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A study of the clinical, ultrasonographic, and bacteriological characteristics of abscesses in farm animals

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ABSTRACT

Abscess is considered one of the most common surgical body surface swellings in farm animals. The recognition of the clinical, ultrasonographic and biochemical characters of abscesses is important in the management and control of this devastating swelling. One hundred twenty-two animals were selected out of two hundred and five animals presented abscesses in different body regions. The clinical and ultrasonographic examinations were carried out to verify the abscess development. The swabs and pus samples for bacteriological study were obtained before the surgical treatment once the abscess maturation was ascertained. The animals were normal clinically and there were no changes in the physiological parameters. The cattle represented the high percentage in abscess development (73.77%). The gluteal, umbilical and the subconjunctival regions were the common seats for abscess development. The size of abscesses varied from small orange to volleyball. In more than 90% of cases, the abscess was developed as a single lesion. The ultrasonographic examination showed that a well-demarcated echogenic wall for all abscesses, but its contents varied in echogenicity and homogeneity according to the type of abscess (acute or chronic) and its seat. Biochemically, a total two-hundred and ninety-two isolates were obtained which included eighteen single isolates and two-hundred and seventy-four mixed isolates. They included *Corynebacterium* and *E. coli* (n=40), *S. aureus* (n=38), *S. epidermidis* (n=36), *Proteus* (n=30), *St. pyogenes* (n=28), *Neisseria* (n=20), *Bacillus subtilis* (n=14), *Bacillus cereus* (n=12), *Alcaligenes faecalis* (n=12), *Enterobacter aerogenes* (n=10), *Enterobacter aerogenes* (n=6) and *Klebsiella pneumoniae* (n=6). It could be concluded that there are multiple different species of microorganisms could cause abscess formation in farm animals, and there is no specific microorganism could be expected to be isolated from the abscess. Additionally, multiple different species of organisms could be isolated from the same abscess.

Introduction

Skin is the first line of immune defense, and the skin infections are common clinical issues in farm animals. Weakness and injuries of this defense line may lead to development of several surgical affections (Mala *et al*., 2021). Abscess is considered one of the most common surgical affections that is developed in farm animal in the developing countries due to the bad management and low hygienic scheme. Despite the abscess is seemed to be a minor surgical problem, it caused a lot of detrimental effects (Paton *et al*., 1994; Williamson, 2001; Alharbi and Mahmoud, 2012).

The abscess is a collection of pus in the tissue after its destruction (Fesseha and Getachew, 2020). It is mainly caused due to a breach and injury in the surface of the skin or mucous membrane which facilitates the entrance of pyogenic organisms through it or it may be associated with many infectious diseases such as actinobacillosis, actinomycosis and pseudotuberculosis (Alharbi and Mahmoud, 2012; Abouelnasr *et al*., 2016; Fubini and Ducharme, 2017). In large ruminants, the foreign bodies migrate from the lumen of the digestive tract inducing subcutaneous abscesses at different regions. Non-sterilized needles that used for intramuscular injection are considered an important cause beyond the formation of abscesses. Punctured or penetrating wound induced by sharp objects are important causes (Fubini and Ducharme, 2017; Hinchcliff *et al*., 2017). Other routes either through the blood or lymph, which play a non-neglected role in producing and formation of abscesses in animals (Alharbi and Mahmoud, 2012).

Gram positive bacteria such as *Corynebacterium* sp., *S. aureus* and *Streptococcus pyogenes* and Gram-negative organisms such as *Pseudomonas aeruginosa*, *Proteus* and Klebsiella were encountered for causing cutaneous infection (Katarina *et al*., 2001; Al-Tuffyli and Shekhan, 2012; Safia *et al*., 2021). Colonization of *S. aureus* in animal skin is a precursor for majority of bacterial skin infections, which range from boils to sepsis, especially in cattle, goats, and sheep (Mala *et al*., 2021).

The recognition of the characters of the pyogenic bacteria causing abscess formation may facilitate taking the hygienic measures against these microorganisms. As well as the management, treatment and prognosis will be determined specifically and accurately. The main aim of this study was to investigate the clinical, ultrasonographic picture and bacteriological identification of the different bacteria causing the abscess formation in farm animals.

Materials and methods

Ethical approval

This study was carried out under the regulations of the Department of Animal Medicine and Department of Surgery, Faculty of Veterinary Medicine, Assiut University, Egypt, according to The OIE standards for use of animals in research under the No. 06/2024/0164. As the surgical procedure performed on animals was simple, minor, and noninvasive, owners have consented to have pictures taken of their animals, including abscesses, and to have a swab obtained for bacteriological testing. The surgical treatment was carried out according to the owners' request. Owners' addresses and telephone numbers were obtained for post-treatment follow-up.

Survey

A total of two hundred and five farm animals were surveyed in As-

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siut governorate for abscess development from January 2021 to January 2022. One hundred twenty-two animals were identified and selected. The remaining eighty-three animals were excluded because their abscesses were either opened or aspirated before admission to the hospital. The breed, age and sex of the infected animals were recorded. As well as the duration and the real cause beyond the formation of these abscesses were determined.

Clinical examination

Once the animal's case history was obtained, the external swelling was visually examined for its seat, size, number, presence or absence of openings, and pus or discharge. A digital examination followed the visual examination. The presence or absence of cardinal signs of inflammation, the consistency, and mobility under the skin were all considered.

Ultrasonographic examination

A hair clipper and razor were used to cut and shave the hair, and warm water and soap were used to clean the skin. Before applying the gel, any greasy material on the skin was removed with alcohol. A 5 MHz sector and 8-10 MHz linear transducers were used for examination (Veterinary Ultrasound Scanner System, Scanner Aqulla Pro.Vet. Model manufactured by Esoate Europe B.V. Philipsweg 1. 6227 Aj Maastricht-The Netherlands). The wall thickness, echogenicity and homogeneity of the contents, and presence or absence of distal acoustic enhancement were determined.

Centesis

Sterile large bore (14-16 gauge) and long (3-6 inches) needles and sterile plastic syringes were used for aspiration of the swelling's contents after the complete surgical disinfection of the swelling. The aspirated material was examined for color and consistency (easily to be aspirated or not).

Surgical treatment

All animals were treated for abscesses on the same day of admission. Surgical treatment was performed as follows. Abscesses were surgically prepared by clipping the hair and thoroughly disinfecting the surgical field with 70% ethyl alcohol and 5% Povidone iodine three times for each consecutively. By using a sterile scalpel, the abscess was opened vertically at the lowest point. The pus was completely evacuated. To detect any foreign bodies or sequestered bones within the abscess cavity, the surgeon introduced his index finger into the abscess cavity. A swab was obtained from the internal wall of the abscess before its lavage. A 3% solution of Povidone iodine was used to lavage the abscess. Sterile gauze rolls were used to obliterate the cavity. The free end of gauze was let to get out between the wound lips. A daily dressing was recommended for abscesses in animals. The animals were followed up for 3 months after surgery.

Microbiological studies

Sample collection

The pus was collected by aspiration from closed ripened abscess before its surgical opening and swabbing of the internal wall of the abscess after its opening and before its lavage by antiseptic solution. One hundred and twenty-two (122) pus samples from different animals were obtained. All samples were collected under complete aseptic conditions to avoid external contamination.

Transportation and Storage

Swab samples were labeled and transported in 2ml fresh Peptone water medium to the laboratory within 1-3 hours in an ice box.

Sample preparation

Direct smear with Gram stain was screened for the presence of microbial flora. Culture on Nutrient agar (NA); blood agar (BA); Mannitol salt agar (MSA); Eosin Methylene Blue (EMB); *Pseudomonas* Isolation agar (PIA); MacConkey Agar (MAC); Baird Parker Agar (BPA) were carried out for 24-48 hours at 37°C. Any growth was identified on the different media by morphologic aspects of the colonies and smears were prepared for Gram's staining for cell morphology.

Sub-culturing and Identification

Purification of preliminary identified colonies was done by sub-culturing the isolated colonies on respective differential and selective media and repeated it several times, including Eosin methylene blue agar (EMB). It was used if the isolates were suspected as *E. coli*. *Pseudomonas* Isolation agar (PIA) for *Pseudomonas* and Baird Parker Agar (BPA) for the isolation and enumeration of *Staphylococcus aureus*.

The purity of the samples was checked by examining stained smear. The pure culture was grown on two agar slants, incubated at 37°C for 24 h, one stored at 4°C and the second bacterial isolates were examined. Preliminary identification of each isolate was done using Gram stain (microscopic morphology) and biochemical characteristics (Catalase, Oxidase, Indole, Coagulase, Triple sugar iron, Simmon citrate, Urease, Gelatin melting, Nitrate reduction, and Carbohydrate fermentation). All methods were carried out as described by Carter (1990); Carter *et al*. (1995) and Quinn *et al*. (2002).

Results

Clinical findings

One hundred and twenty-two animals were selected out of two hundred and five. The mean age ± standard error of animals was 2.3±0.15, 1.64±0.1 and 1.35±0.2 years for cattle, sheep, and goat respectively. The weight was 306±9.3, 20.4±1.72 and 16.4±1.4 kilograms respectively for cattle, sheep, and goat. The mean body temperatures of animals in °C±SE were 38.5±0.05, 39.39±0.39 and 83.3±1.3 for cattle, sheep, and goat respectively. The mean heart rate was 76.9±0.54, 82.77±1.07 and 83.3±1.3 beat/minute for cattle, sheep, and goat respectively. The distribution of abscesses on the body surface in different animals was displayed in Table 1 and Figure 1. Nearly all the surface of the animal's body was affected by the abscess. The results revealed that cattle represented 73.77% of the total selected cases. Sheep and goats represented about 18.03 and 8.2%, respectively. The most common seats for abscess formation were the gluteal, umbilical and the subconjunctival regions in cattle. The parotid, prescapular, pre-sternal and udder were the common sites for development of abscesses in sheep and goats. The mean interval from the abscess development to clinic admission was 9.4±0.16 days in cattle. It was 5.36±0.3 and 4.8±0.33 days in sheep and goat respectively. About 90% of animals according to the history were developed abscesses after incidental or accidental intramuscular injection of drugs. The development of abscesses in sheep and goats appeared after shearing of animals. The udder abscesses were recorded in cattle and goats that were subjected to mastitis post-parturition. The size of abscess ranged from small orange to a volleyball in excess skin regions and the seats of lymph nodes. In the regions such as thigh and gluteal the abscess was so huge and obvious to cause a distinct asymmetry between the affected side and the normal contralateral side. The abscess was developed as a single swelling af

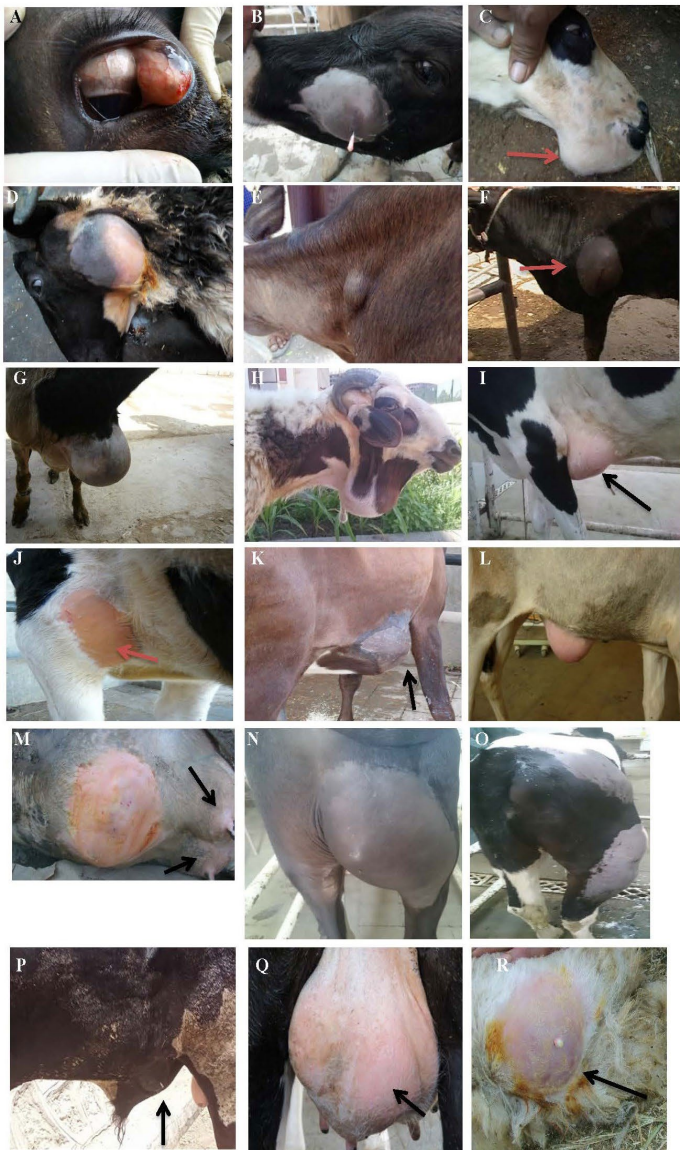

Figure 1. Abscesses at different regions on the body surface in animals are showed. A. Subconjunctival, B. Cheeck, C. Submandibular, D. Parotid, E. Prescapular, F. Left Shoulder, G. Presternal, H. Mandibulo-cervical, I. Parasternal, J. Cubital (level of elbow), K. Lateral thoraco-abdominal, L. Umbilical, M. Infront of udder(arrows refer to teats), N. Caudal thigh, O. Gluteal and thigh, P. Preputeal, Q. Udder and R. Tail (pus came out from needle). The red and black arrows refer to the seat of abscess.

fecting one seat in about 91% of the total selected cases. The remained 9% were 6 cases with diffuse abscess in the gluteal and thigh regions, 4 cases have multiples abscess in the udder and one case has a bilateral submandibular abscess. The umbilical abscess was recorded in 18 animals all of them are cattle breed. Three of 18 were umbilical abscess associated with rent in the abdominal wall as shown by the ultrasonography (Figure 2). Subconjunctival abscess occurred in 11 cases, all of them were cattle breed, 8 out of 11 affected the lateral canthus. The other 3 animals had an abscess of the lower eyelid. All subconjunctival abscesses were associated with lacrimation and staining of the skin under the eye.

The skin was movable over the abscesses that affected the lymph nodes especially in sheep. All the abscesses were ripped and ready for surgical opening. The pointing of the abscess was recorded in about 33% of the selected cases. The pain under palpation and hotness were the most common cardinal signs. The development of the abscess in all selected cases did not affect body condition, feed intake and the gait of animals.

The ultrasonographic characters of abscess

The contents of the abscess had different degrees of echogenicity and homogeneity. In acute abscesses, the contents were hypoechogenic and homogenous. There were small number of small white (echogenic) dots distributed within the abscess (Fig. 2A, B). The wall of abscess was well-demarcated and echogenic in all cases especially the chronic abscesses. The thickness of the wall was varied according to the location, and duration of abscess. It was thick and hyperechogenic in chronic and deep-seated abscesses (Fig. 3A), but it was thin in superficial abscesses, and which were developed at bony structures such as prescapular, cubital, udder and mandibular abscesses (Figure 3B). The distal acoustic enhancement was recorded in some abscesses especially that had hypoechogenic contents (Figure 4A), unlike the abscess within the lymph nodes may not be associated with distal enhancement (Figure 4B). Umbilical abscess was associating with rent in the abdominal wall as shown by the ultrasonography (Figure 2B).

Table 1. Distribution of abscesses on the body surface in animals of different species (n.=205).

Region of abscess	Cattle	Sheep	Goat	Total	Selected cases		
					Cattle	Sheep	Goat
Sub-conjunctival	11	---	---	11	8	---	---
Cheek	5	2	---	7	3	2	---
Sub-mandibular	5	4	3	12	3	2	2
Parotid	---	5	4	9	---	2	2
Neck/mandible-cervical	8	2	2	12	4	2	1
Prescapular	7	5	3	15	4	2	1
Shoulder	5	---	---	5	3	---	---
Pre-carpal	7	---	---	7	4	---	---
Pre-sternal	6	5	---	11	4	2	---
Sternal	4	2	---	6	2	2	---
Para-sternal	7	---	---	7	4	---	---
Cubital	5	---	---	5	3	---	---
Lateral abdominal	6	---	---	6	4	---	---
Umbilical	18	---	---	18	10	---	---
Infront of udder	7	2	2	11	5	1	---
udder	8	4	4	16	5	2	2
Preputial	3	---		3	3	---	---
Gluteal	20	4	3	27	12	2	1
Thigh	11	2	2	15	9	1	1
Tail	---	2	---	2	---	2	---
Excluded	53	17	13	83	53	17	13
Selected	90	22	10	122	90	22	10
Total	143	39	23	205	143	39	23

Figure 2. A) Ultrasonogram of an abscess at the retropharyngeal region in adult sheep using 5 MHz convex probe. Note the heterogeneity of the abscess contents and presence of distributed hyperechogenic dots within it indicating the inspissation of the pus and chronicity of abscess. B) Ultrasonogram of an umbilical abscess in 6 months calf using 5 MHz convex probe. Note the heterogeneity of the abscess contents and presence of distributed hyperechogenic dots within it indicating the inspissation of the pus and chronicity of abscess. There was a rent in the abdominal wall (arrow).

Biochemical findings

One hundred twenty-two farm animals at the Veterinary Teaching Hospital, Assiut University, were diagnosed of closed skin abscess over a

Figure 3. A) Ultrasonogram of abscess at the caudal thigh in 2 years bull using 5 MHz curvilinear probe. The thickness of the wall was 1.99 cm. There was a distance between the wall and the skin surface. The contents of the abscess are homogenous. The distance between 2 cursors (1.99 cm) represented the wall thickness which appears hyperechogenic relative to the contents. B) Ultrasonogram of udder that was filled with pus in 5 years recently parturient cow using 10 MHz linear probe. The glandular cistern was dilated and the tissue below it was heterogenous and ended with hyperechogenic line represents the line of demarcation between the suppurative and non-suppurative areas of the udder.

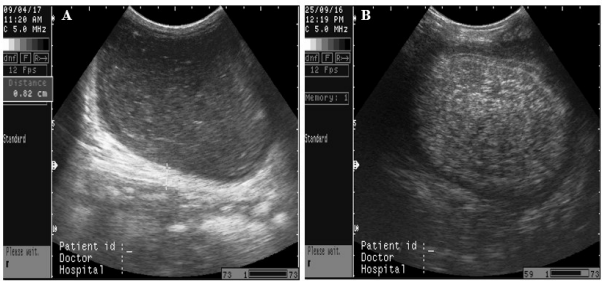

Figure. 4. A) Ultrasonogram of an umbilical abscess in 9 months calf using 5 MHz convex probe. Note the heterogeneity of the abscess contents which is hypoechoic ventrally and hyperechoic dorsally and presence of low number of distributed hyperechogenic dots within it indicating the acuteness of the abscess as well as the presence of distal acoustic enhancement. The wall thickness is 0.82 cm. B) Ultrasonogram of an abscess affecting the prescapular lymph node in 3 years sheep using 5 MHz convex probe. Note a hypoechogenic halo zone surrounding the oval structure. Also, alternative hypo and hyper-echogenic lines were showed the lamellated layers of L.N.

period of one year (January 2021 to January 2022). One hundred twenty-two (122) samples were obtained (pure pus or pus with blood) and bacteriologically identified (culture, smear, and biochemical test). The results revealed that 292 isolates were belonging to 11 bacterial species (genera) (Table 2). The obtained samples were classified according to the number of isolates (type of microorganisms) into single and mixed isolates. The single isolates were isolated from 18 cases (18/292), whereas the mixed isolates (more one isolate) were 274 out of 292 that were obtained from 104 animals (Table 3). The single isolates were *Proteus* (2), *Corynebacterium xerosis* (4), *S. aureus* (4), *Streptococcus pyogenes* (6), *Streptococcus pyogenes* (2) in goat, ewe, cattle, cattle, and ewe respectively. The results also had showed that *E. coli*, *Pseudomonas* and *Neisseria* only were isolated only from cattle, sheep & goat, and male bull respectively. There was not infection reported in male goat (Billy goat) (Table 4).

Table 2. Different types of isolated bacteria and their percentages.

Identified microorganism	Number of repetitions of bacteria in isolates	%
Gram +ve cocci		
S. aureus	38	13.01
S. epidermidis	36	12.33
Streptococcus pyogenes	28	9.59
Gram -ve cocci		
Neisseria	20	6.85
Gram +ve bacilli		
Bacillus cereus	12	4.11
Bacillus subtilis	14	4.79
Corynebacterium xerosis	40	13.70
Gram -ve bacilli		
E. coli	40	13.70
Proteus	30	10.27
Pseudomonas	6	2.05
Enterobacter aerogenes	10	3.42
Alcaligenes faecalis	12	4.11
Klebsiella pneumoniae	6	2.05
Total isolates	292	100%

Discussion

The present study aimed to investigate the abscess formation in farm animals with special reference to case history, clinical findings, most common seats, ultrasonographic characters, and bacteriological studies of the causative agents of abscesses. In this study, it was found that abscesses develop everywhere on the body surface of animals. Previous studies had also found similar results (Kumper, 2003; Mohamed and Oikawa, 2007; Misk *et al*., 2008). The clinical findings of the present study showed that the abscess developed in a single site in most of the clinical cases (more than 91%). The remained % (9%) was developed as a single lesion that was extended up/down or even beside the original site. This might refer to that the hematogenous route of infection had not occurred. As well as the history revealed that most of abscesses appeared after either intramuscular or subcutaneous injection in cattle or shearing of wool or hair in goats (Brown and Olander, 1987; Fuente *et al*., 1997; Rizvi *et al*., 1997). The results showed that the pus is collected mainly in the umbilical, gluteal, thigh and sub-conjunctival regions. The authors attributed these seats to

Table 3. The mixed isolates in different animal species.

Bacterial isolates	Type of animal	Number of animals
S. epidermidis *E. coli*	cow	18
S. epidermidis *Proteus*	Female calf	14
E. coli *Enterobacter aerogenes* *S. aureus* *Corynebacterium xerosis*	Female calf	10
Bacillus cereus *Bacillus subtilis* *S. aureus* *Streptococcus pyogenes*	cow	6
Bacillus subtilis *Corynebacterium xerosis*	bull	8
S. epidermidis *Streptococcus pyogenes* *Corynebacterium xerosis* *Klebsiella pneumoniae*	cow	4
Proteus *Alcaligenes faecalis* *S. aureus* *Neisseria*	bull	8
E. coli *Neisseria*	Male calf	12
Bacillus cereus *S. aureus* *Corynebacterium xerosis*	Ewe	6
Proteus *Alcaligenes faecalis*	Ram	4
Pseudomonas *Streptococcus pyogenes*	Ewe	2
Streptococcus pyogenes *Proteus*	Ewe	2
Streptococcus pyogenes *S. aureus*	Ewe	2
Streptococcus pyogenes *Corynebacterium xerosis*	She- Goat	4
Pseudomonas *Klebsiella pneumoniae*	She- Goat	2
Pseudomonas *S. aureus*	She-Goat	2
Total		104

be common for abscess formation due to the penetration of infected materials into the tissue, and sometimes due to the injection of irritant drugs or injection of other drugs unhygienically. The infected needles could be a source of infection or even the injected drugs. As well as the navel disease (omphalitis and omphalophlebitis) and umbilical herniorrhaphy in calves are complicated by umbilical abscess (Misk *et al*., 2008; Steiner and Lejeune, 2009). In the present study, some (3/18) of the umbilical abscesses were associated with rent of the abdominal wall which was clear under the ultrasonographic examination. It could not be predicted which comes first, the abscess formation is followed by abdominal rent or vice versa (Rings and Anderson, 2009). The umbilical abscess mainly occurred in calves in the first three months after parturition associating the infected umbilical cord. As well as the umbilical hernia also develops (Underwood *et al*., 2015). According to the available data of the animals in this study, the calves that had umbilical abscess with abdominal rent did not subject to previous surgery and their age were about 6 months. Therefore, the infected umbilical cord (omphalitis) could be ruled out as a direct cause for umbilical abscess and the authors expected that the calves may suffer umbilical hernia that was followed by formation of abscess due to the abrasion of the hernia sacs. The combination of umbilical abscess and hernia was recorded before (Steiner and Lejeune, 2009).

The subconjunctival abscess (S/C) is commonly developed in cattle than other species. Moreover, it was detected mainly at the lateral canthus in 8/11 of cases. The other three cases had S/C abscess at the lower eyelid. These findings were not in agreement with the results of foregoing studies (Misk and Ismail, 1986; Misk and Misk, 2014). The bulbar and palpebral conjunctiva were incorporated. The animals showed profuse lacrimation with staining of the hair under the eye. This may be resulted from the irritation of the cornea which lead to reflex lacrimation. The S/C abscess may be occurred due to the penetration of foreign bodies through the conjunctiva during grazing or eating the straw or hay in the manager (Misk and Ismail, 1986).

It was observed in this study that the abscess in sheep and goat was mainly concentrated at regions of lymph nodes. The parotid and prescapular abscesses were 10/39 and 7/23 from total cases in sheep and goat respectively. It might be resulted from *Corynebacterium* species infection that mainly settles in the lymph node (Alharbi and Mahmoud, 2012) causing changes such as swelling, hardness and eventually formation of pus with characteristic color and odor (Williamson, 2001). There is an aggressive hassle between the pyogenic microorganisms and the immune system of animals. If the pyogenic organisms overcome the animal's immunity, the bacteremia and septicemia will develop. While the other pathway lead to the killed microorganisms will be transferred to the animal's lymph nodes causing swelling and abscess formation of these lymph nodes (Dorella *et al*., 2009; Alharbi and Mahmoud, 2012;). Therefore, the abscess formation within the lymph nodes may refer to the good immunity of these animals. Obviously, this does not mean that raising these infected animals is beneficial or valuable to the clients, but it might be a catastrophe (Biard and Fontaine, 2007; Dorella *et al*., 2009).

Ultrasonography is a valuable and non-invasive tool for diagnosis of different body surface swellings in animals (Magda and Abd El-Hakiem, 2012). In the present study the ultrasonography was so important for diagnosis of cystic or fluid filled swelling (McAchran *et al*., 2005). The combination of history, clinical examination, ultrasonographic picture and differential diagnosis of various swelling guided the authors to final diagnosis of abscess. In the present work the ultrasonography determined some characters that may help in diagnosis of abscess. The results revealed that the wall thickness of abscess varied under ultrasonographic examination. It depends on the seat of abscess on the body surface, the degree of depth of abscess and the duration of abscess (Acute or chronic). The wall of abscess was hyperechogenic relative to the contents. It was highly distinct and easily to be detected and measured in all abscesses (Khalf *et al*., 2020; Magda and Abd El-Hakiem, 2012). The contents of abscesses at different seats of body surface except the lymph nodes varied from homogenous-hypoechogenic to heterogenous- hyperechogenic depending on the duration of abscess and absorption of fluids and precipitation of cellular contents (Crilly *et al*., 2017; Magda and Abd El-Hakiem, 2012). The presence or lack of acoustic enhancement for the abscess depends on its contents. More blackness and homogeneity of abscess contents means more acoustic enhancement (Magda and Abd El-Hakiem, 2012; Khalf *et al*., 2020;). The results showed that the ultrasonographic picture of pyogenic lymph nodes in sheep and goats differ than that was in other abscesses. It appeared as alternative hypo and hyperechogenic layers. This may be attributed due the macroscopic appearance of the normal lymph nodes in sheep and goats. It looks like the onion (Tehrani *et al*., 2012; Zidan *et al*., 2013), and the pus was included between these layers. The pus was displayed as a hypoechogenic sheet that was enclosed between two hyperechogenic layers of the lymph node tissue.

Various studies throughout the world have a high rate to isolates of bacterial organisms from wound samples of animals. However, the results of the present study showed difference from the results of others. Animals handling, misuse of antibiotics, geographical location, and many other factors may be responsible for this difference. Based on the bacteriological analysis of 120 farm animals with closed skin abscesses (120 pus samples), 292 isolates have been obtained. It had been found a high percentage of *Corynebacterium* and *E. coli* (n=40), *S. aureus* (n=38), *S. epidermidis* (n=36), *Proteus* (n=30), *St. pyogenes* (n=28), *Neisseria* (n=20), *Bacillus subtilis* (n=14), *Bacillus cereus* (n=12), *Alcaligenes faecalis* (n=12), *Enterobacter aerogenes* (n=10), *Enterobacter aerogenes* (n=6) and *Klebsiella pneumoniae* (n=6). According to the results of previous studies, it had been recorded that the *E. coli* and Staph. aureus were the most common pathogens incorporated in the dairy farms (Oloso *et al*., 2018; Zhang *et al*., 2018; Safia *et al*., 2021). The highest rate of *S. aureus* isolates were observed in the wound of donkeys and cows (66.7%) followed by camel 60%; goats 22.5%; sheep 8.6 and buffalo 8.3% (Tiwari *et al*., 2016).

In the present study the common isolated species of bacteria were *Corynebacterium xerosis*, *E. coli* and *S. aureus*. They represented about

Table 4. Total number of isolates in different species according to sex.

Name of MOs	Cattle			Sheep			Goat		
	Male	Female	Total no. of MOs in cattle	Male	Female	Total no. of MOs in sheep	Male	Female	Total no. of MOs in goat
E. coli	12	28	40	–	–	–	–	–	–
S. aureus	8	20	28	-	8	8	-	2	2
S. epidermidis	-	36	36	–	–	–	–	–	–
Corynebacterium xerosis	8	14	22	-	14	14	-	4	4
Streptococcus pyogenes	-	16	16	-	8	8	-	4	4
Proteus	8	14	22	4	2	6	-	2	2
Neisseria	20	-	20	–	–	–	–	–	–
Bacillus subtilis	8	6	14	–	–	–	–	–	–
Bacillus cereus	-	6	6	-	6	6	–	–	–
Alcaligenes faecalis	8	-	8	4	-	4	–	–	–
Enterobacter aerogenes	-	10	10	–	–	–	–	–	–
Klebsiella pneumoniae	-	4	4	–	–	–	-	2	2
Pseudomonas	–	–	–	-	2	2	-	4	4
Total	72	154	226	8	40	48	-	18	18

Total number of isolates in different species and different sexes= 292

13.69, 13.69 and 13.01% from the all isolates respectively. According to the previous studies, *Corynebacterium* was one of the most common bacteria causing abscess in sheep and goats. The isolated percentage of *Corynebacterium pseudotuberculosis* was 27.84% (Alharbi and Mahmoud, 2012). However, the isolated percentage of *Corynebacterium pseudotuberculosis* in cattle was low (7.1%) in the study that was carried out by Al-Tuffyli and Shekhan (2012). The present work recorded a different subspecies of *Corynebacterium*. It was *Corynebacterium xerosis*. It was recorded that the latter is a common organism on the skin and mucous membrane in human and animals, but it is rarely to be isolated from clinical samples in human and animals (Hernández-León *et al*., 2016). Other studies mentioned that *Corynebacterium xerosis* is incorporated in clinical cases of endocarditis, pneumonitis, osteomyelitis, and skin infections especially in immunocompromised patients (Krish *et al*., 1989; Funke *et al*., 1996).

In accordance with Al-Harbi (2011), 12.37% of all isolates of abscesses in sheep and goats were positive for *S. aureus*. On the other side the percentages of *S. aureus* isolate from subcutaneous abscesses in cattle and sheep were 33.9% and 30.4% respectively as was mentioned by Al-Tuffyli and Shekhan (2012). It is worth to be mentioned that *S. aureus* in this study was isolated from cattle, sheep, and goats. These results were consistent with the findings of previous studies (Meller *et al*., 2000; Al-Harbi, 2011; Al-Tuffyli and Shekhan, 2012) .

It was widely recognized that *E. coli* are the predominant facultative organisms in the gastrointestinal tract, and they form liver abscesses all over the world. It was recorded that *E. coli* caused about 21.48% of hepatic abscesses in sheep and goats (Madhav *et al*., 2015). In the present study *E. coli* represented the highest isolated bacteria (40/292 ~13.7%) but it was isolated only from cattle. It had not been detected in sheep and goat abscesses.

The present study recorded another subspecies of staphylococcus bacterium. About 36/290 isolates were for the *S. epidermidis*. It was isolated from abscesses that were developed in cattle, and it had not caused a problem in sheep and goats. The *S. epidermidis* has the same characters of staph species especially *S. aureus*, but its colonies are non-hemolytic and white in color according to Markey *et al*. (2013).

Proteus in the present work was isolated from all animals. It represented a high percent between the isolates (n=30/292~ 10.3%). It was isolated as a single sole agent causing abscess in goats or as a mixed bacterium with other gram positive (*S. epidermidis* and *Streptococcus pyogenes*) and negative bacteria (*Alcaligenes faecalis*). The study that was carried out by Alharbi and Mahmoud (2012) revealed that *Proteus* in sheep and goat had represented a low percentage 3.09% when it is compared to other bacteria causing abscess formation. As well as it was isolated as a single isolate. In our study, *Proteus* in sheep and goats represented about 8/292~2.74% but in cattle it incorporated in 22/292~ 7.5%. This may be attributed to the small number of sheep and goats that were included in the study relative to the number of cattle. Or might be the immunity was lower in cattle than small ruminants, this led to the normal commensal organisms like *Proteus* causing diseases and abscess formation (Hamilton *et al*., 2018). Or it may be vice versa. The cattle had higher immunity than small ruminants. The microorganisms caused abscess when the animals' immunity overcomes the virulence of bacteria. But when the animal is immunocompromised the bacteria causing bacteremia and septicemia and may be the death of animal occurred eventually (Dorella *et al*., 2009; Alharbi and Mahmoud, 2012).

Enterobacter aerogenes is a member of the Enterobacteriaceae. It is found in water, soil, sewage, and feces. It is recorded to cause coliform mastitis in cows, uterine infections, occasionally part of the mastitis-metritis-agalactia (MMA) syndrome in sows (Markey *et al*., 2013). The present study recorded *Enterobacter aerogenes* in female calves. It represented 3.4% of the total isolates. The members of *Enterobacteriaceae* may share the same characters either the biochemical or pathological. They mainly found in water, soil, utensils, and environment around animals. Therefore, they get into the animals causing illness especially when the animal's immunity decreases or at the negative energy status around the parturition (Dorella *et al*., 2009; Alharbi and Mahmoud, 2012). It was observed that the Gram-negative bacteria except *E. coli* and *Proteus* represented low percentage of total isolates. As well as they were not isolated alone. This means that these bacteria are opportunistic and get into the wound or different tissue when the immunity become lower than normal.

According to the previous studies, *Pseudomonas* spp. were isolated from cows, sheep, goat, and camel in a rate 15%, 15%, 5% and 10.52 % respectively (Devrajani *et al*., 2010; Saha *et al*., 2019). In the present study *Pseudomonas* Spp. were isolated only from sheep and goats and they were not detected in cattle. It was mentioned that *Pseudomonas* aeruginosa caused some problems in animals such as otitis externa in dogs, mastitis in dairy cows, and pneumonia in mink. It caused an opportunistic skin infection in many species. This bacterium is susceptible to a group of antibiotics such as gentamicin, tobramycin, fluoroquinolones and cephalosporins (Markey *et al*., 2013). The authors found that these anti-bacterial agents are the most used drugs in the veterinary field in Assiut governorate and areas around it, especially in cattle. So, it could be the reliable cause around the decrease of percentage of isolated *Pseudomonas* spp. in this study and non-isolation of them from cattle.

Streptococcus pyogenes is an uncommon agent of mastitis in cattle and lymphangitis in foals but is an essential human pathogen causing severe respiratory and soft tissue infections such as acute mastitis (Markey *et al*., 2013). It is associated with abscess formation in sheep (Tadayon *et al*., 1980). The present study revealed that *Streptococcus pyogenes* resulted in abscess formation in cattle, sheep, and goat. It was isolated as sole agent causing abscess development and it was detected with other bacteria such as *S. aureus*, *S. epidermidis*, *Pseudomonas*, *Corynebacterium xerosis*, and *Proteus*. The total isolates of *Streptococcus pyogenes* were 28 out of 292 (9.6%).

Neisseria spp. were stated as glucose non-fermenting bacteria with minor veterinary importance. It is a gram-negative diplococcus. There are a lot of subspecies of *Neisseria* that affect human and animals. The dogs and cats are the most common affected animals. As well as it was reported that these bacteria are commensals in oral cavity, oropharynx, and nasopharynx, and it was isolated from the conjunctival sac (Markey *et al*., 2013). Although it was declared that *Neisseria* spp. had minor veterinary importance, the present study recorded 20 isolates out of 292 total samples. *Neisseria* were isolated from cattle and they were not detected in pus samples collected from sheep and goats. It is postulated that these bacteria are opportunistic and get into the wound or different tissue when the immunity become lower than normal (Dorella *et al*., 2009; Alharbi and Mahmoud, 2012;).

Bacillus spp. is isolated from healthy cornea of horses (Williams and Pinard, 2013). The genus *Bacillus* comprises about 200 species. They are large gram-positive endospore-producing rods. They are widely distributed in the environment. Most of species of *Bacillus* are non- pathogenic (Quinn *et al*., 2016). But it was described that is an opportunistic pathogen (Markey *et al*., 2013). The bacilli can be allocated into three major groups: *B. subtilis* group (*B. subtilis*, *B. licheniform*, *B. pumilis*, and *B. amyloliquefaciens*), *B. cereus* group (*B. anthracis*, *B. cereus*, *B. mycoides* and *B. thuringiensis*) and *B. circulans* group (*B. circulans, B. firmus, B. coagulans* and *B. lentus*) (Markey *et al*., 2013). *Bacillus cereus* causes food poisoning (diarrheal and emetic types) and eye infections in human because it is distributed in soil, feces of animals, and water. In animals, it was informed that *Bacillus cereus* may result in mastitis in cattle (rare) and food poisoning in dogs and cats (rare) (Markey *et al*., 2013). While the *Bacillus subtilis* may cause abortion in sheep and mastitis in cattle and food poisoning in human (Logan, 1988). The ability of *Bacillus* spp. to grow aerobically and produce catalase help to distinguish them from clostridia (Markey *et al*., 2013; Quinn *et al*., 2016). The problem in *Bacillus cereus* is its resistance to penicillin and other beta lactam agents due to chromosomally encoded β-lactamases (Markey *et al*., 2013). According to the previous studies, *Bacillus cereus* and subtilis are widely distributed in environment and are considered opportunistic organisms. There was no previous work recorded the isolation of these species of Bacilli from abscesses in farm animals. In the present work the total isolates of *B. cereus* and subtilis were 12 and 14 out of 292 respectively. They were isolated as mixed bacteria in cattle and sheep, and they were not isolated from the goats. This refers to the entrance of these organisms into the tissue because of using of contaminated materials (needles or drugs).

Alcaligenes faecalis is non-pathogenic bacteria (Quinn *et al*., 2016). It is present in soil, water, and feces. It was reported that this bacterium is occasionally present as a contaminant in clinical specimens (Markey *et al*., 2013). The present study recorded 12 isolates of *Alcaligenes faecalis* in male cattle (8/12) and rams (4/12). It was not isolated alone but it was found with other bacteria. It was expected that this bacterium could be present as a contaminant during obtaining samples or it was got into the tissue coexisting with other bacteria.

Klebsiella pneumoniae are found in faeces of animals and man, sawdust, and other bedding. It was reported that they are responsible for coliform mastitis with other bacteria such as *E. coli* and *Enterobacter aerogenes*. *Klebsiella pneumoniae* caused metritis, placentitis and abortion in mares. Cystitis and urethritis were recorded in horses, dogs, and cats as well as pyelonephritis in dogs as result of infection with Streptococci, *Escherichia coli*, *Staphylococcus aureus*, *Proteus* and *Klebsiella pneumoniae*. The latter caused Pneumonia and suppurative conditions in foals (Markey *et al*., 2013). The results of the present study showed the female cattle and goats are infected with *Klebsiella pneumoniae*. The total isolates were 6/292 (2.0548). It shared other Gram-positive and negative bacteria in development of abscesses. The presence of this bacterium as other Enterobacteriaceae in the environment around the animals increase its chance to cause illness of immunocompromised patients (Dorella *et al*., 2009; Alharbi and Mahmoud, 2012).

The present study included some of limitations such as the low num-

ber of animals that were included in the study specially in sheep and goats. In addition to the study should be conducted on a large space including many towns and cities.

Conclusion

Abscess in farm animals is developed at everywhere on the skin surface. The abscess development often is not associated with systemic and physiological disturbances (fever, increase of heart rate and respiratory rate) in animals. The ultrasonography is a valuable tool in diagnosis of abscesses with special reference to its depth and its connection to surrounding structures. *Corynebacterium xerosis*, *E. coli* and *S. aureus* are the most common bacteria that were isolated from abscesses in farm animals. *E. coli*, *S. epidermidis*, *Neisseria* spp. are not isolated from sheep and goats. *Pseudomonas* Spp. was not isolated from cattle. *B. cereus* and subtilis were not obtained from goats.

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Conflict of interest

The authors declare that they have no conflict of interest.

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