	Bi L. L4-L5, L5-S1
Patients number (n = 454)	3	7	242	152	15	5	7	14	9
Mean age (year) (mean: 22.8 years)	23	24.8	22.3	22.77	21.7	23.6	22.5	22.15	22.8
Recurrence (n = 14)			10	2	1				1**
Familial predisposition(n: 126)		3	44	30	12	8	5	16	8
Smoker (n: 354)	1	5	189	119	9	5	5	14	7
Sedentary life (n: 364)*			195	135	12		1	12	9
Sports hobby (n: 90)	1	4	53	17	3	5	5	2	

* Number of the patients is given who had sedentary conditions in civilian circle.

** One patient who had recurrence LDH at the L5-S1 level

L.: Lateral

Table 2: Patient groups depending on the duration of symptoms

Group	I	II	III	IV
Duration of symptoms (months)	0-3	4-6	7-9	10-12
Number of patients	219	145	68	22

Table 3: Overall mean preoperative to postoperative outcome scores and p values of VAS and ODI (VAS: visual analog scores; ODI: Oswestry disability questionnaire index scores; preop: preoperative; postop: postoperative)

patients (n=454)	mean preop score (n=454)	mean postop score (3^{rd}month)	mean postop score (6^{th}month)	mean postop score (12^{th}month)	p value paired t-test
ODI	60,45±4,23 (10-100)	36,13±2,38 (0-90)	26,23 ±2,11 (0-70)	13,25±1,76 (0-35) **(n=359)**	< 0,001
VAS	7,08±1,55 (0-10)	3,87±0,86 (0-7)	2,84 ±0,64 (0-6)	1,52 ±0,32 (0-5) **(n=368)**	< 0,001

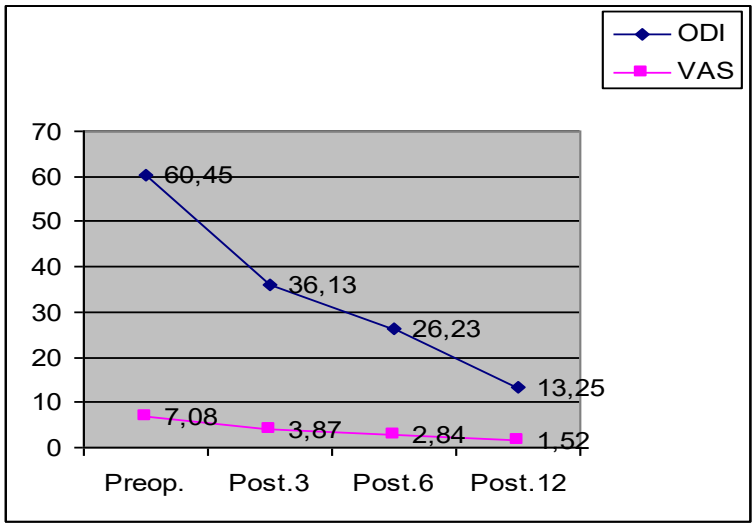

Figure 1: The correlation of VAS and ODI scores of the study group at the clinical follow-up periods. VAS: visual analog scale scores; ODI: Oswestry disability index scores; Preop: preoperative period; Postop.3: postoperative 3rd months; Postop.6: postoperative 6th months; Postop.12: postoperative 12th months.

Discussion

The aim of our current retrospective study was to analyze the symptoms, findings, and clinical outcome of lumbar discectomy in young military personals between ages of 20-26 years. Previous studies have suggested that patient age at the time of surgery is not predictive of outcomes (8). However, we are not aware of any previous large case series focusing on outcomes in a young male population in the military service. To our knowledge, the mean age of 23 years in our study is approximately 15 to 20 years younger than any other large series reported in the literature (9-13).

Varlotta et al. (14) calculated the relative risk of lumbar disc herniation before the age of 21 and found it to be approximately five times greater in patients who have a positive family history. Matsui et al. (15) suggested that there is a familial predisposition and a clustering of lumbar disc herniations among the relatives of 18- year-old or younger patients with lumbar disc herniation. Smorgick et al. (5) reported that there is a familial predisposition (46%) in young patients. In the current study, there is a family history (27.7%, n = 126) between the ages of 21-26. In our opinion, familial history may not be a predisposing factor in young and prospective studies are needed to further evaluations.

Although there is a correlation between smoking and failed back spine surgery, Dewing and Battie reported that there was not any correlation between smoking and less satisfactory outcomes (4, 16-18). In the current study, 78% of the patients were smokers (19). Nevertheless, all recurrent disc patients (100%, n = 14) were heavy smokers. There may be a correlation between recurrence and smoking because of the comparable effect of smoking on microvascular circulation at the operation site (16, 20, 21).

Bradford and Epstein considered trauma as the main etiological factor in the development of adolescent disc herniation that was most often related to lifting or twisting in adults. However, Smorgick et al. (5) suggested that there was not any relationship between trauma on lumbar spine and disc hernia but severe physical stress on the lumbosacral spine related to participation in competitive sports was probably predisposed to disc herniation. In the current study, there was no history of trauma. 19.8% patients had sports practice and 87.6% had sedentary life conditions in their civilian circle.

Moreover, the young patients in our series had a history of mechanical stress to the lumbar spine, specifically because

of intense sports activity that includes heavy lifting, long jumping, height jumping, carrying back packs that can weigh in excess of 80 lbs, and mandatory physical readiness testing in military practice.

The clinical presentation of adolescent disc herniation is varied. The symptoms are subjective and it is difficult to evaluate the adolescent age group. Pronounced back stiffness with or without sciatic scoliosis may evolve. Many adolescents may be undiagnosed for many months because their leg pain may be attributed to minor trauma, muscle sprain, or tight hamstrings. The predominant mechanical signs were low back pain, paravertebral muscle spasm, and severe radicular pain. Lordosis and degenerative changes at the L4-L5 level may be predisposing factors as in the literature. As noted, this range of signs is more specific presentation of lumbar disc herniation (22).

In addition to leg pain, gait abnormalities are also common, presenting signs of adolescent disc herniation. Previous studies (5) have suggested that low back pain associated with leg pain was the main clinical symptom in 77% patients, leg pain in 15%, and back pain without leg pain in 8%. In the current study group, radicular pain was the main complaint of all patients. Increased duration of preoperative symptoms has been independently associated with poor outcomes in previous studies.

Mostly, in the study group, duration of complaints was less than 12 months and postoperative course was uneventful. Conservative treatment (bed rest, appropriate physical therapy, medication, etc.) as the primary treatment modality are recommended for most young patients with lumbar disc disease (22, 23). They had medically intractable or long-term incapacitating persistent back pain, severe radicular pain, and neurological deficits. Conservative treatment was ineffective for our study group because of continuous intense sportive activity in the military service.

Detailed evaluation of the young patients with back pain is very important. Physical examination and plain radiography often do not identify disc herniation but any possible causes of disc disease could be identified (23, 24). However, if there is a history of trauma, computed tomography is also very helpful for diagnosing lumbar fractures or bone anomalies. Whereas computed tomography and plain radiography are valuable for identifying fractures and different bone pathologies, magnetic resonance imaging is still effective diagnosing lumbar disc herniation or lumbosacral nerve root anomalies (25-27). We used magnetic resonance imaging to establish the diagnosis in our series.

All of the patients underwent surgery due to disc herniation with severe radicular pain that were resistant to conservative treatment. The technique of lumbar disc surgery is still controversial. There are different techniques such as laser disc decompression, endoscopic discectomy, fragmentectomy alone, simple discectomy, with or without lumbar dynamic stabilization in several series (4-6, 11, 13). The preferred surgery was microsurgical discectomy with extended foraminotomy in our series (6). Patient satisfaction was good, and the complication rate was comparable (3.3%, n = 15) (4). Our findings reinforce the accepted surgical technique (lumbar microsurgical discectomy with extended foraminotomy) effective and predictable treatment for radicular pain recalcitrant to non-operative management (4).

Ito et. al (28) have suggested that non-contained disc herniations may be successfully treated non-operatively. Contained disc herniations were associated with significantly poorer outcomes than either sequestered or extruded disc types (4, 10). In the current study, contained centrolateral discs were associated with the best outcome scores, significantly better than those associated with extruded disc herniations. In addition to that, early surgery patients (Group I) had poorer outcomes. Majority of the re-operated patients had extruded disc herniation. However, two patients underwent repeated surgery due to wrong operated levels. We evaluated all re-operated levels. We hypothesized that insufficient disc surgery may be accused.

In the current study, we observed the disc as soft, hydrated, and rubbery. Posterior longitudinal ligaments (PLL) were intact and also disc hernia was located subligamentously in young patients. Scapinelli's (29) hypothesis is the meningovertebral ligaments are a barrier to side-to-side migration of extruded lumbar disc herniations. Martinez et al. (30) suggested different type of disc herniations. Annulus breakage, annulus plus PLL breakage are the types of disc herniation. We did not observe any PLL breakage in young recruits. So, in our opinion, there may be two different hypotheses: 1) PLL is flexible and has a strong stretch structure, 2) disc is contained, hydrated and not more degenerative or calcified so, bending forces are not more effective to extrude the intervertebral disc.

Disc herniation level and clinical outcomes were also assessed. Dewing et al. (4) reported that L5-S1 level was the most commonly affected level contrarily to our series. In 95.3% of the cases, only 1 level was affected; the most common level was L4–L5.

There was no significant difference between the outcomes of L4-L5 and L5-S1 levels. The neural foramina for the S1 nerve are larger and less affected by progressive disc degeneration and foraminal narrowing. At level L3-L4 and L4-L5, there will be a narrowing at the disc space after removing the disc. There will be an effective decompression for nerve roots and good postoperative outcome scores after extended foraminotomy (Figure 1). We postulate that the surgical technique as microsurgical discectomy with extended foraminotomy is still effective on different disc levels.

Military personnel are required to maintain weight standards and physical readiness. They must be ready for conflict zone and hard life conditions in the field. Although the clinical presentation of disc herniation is varied, Dewing et al. (4) reported that the patients in military service returned to full duty after microdiscectomy 6 weeks later. We observed the young recruits and stated that they returned to full duty after 6 weeks after microsurgical discectomy with extended foraminotomy. Two of the patients (one discitis patient and one patient who underwent posterior fixation surgery) could not return to full duty.

Conclusion

Smoking can be a predisposing factor in developing recurrent lumbar disc disease. Mostly, centrolateral and subligamentous disc herniation were shown in young recruits. Early surgery has a poorer outcome but, microsurgical discectomy with extended foraminotomy has a high success rate for non-degenerative disc herniation, to maintain good outcome scores and patient satisfactions for young active patients.

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