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Outcome of Pin Tract Care in Sudanese Patients Treated with Ilizarov

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Abstract **Background:** Ilizarov introduced recently in Sudan for treatment of major devastating limbs injuries, correction of complex deformities, lengthening, infected nonunion, joint fusion and some other conditions. The result seems reasonable but Pin tract infection has always been the main drawback for use of these frames. And this fact necessitates defining and evaluates our current protocol and calculates the related incidence rate of pin tract infection. **Methods**: A descriptive, prospective hospital based study of the outcome of pin tract care for patients who were treated with Ilizarov for different indications in north Khartoum hospital over a period of two years from December 2016 to December 2018, data was collected by questionnaires and analyzed by SPSS. **Result**: 31 consecutive patients underwent Ilizarov frame application, for different indications, in north Khartoum hospital, involve 19 male and 12 female, the Minimum age was 5 years and maximum age was 60 years (mean age 32.5 years), minimum Ilizarov application period is 5week and maximum Ilizarov application period is 35 week (mean 20 week) pin tract infection rate is (71%), the infection is superficial (86.36%) in the majority of infected cases involving shanz screws more frequent than smooth wires and located in the metaphysis more than the diaphysis. **Conclusion**: Ilizarov pintract infection, is a common complication associated with Ilizarov frame application and the incidence rate was 71%, most of infection is superficial and this will not plague the device. our current local protocol is valid in minimizing the incidence of pin tract infection and reducing the magnitude of the problem.

Keywords Pin tract care, Sudanese patients, Ilizarov

1. Introduction

The Ilizarov recently introduced in Sudan for treatment of devastating injuries, correction of complex deformities, lengthening of long bones, definitive management of infected nonunion, joint fusion when the use of internal devices is prohibited and many other conditions.

Ilizarov is an external circular fixator, the structure of the frame include simply the presence of shanze screws, smooth wires and outer rings fixator. The procedure include a percutanouse insertion of shanz screws, Connecting the segments of the bone to the outer rings, while the wires are passed percutaneously through the bone using a drill, and the protruding ends of the wires are attached to metal rings, which encircle the limb, and tensioned to enhance stability. Ilizarov is a very useful tool for many reasons, one of them is the modular design of the apparatus which allows the frame to be custom built for each individual patient, and that is in addition to circular nature of the frame which enhances the stability and evenly distributes the stress across the corticotomy sites and the distraction gap or over the compressed fracture site in cases of fractures or particularly infected non united fractures. Moreover, the structure and strength of the frame allows weight bearing throughout the period of treatment, which is beneficial to the patient, both in terms of day to day mobility and helping to build muscle strength and prevent joint stiffness, additional more unique surgical advantage, is the gain from less invasive technique, when the frame is applied to the limb, in trauma setting, only wires and shanz screws fix the bones to the rings, and no more skin incisions are made, which in turn reduces the risk of bleeding, infection, and damage to the surrounding soft tissues.

In spite of all these advantages, pin tract infection has always been the main drawback for use of these frames. As the infection is a common problem around pin sites, and this is why many efforts, were carried out, to define the pin tract infection, categorized them into certain stages according to the degree of the infection, setting a certain criteria for each stage and appropriate line of action, Checketts and Otterburn system is used widely, for this purpose [10] and is adopted in this study, in literature there is general agreement considering the problem common [1,2,3,10], but many

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answers for any question wondering about how common is the problem and this is why different numbers or figures which considered as incidence rate was set by different limb reconstruction surgery centers, appear so variable, similar diversity is also noticed in operative techniques and postoperative care protocols [12].

As different protocols may set a different incidence rates, this study, is trying to determine the incidence rate of pin tract infection, in order to evaluate our current local protocol, which has a certain operative technique, and certain postoperative care.

There is global agreement in the literature, that the early symptoms and signs of pin tract infection are, pain or tenderness around the pin in an area that was previously not tender, erythema and white, yellow or green cloudy discharge from the pin site, while fever and malaise come as a late features. [1,3,4,10,12], but other state that at presentation, additional features of bacterial endocarditis may be seen or even features of septic shock if the pin site infection is overlooked [2].

Many classification systems was adopted to deal with this condition with concomitant recommended management for each category, the most wide adopted one is the Checketts-Otterburn's grading system [10] for evaluating, the degree of pin-site infection, during the period of mangment or when the fixator was removed. According to this system. **Grade 1** pin-tract infection is characterized by slight discharge and redness around the pins that requires only local treatment. **Grade 2** infection is indicated by redness of the surrounding skin, tenderness in the soft tissues and sometimes discharges of pus, Infections of this type resolve with local care and oral antibiotics. **Grade 3** infection is similar to grade 2 infection but fails to improve with intensive local treatment and antibiotics. The infection resolves when the involved pin or pins are removed and repositioned, after which it is possible to continue use of the fixator. **Grade 4** infection is characterized by severe soft-tissue involvement that affects more than one pin site and fails to respond to local treatment and oral antibiotics. it is necessary to remove the affected pins and to abandon use of the external fixation device. The clinical appearance of **Grade 5** infection is the same as that of grade 4 infection, but there is radiographic evidence of osteomyelitis. It is necessary to remove the affected pins and to abandon use of the external fixation device, **Grade 6** infection is characterized by the formation of a sequestrum within the bone and the development of apersistent sinus. Additional surgery is required to eradicate the problem. Grades 4, 5, and 6 are indicative of major infection. Whereas, grade 1,2,3 are considered as superficial infection, in other words cellulitis or a localized form of osteitis (table 1).

Also, there is another simplified classification get some popularity in the literature present under title of The Saleh and Scott classification system to grade pin-tract infection [13] and it has been mentioned in many authors publications, this system composed of five stages, classified pin site according to successful therapeutic response, Grade 0 No problem, Grade 1 Responds to local treatment (increased frequency of dressing). Grade 2 Responds to oral antibiotics, Grade 3 Responds to intravenous antibiotics or pin removal, Grade 5 Responds to local surgical curettage (table 2).

There are certain precautions during operative application of the frame, must be taken to decrease the possibly of the infection, apart from operation rooms and a septic conditions, Wire and pin insertion should be as low energy and less traumatic as possible, with minimum damage to the skin, soft tissue and bone. Skin incisions should be placed with care, in order to avoid tension on the skin. At the same time, the incisions should only be as large as the diameter of the pin. Large open wounds surrounding pins should be avoided, and we recommend suturing unnecessarily large wounds around pins, by all means the pin sites should encouraged to heal around the wires and pins like a pierced ear heals, as the aim is to facilitate rapid healing of the skin around the shanz screws or wire in order to create a bone–pin interface that is sealed from the external environment [6].

Table 1. Checketts and Otterburn's Grading System

Grades of infection	Characteristics	Treatment
Grade-I	• Slight discharge • Redness around the pins	Improved pin site care
Grade-II	• Redness of the surrounding skin • Pain and tenderness in the soft tissue • Discharge of pus.	Improved pin site care, oral antibiotics
Grade-III	• Similar To Grade-II • Fail to improve with intensive local treatment and antibiotics.	Affected pin or pins resited and external fixation can be continued
Grade-IV	• Severe soft tissue involvement • Affecting more than one pin • Associated loosening of the pin	External fixation must be abandoned.
Grade-V	• Clinical appearance same as grade-iv • Bone involvement • Radiographs show osteomyelitis	External fixation must be abandoned
Grade-VI	• Sequestrum formation within the bone • A persistent sinus develops	Curettage of the pin tract

Grade I- III = Minor infections. Grade IV- VI = Major infections

Table 2. Saleh and scott grading protocol for pin tract infection (Saleh and Scott, 1992)

Grade	Response
Grade (0)	No problem
Grade (1)	Responds to local treatment, increased cleaning, and massage
Grade (2)	Responds to oral antibiotics
Grade (3)	Responds to intravenous antibiotics or pin releases
Grade (4)	Responds to removal of the pin
Grade (5)	Responds to local surgical curettage

The location of the shanz screw or wire must also be considered, as, soft tissue movement around shanz screws and wires leads to increased risk of infection. To guard against heat generation during shanz screw or wire insertion, cooling with normal saline is recommended, as the extreme heat generation may lead to thermal necrosis of the surrounding bone, forming a dead zone of ring sequestra which attract infection or been responsible for pin loosening. For this reason, we must avoid direct continuous shanze screws insertion over a dense cortical bone, like the anterior tibial crest as this can generate excessive heat so, cortices can be breeched first via drilling and then advance the shanz screw manually through the bone and also wires after they pass both cortices of bone need to be advanced manually to the distal soft tissues.

So, for shanze screws placement, predrilling should always be performed even when using self-drilling pins, Drilling should be done in a pulsatile manner (stop–start) which is called, metronomic fashion together with continuous irrigation with cold saline to ensure proper pin cooling that is in order to decrease the possibility of thermal cortical necrosis [8].

There are two recognized conflicting operative technical protocols, the Russian Protocol was developed by the "Ilizarov Scientific Centre which advises non-touch techniques when using the wires and pins, the utilization of a pulsatile manner for drilling, then removal of bone swarm and immediate coverage of the pin-site with dressings then once weekly with 70% alcohol solution, that is in contrast to Britain protocol which also has a considerable popularity in the literatures, which it does not consider non-touch techniques, for handling of the wires and pins, moreover this protocol respect the idea of predriling but not in pulsatile manner, and no removal of bone swarm the coverage of the pin-site with dry dressings, followed by daily dressing using just normal saline. One very important comparative prospective study inspect these different two operative techniques and after-care found that the risk of pin-site infection is lower if attention is paid to avoiding thermal injury and local formation of hematoma during surgery and if after-care includes the use of an alcoholic as antiseptic solution and occlusive pressure dressings is maintained [14].

Pin tract infection decreases the stability of the pin–bone interface. Conversely instability of the fixator pin–bone construct can lead to half-pin loosening and infection [3].

We can categorize these different protocols into four groups, as each group shear the same features including the frequency of the care, throughout the treatment period (from the application of the dressing in the operation room, till removal of the frame).

The first group represent a wide spread practice, and include, Betadine soaked gauze placement around each pin site and elastic bandage is then used as an occlusive dressing around all the pin sites. The dressing is left undisturbed for 48 hours, Thereafter, each pin site is clean with normal saline for crust removal and a light gauze dressing is applies only in the presence of exudates. In the absence of exudates, the pin sites are left uncovered. So the regular dressing is not recommended in this group [15].

The second group includes the British technique, and its fellows, which involve, Application of dry dressing around the pin site at completion of surgery and these dressings are left undisturbed for 48 hours, followed by daily cleaning of the pin sites with normal saline for crust removal and application of a non-adherent dressing only in the presence of exudates. Pin sites otherwise are left uncovered. So the frequency of the care here is 24 hours and then daily dressing [7,17].

The third group includes the Russian technique, and its fellows, which involve Cleaning of pin sites daily for three days after operation, with a solution of 70% alcohol and dressing moistened with Hydrex; then an occlusive pressure dressing is applies after the third day; pin cleaning and dressing changes repeated every seven to ten days. So the frequency of the care here is daily for 72 hours and then every 7-10 days [17].

The fourth group includes another school, with some popularity, which recommend, daily dressing to all pins that should start on the second day following the operation, with new dressing application each day [7].

2. Patients and Methods

This is a descriptive, prospective, hospital based study of the outcome of pin tract care following Ilizarov frame application. This study was carried out in North Khartoum Hospital accidence and emergency department, which receives patients, through the whole 24 hours of the day, with 15 beds for short stay, and 45 beds for long stay. all patients were initially seen by trauma team, then referred to orthopedics team which consisted of an orthopedic surgeon, registrars, house officers. All cold cases, were referred from different orthopedics units in the same hospital or from different hospitals directly to outpatient department (referred clinic), which was held once weekly.

The study population consisted of all patients who were treated with Ilizarov in tow -years period from December 2016 to December 2018. Patients were included if they had completed treatment and the fixator had been removed. Patients were excluded if the fixator had not been applied at our unit or the records were insufficient with regard to the

required data, inclusion criteria's as follow: All patients who underwent, Ilizarov application in our unit for different indications, for any sex and age groups, for a period not less than 5 week, as definitive treatment, done by the same senior orthopedic surgeon, who was following the same operative techniques, and same post operative care all patients who came on weekly basis for follow up throughout the period of management till she / he underwent removal of the frame in our operating theater, followed for another two weeks for any evidence of residual infection, all patients who meet these criteria's and signed an informed consent to participate in this study were included.

Exclude patients who underwent Ilizarov application outside our unit, or referred to us for revision or not done by the same orthopedic surgeon in our units, or by other operative technique, or did not follow the same postoperative after care, or lost during follow up, or underwent removal outside our operating theater, that in addition to not agreed to participate in this study, they were excluded.

After, the objectives were explained, an informed-consent form was signed and patients were admitted to the study, then after that we used total coverage sampling technique in a consecutive fashion.

Initial information regarding the personal data, main presented condition, and the main indications for surgery was taken from all Patient who agreed to participate in the study and filled in specific part in the questioners.

Iodine 10% soaked squares of gauze were placed around each pin site and a kling bandage was then used as an occlusive dressing around all the pin sites. The dressing was left undisturbed for 48 hours. Thereafter each pin site was cleaned with normal saline initially then with Iodine 10% soaked squares of gauze and light Iodine 10% gauze dressing was applied. All patients were trained to do this kind of dressing, observed and corrected, after they learn the procedure then they discharged. Patients were instructed to clean the pin sites with those methods every two days.

The signs and symptoms of a pin site infection were explained to the patient and relative (pain, erythema, tenderness, discharge and systemic manifestations). Patients were evaluated weekly by the authors during the whole period of treatment according to Checketts and Otterburn system investigating and treating pin tract infection, in another word at each visit a record was made of the condition of the pin sites, the location of each infected pin site was noted, and the type of pin that got infection

After removal of all pins, pin sites left covered with iodine 10% for another week, then after pin site left uncovered patient followed up for another 2 week to make sure that there was no evidence of residual infection and patients reports satisfaction was recorded.

Data was collected by the authors, from admission sheets, postoperative notes discharge cards and direct clinical interviews and filled in questionnaires, which was consisted of the following blocks; personal data, the presented condition, the main indication for Ilizarove, component of the operative technique, Contains of the construct, routine pin care, the frequency of pin care, the type of solution used, Treatment period per weeks, incidence of pin tract infection, the main presented symptom, the grade of pin tract infection according to Checketts and Otterburn system the degree of pin tract infection, the type of pin involved the number of the pins that got infection the location of the pin that involved, the treatment options that responded to, incidence of pin loosening and patients report satisfaction.

At the end of the study data was analyzed, figures and tables of frequencies were layout, chi-square test was used, to test the relationship between dependant variables and the independent variable; P value which was less than 0.05 considered as statistical significance value. This analysis was performed using the statistical package for social sciences (SPSS).

3. Results

31 consecutive patients underwent Ilizarov frame application; they were 19 males and 12 females (figure 1) with mean age of 32.5 years (range 5–60 years) (figure 2). No patient was lost to follow-up, Infection rate was assessed as a percentage of the number of pin sites as well as a percentage of the number patients.

22 patients out of 31 developed infection, while 9 patients remain free of any sort of infection throughout the period of treatment. The incidence rate was 71% (figure 3, table 3).

Table (3). Incidence of Pin tract infection

	Frequency	Percent
infection	22	71.0
No infection	9	29.0
Total	31	100.0

Of the 22 patients, 19 patients, developed pin tract infection, and according to Checketts and Otterburn system, 17 patients had grade one, they respond well to increase frequency of dressing, 2 patient had grade two, they respond to increase frequency of dressing with short term of oral antibiotics, the other remaining 3 patients developed deep infection all of them had grade four, after removal of the infected pin and debridement of pin site, the infection was settle down, we found that the relationship between, our recognition to pin site infection and Checketts & Otterburn grading system, was of statistical significant value (P. value 0.000) (table 4,6).

According to Checketts and Otterburn system the general consideration of the concept of minor versus major infection of the 22 patients, 19 patients developed minor or superficial infection, 3 patients developed major or deep infection, all of them respond well to the appropriated line of action (figure 4).

In this study we found that the incidence rate was varies according to the initial indication for surgery, the lowest rate was recorded in the group of fusion of Charcot ankle

neuroarthropathy 25%, followed by the group which underwent surgery for fixation of pathological fracture due chronic osteomyelitis (33.3%), it was (66.7%) in deformity correction, (81.8%) in patients treated for infected non union, (100%) in all of the following conditions, joint fusion, Pilon fracture, distractive joint arthroplasty and open fracture (table 5).

The pattern of presentation of the pin tract infection varies, in children less than 15 years the main presented symptom was systemic manifestations (100%) while in the rest of age groups 60% presented with painless pin site discharge, 40% presented with painful pin site discharge and we found that the results of Cross tabulation between pin tract infection and main presenting symptom were statistically significant (p. value 0.000), (table 5,7).

Ilizarove was applied to 20 patients (64.52%) because of traumatic conditions, while to 11 patients (35.48%) because of non traumatic conditions (figure 5), we found that the relationship between the incidence of pin tract infection and the main presented condition (traumatic versus non traumatic) was of statistical significance value (P. value 0.02) (table 12).

Ilizarove was used in this study for 8 indications, 11 patients (35,48%) underwent Ilizarov frame for treatment of infected non union, 6 patients (19.35%) for deformity correction, 4 patients (12.9%) for fusion of Charcot foot and ankle joint neuroarthropathy, 3 patients(9.68%) for fixation of pathological fractures due to chronic osteomyelitis, 3 patients (9.68%) for fixation of open fractures, 2 patients (6.45%) for fixation of Pilon fractures, 1 patient (3.22%) for knee joint fusion, and another 1 patient (3.22%) for distractive arthroplasty (figure 6), but the relationship between the main indication and the between the incidence of pin tract infection was of statistical insignificance value (P. value 0.2).

Treatment period, {the time from Ilizarov application to removal} (range 5-35 week) with mean period of 20 weeks, the results of Cross tabulation, between incidence of pin tract infection and treatment period were statistical insignificance P. value (0.35): (Figure 7 & table 8).

A total of 166 pins (wires and Schanz screws), which included 91 wires and 75 Schanz screws, were studied. A transfixing wire has two pin sites and therefore tensioned wires have twice as many such sites as Schanz screws. The total numbers of pin sites were 257 (182 wire sites and 75 Schanz screw sites) and the total number of infected pin sites were 33 (12.84%).

The numbers of shanzs and wires were different from one frame construct to another (figure 7). And four pattern of frame configurations were recorded in this study:-

1. 5 pins construct applied to 12 patients (38.7%), in 10 patients the construct contained of 2 Schanz and 3 wires, which create 8 pin sites while in the remaining 2 patient the construct contained of, 3 Schanz and 2 wire which create 7 pin sites.
2. 4 pins construct, applied to 7 patients (12.9%), in 6 patients the construct contained of 2 Schanz and 2 wires which create 6 pin sites, while in the remaining 1 patient the construct contained of no Schanz and 4 wire which create 8 pin sites.
3. 6 pins construct, applied to 6 patients (19.35%), in 5 patients the construct contained of 3 Schanz and 3 wires which create 9 pin site, while in the remaining 1 patient the construct contained of 4 Schanz and 2 wire, which create 8 pin sits.
4. 7 pins construct applied to 6 patients (19.35%), in 4 patients the construct contained of 3 Schanz and 4 wires which create 11 pin sites, in one patient the construct contained of, 4 Schanz and 3 wires, which create 10 pin sites while in the remaining last patient the construct contained of, 2 Schanzs and 5 wires, which create 12 pin sites.

Table (4). The grades, of pin tract infection which were recorded according to Checketts and Otterburn system

	Frequency	Percent
grade 0 (healthy appearance)	9	29.0
grade 1	17	54.8
grade 2	2	6.5
grade 4	3	9.7
Total	31	100.0

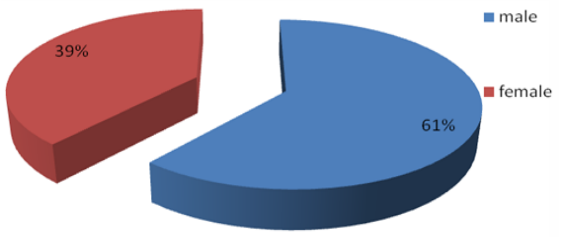

Figure (1). Sex Distribution

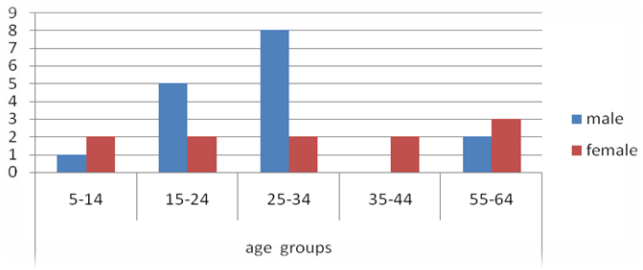

Figure (2). Age groups and sex distribution

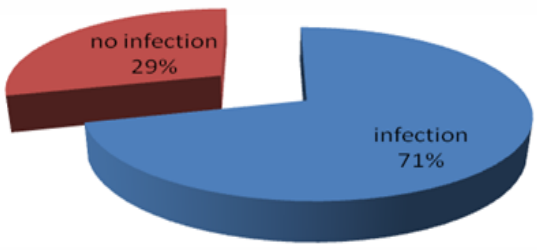

Figure (3). Incidence of pin tract infection

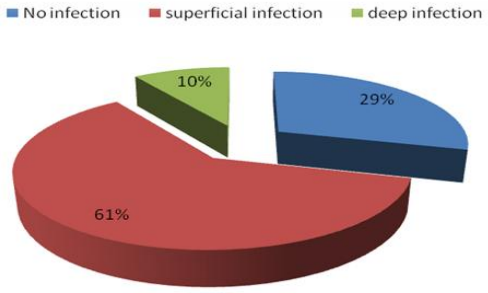

Figure (4). The degree of the infection versus no infection

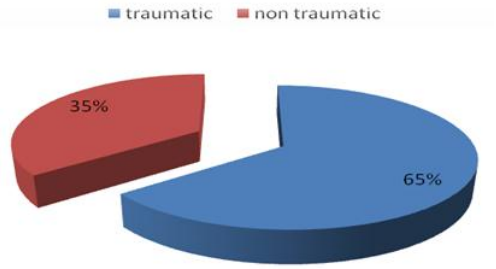

Figure (5). The main presented condition

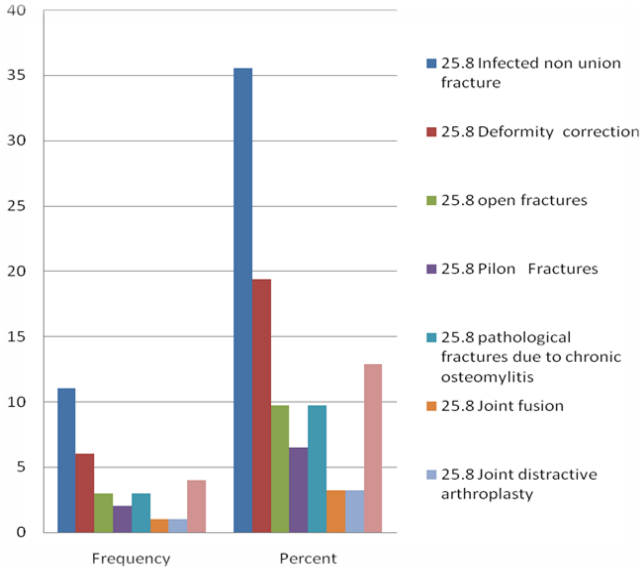

Figure (6). The indications for the use of ilizarov in this study

Table (5). The relationship between pin tract infection and the main indication for surgery Crosstabulation

	INU	D.C	O.F	P.F	P.F	J.F	J.A	F.C.J	TOTAL
Infection	9	4	3	2	1	1	1	1	22
No infection	2	2	0	0	2	0	0	3	9
TOTAL	11	6	3	2	3	1	1	4	31

INU= Infected Non Union, D.C=Deformity Correction, O.F=Open Fracture, P.F=Pilon Fracture, J.F=Joint Fusion, J.A= Joint distractive Arthroplasty, F.C.J= Fusion of Charcot ankle and foot Joints. P. value =0.2 =>0.05.

Table (6). The relationship between recognition of pin tract infection and Checketts & Otterburn grading system; Crosstabulation

		Checketts & Otterburn grading system				Total
		grade 0 (healthy appearance)	grade 1	grade 2	grade 4	
incidence of pin tract infection	infection	0	17	2	3	22
	No infection	9	0	0	0	9
Total		9	17	2	3	31

p. value =0.000 = <0.05

Table (7). The relationship between pin tract infection and the frequency of the main presented symptom; Crosstabulation

		The main presented symptom				Total
		no evidence of infection	systemic symptoms	painless discharge	painful discharge	
Incidence of pin tract infection	infection	0	1	17	4	22
	No infection	7	0	1	1	9
Total		7	1	18	5	31

P. value =0.000= <0.05

Table (8). The relationship between; the frequency of pin tract infection and The treatment period (per weeks); Crosstabulation

WK	5	8	9	10	11	12	13	14	15	16	18	20	21	24	26	28	29	32	35	Total
Infection	0	1	1	0	0	2	1	0	1	2	2	0	3	3	2	1	1	1	1	22
Non	1	1	0	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	0	9
Total	1	2	1	1	1	2	1	1	2	3	3	1	3	3	2	1	1	1	1	31

P. value =0.35 =>0.05

Table (9). Incidence of pin tract infection, Type of Pin that got infection Crosstabulation

		Type of Pin that got infection				Total
		Non	Schanz screw	Wire	Both (Schanz & Wire)	
Incidence of pin tract infection	infection	0	15	6	1	22
	No infection	9	0	0	0	9
Total		9	15	6	1	31

P. value =0.000= <0.05

Table (10). Incidence of pin tract infection * Site of infection Crosstabulation

		Site of infection			Total
		no infection	metaphysis	diaphysis	
Incidence of pin tract infection	infection	0	14	8	22
	No infection	9	0	0	9
Total		9	14	8	31

P. value =0.000= <0.05

Table (11). Type of Pin that got infection * Pins loosening Crosstabulation

		Pins loosening		Total
		presence of loosening	No loosening	
Type of Pin that got infection	Non	0	9	9
	Schanz screw	1	14	15
	Wire	1	5	6
	Both (Schanz & Wire)	1	0	1
Total		3	28	31

P. value =0.01= <0.05

Table (12). Incidence of pin tract infection * the main presented condition Crosstabulation

		the main condition		Total
		traumatic	Non traumatic	
Incidence of pin tract infection	infection	18	4	22
	No infection	2	7	9
Total		20	11	31

P. value =0.02= <0.05

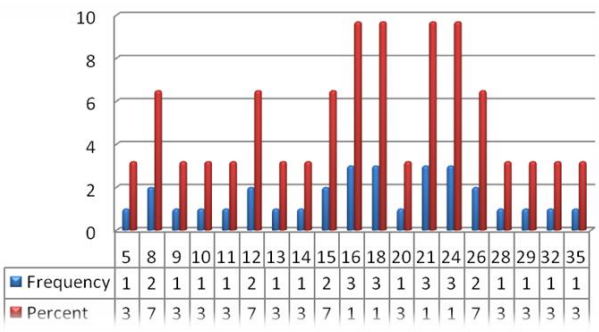

Figure (7). Durations of treatment period per week

We found that the frame pins resulted in 6 pin sites for each of a 5 patients (16.12%), 7 pin sites for each 2 patients (6.45%) 8 pin sites for each 14 patients (45.16%), 9 pin sites for each 4 patients (12.9%), 10 pin sites for 1 patients (3.22%), 11 pin for each 4 patients (12.9%), 10 pin sites for 1 patients (3.22%) (figure 7).

But we did not found statistical significant value between incidence of pin tract infection and the type of frame construct, that stetted, different number of pin sites (P. value 0.43).

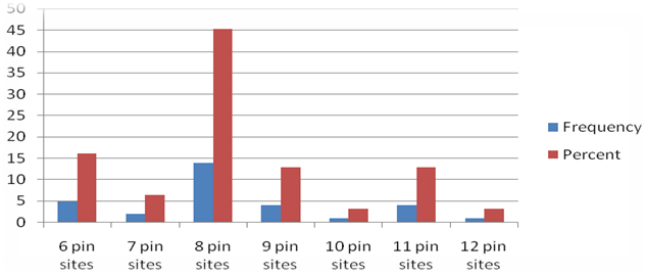

Figure (8). The numbers and percentage of the pin sites per difrenent frame constructions

Of the 76 Schanz screws, 17 Schanz screws (22.36%) got infection, while of the 91 wires, 8 wires (8.79%) got infection, so Schanz screw got infected more frequent than wires and the results were statistically significant (p. value 0.000) (figure 9, table 9).

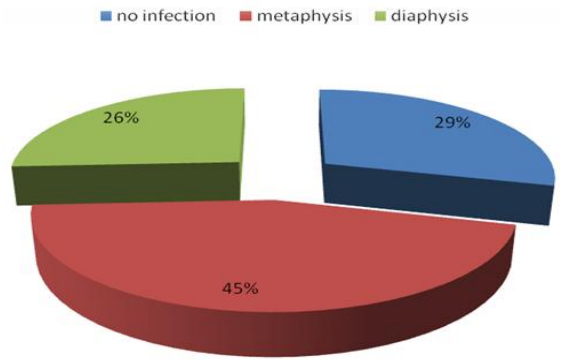

Figure (9). The site of infection

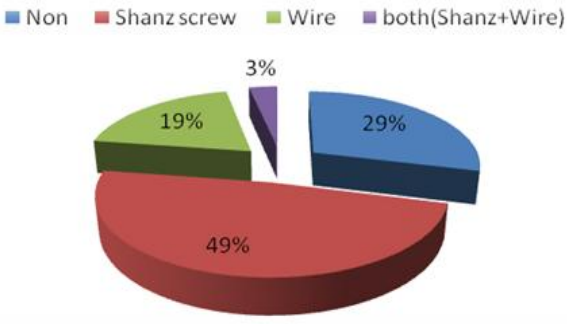

Figure (10). The type of pins which get infected

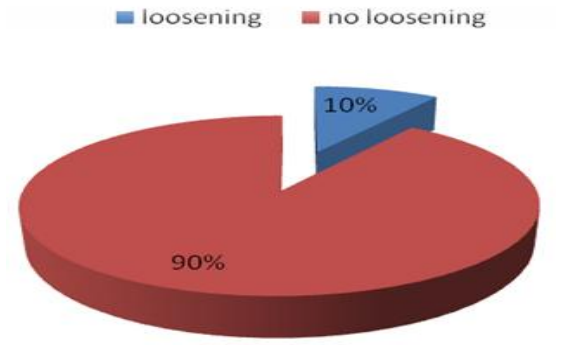

Figure (11). Incidence of loosening

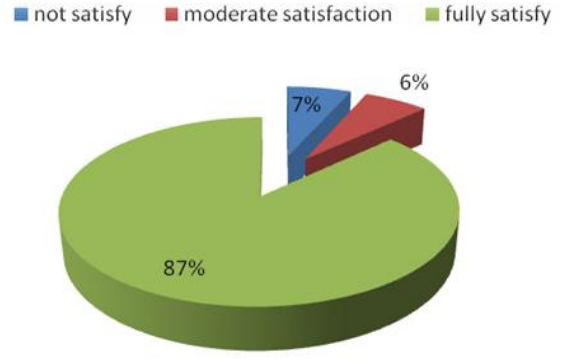

Figure (12). Patients satisfaction

Most of the infected pins were found in metaphyseal region, rather than diaphyseal region and the results were statistically significant (p. value 0.000), (figure 8, and table 10).

Of the 31 patients 28 patients (90.3%) did not experience pin loosening, while 3 patients (9.7%) did and the infection was detected in all of the loose pins (figure 10 table 11).

Patient's report satisfaction about pin tract care was found to be as follow, 27 patients (87.1%) were fully satisfied, 2patients (6.5%) were moderately satisfied and 2patients (6.5%) were unsatisfied (figure 11).

4. Discussion

Pin tract infection is the most common complication associated with Ilizarov frame application; its rate varies. Many different institutions reported many different protocols for preventing and treating pin tract infections. The protocols for the care of pin sites are often derived from the preference of the surgeon, habit, consensus or inappropriate conclusions from the basic principles of wound care. There is little scientific evidence to support one technique over another.

But however, the diversity was, there is a global agreement in the literature, that pin tract infection is the main drawback following, Ilizarov frame application, we agreed with, Moroni et al 2002 [16], who stat that pin tract infection is a common complication with the use of Ilizarov frames and the incidence rate range from 11.3 to 100%, Our results compare favorably to published figures with an overall pin tract infection incidence rate of 71% (22 out of 31) was observed in this series.

In an effort made to report the degree of the infection and treatment response, Schalamon et al 2007 [4], found that 94% of infections were mild and responded to local frequent dressing only or with antibiotic management. Piza et al 2004 [15], also reported that 75 % of their pin site infections were minor infections when using the Checketts–Otterburn classification. In our study we found that of the 22 patient who got the infection, 19 patients (86.36%) their infection was mildand they were responded to increased frequency of dressing and empirical oral antibiotic management. But we had 3 patients (13.63%) who developed, deep infection and they were responded to removal of the pin, surgical debridement of the pin sites.

Valentin et al 2008 [2], found that, the rate of Schanz screw site infection (78%) was significantly (P<.05) higher than that of fine-wire site infection (33%), this study support our result, as we found that, Of the 76 Schanz screws, 17 Schanz screws (22.36%) got infection, while of the 91 wires, 8 wires (8.79%) got infection, so Schanz screw got infected more frequent than wires and the results were statistically significant (p. value 0.000), that in contrast to the opinion of, R. Rose 2009 [24] she found that, Schanz screw infection site was 6.3%; and wire site infection was 18.7%. Total pin site infection was 25% and periarticular pin site infections accounted for 13.6% and diaphyseal infections 1.36%., but also we found part of her result supporting part of our results, as we found that, Most of the infected pins were in the metaphyseal region, rather than diaphyseal region and the results were statistically significant (p. value 0.000), our

results is also supported by the work of Ferreira et al 2012 [6], when they found that, soft tissue movement around a wire or pin leads to an increased risk for infection.

Valentin etal 2008(2), also reported that pin tract infection has a certain clinical feature, which include,, pain and tenderness around the pin in an area that was previously not painful or tender, erythema, and, white, yellow or green cloudy discharge from the pin site, while fever and malaise come as a late features.

In our study, we come across all these symptoms, and we follow the pattern of presentation of pin tract infection, in term of, what the prominent symptom that the patient complain of at presentation, and we found that, the pattern of presentation of the pin tract infection varies, in children less 15 years the main presented symptom, was systemic manifestations, all of them presented because of fever and malaise, and when the pin sites were inspected there was a clear evidence of pin site infection, in contrast this was not the case, in the rest of age groups, the majority of patients (60%) presented with painless pin site discharge without systemic manifestations, while 40% of the patients presented only with painful pin site discharge.

Erythema as main concern was not presented at all, and considered as missing value in the analysis. Interestingly wefound these results, have statistically significant value (p. value 0.000).

Bhattacharyya et al 2006 [9] found that, there were many classification systems adopted to deal with this condition; according to this and to the observation of Saw et al 2012 [1] when they mentioned that, Checketts and Otterburn's classification is most commonly used to evaluate the pin site infection, in regard to all of the above this classification was adopted in our study, and it was found to be, useful and reliable, in term of detailed description of each grade, and further recommendation of treatment and we found The relationship between, our recognition of pin tract infection and Checketts & Otterburn grading system, was of statistical significant value (P.value 0.000).

According to Checketts & Otterburn grading system, we found that, 17 patients had grade one, pin tract infection, and they were responded to increase frequency of dressing, 2 patient had grade two, they were responded to increase frequency of dressing with seven days course of oral antibiotics, the other remaining 3 patients, who developed, deep infection, all of them had grade four, after removal of the infected pin and debridement of pin site, the infection was settle down.

We think that, the operative techniques, had much to do with the incidence of pin tract infection, Davies et al 2005 [14] inspect two conflicting operative protocols, the Russian Protocol and the Britain protocol, both of them were widely used and have a recognized good reputation, they found that no one of these two protocols was superior in the outcome than the other, but the risk of pin-tract infection is lower if attention is paid to avoid thermal injury to the skin and bone in addition to avoidance of local formation of hematoma during surgery, in this regard we adhere to the recommendations which were set by Davies et al when they emphasized that any strategy for reducing pin site complications, must begin in the operating theatre.

Wire and Schanz screw insertion should be as low energy and a traumatic as possible, with minimum damage to the skin, soft tissue and bone, in this concern, we found that, our operative protocol, was reasonable, as it consisted of, Non-touch handling of wires/Schanz screw, which ensured by the use of normal saline-soaked gauze to handle and manipulate wire /shanz, also we were accustomed to use the normal saline for cooling of drill bit, while pre-drilling before manual insertion shanz screw that in addition to manual advancement of the wires to the soft tissue, after they approached the bone, all of the patients included in this study were operated on, with the light of this protocol, In an effort to prevent or at least minimize this complication, through the door of pin loosening which may initiate or propagate, pin tract infection, and this is, why we agreed, also with Ferreira et al 2012 [6], when he stated that, If all surgical precautions were considered, we would get an optimal bone–pin interface, which can withstand the subjected force upon, with great expectation of formation of rigid bone-metal interface, rather than loose fibrous –metal interface, which can leads to increase motion at the fixator pin–bone interface, producing pin site irritation, loosening and infection.

Parameswaran et al 2003 [3] mentioned that, pin tract infection decreases the stability of the pin–bone interface. Conversely, instability of the fixator pin–bone construct can lead to Schanz screws loosening and further infection, Piz à et al 2004 [15], mentioned that, there is a common misconception that pin loosening only results from pin tract infection when in actual fact pin loosening is often an isolated event from failure of surgical technique, resulting in pin tract infection. In our study we found that Of the 31 patients, 28 patients (90.3%) did not experience any pin loosening, while 3 patients (9.7%) did, and the infection was detected in all of these loose pins, and we found that, the relationship between the pin that got the infection, and the pin that got loosening, of statistical significance value (P. value 0.01).

Many construct materials, and coating substances were suggested, assuming that they might offer an additional defending mechanisms, against the incidence of pin tract infection, this idea was very obvious, in the work done by Zheng et al 2009 [11] when they compared two forms of titanium-copper alloys (1% CU & 5% CU), with stainless steel and found that there was a dramatic decrease of pin tract infection, in titanium-copper alloys, as compared to stainless steel, but the main limitation of this study, been an animal models study and even the type of alloys which were suggested not present out the doors of these labs, in our study we used stainless steel, as many did, because of its availability and its mechanical properties in term of has an acceptable material stiffness, which proved enough optimal environment for bone healing, and in this regard we follow the recommendations of Ferreira et al 2012 [6] when they found that, the forces transmitted through the fixator device

and the limb, is a function of the geometrical and mechanical properties of the fixator as well as the properties of the surrounding tissues and the fracture pattern, so the global stability is one of the major factors that can affect the incidence of pin tract infection, and not too far from this area (stability), the recommendations of Saithna et al 2010 [13], when they stated that, hydroxyapatite- coating pins, appears to be an effective method of reducing the incidence of pin loosening and infection and it was highly recommended, in leg lengthening reconstructive limb surgery, but we did not used hydroxyapatite- coating pins, partly because these type of pins are not available, in our areas that in addition to; the fact which recommend meticulous surgical techniques as mainstay, for stability, Our results regarding the associated incidence rate of pin loosening was of compared favorably to published figures with an overall pin loosening of 9.7%..

To date, there is a lack of evidence available to demonstrate whether dressing should or should not be used in routine pin site care. The Cochrane review (Lethaby et al., 2008) [23]; supports this, suggesting that there are no studies that specifically focus on whether or not to use dressing. There were a handful of studies which involve dressings but these usually set out to measure the entire pin site care regime rather than this specific aspect. A study of note would be, (Davies et al. 2005) [14] Which suggested that pin site dressing should be used at all time, along with other several operative actions. Egol et al. (2006) [21] end their controversial paper with this statement: 'we do not recommend additional wound care beyond the use of dry sterile dressing for pin-tract care after external fixation for the treatment of distal radial fractures'; but this study, however, was not a direct comparison between dressed pin sites and those which, left open to the environment. In review of earlier British Consensus, Timms et al. (2011) [12], advocated the use of dressing and advised that, a dressing that applies a small amount of pressure should be used, to prevent tenting of the skin along the pin and must kept continuously in place, while Carlo Camathias et al 2012 [28] conclude that routine pin tract care is unnecessary, in our unit we do agree still with, Davies et al, and Timms et al, and all patients involved in our study did dressing in regular basis, throughout the period of treatment, and our philosophy behind that, we think that, pin tract care is not a nonsense routine habit, but it is our mean to treat grade one and a good partner in treatment of grade two pin tract infection with oral antibiotic, that in addition to, some patient might got any type of (subclinical) superficial infection, and when they were already done the care, they were actually participated actively in the treatment of their ongoing infection before it got complicated and upgraded.

The appropriate times to commence pin tract care, ranging from 24 h to 10 days, (Davies et al. 2005) [14], mentioned that, it was daily in, the British protocol and every seven to ten days in, the Russian protocol, (W-Dahl et al 2003) [22] found that, No difference between daily and weekly pin tract care in a randomized study of 50 patients. for us, we found, every 2days dressing, more reasonable and compliance for the patient, our patients report satisfaction, about the, nature and frequency of pin tract care record the following; 87% fully satisfaction, 7% non satisfy, and 6% moderate satisfaction.

Various cleaning solutions are advocated in the literature, including, sterile water, normal saline, hydrogen peroxide, silver sulphadiazine, Povidone-iodine, isopropyl alcohol and chlorhexidine, [1,2,3,5,6,9,12,20], we are accustomed to train our patient to use normal saline as initial dressing solution, followed by formal dressing with 10% Povidone-iodine as a main cleaning solution, because, iodine has a wide range of bactericidal, antifungal, and some antiviral effect, while many studies had a serious concern of iodine, mainly about, its irritation effect to the skin, its corrosive effect to stainless steel pins, and cytotoxicity at cellular level of bone and soft tissue, as mentioned by Trigueiro et al 1983 [43], we found the work of Hiroyuki et al 2012 [20] of great value, when they explained that, iodine is a trace metal that already present in the body, as it is an essential component of the thyroid hormone, it is biologically safe because it can be excreted by the kidneys, if it was enter the circulation, and they also proved that it has no clinical cytotoxic effect, as implant treated with iodine, in arthroplasty field, showed an excellent bone ingrowth and ongrowth, around hip and tumor prostheses on radiographs that in addition to, relative sustainable bioavailability, as the amount of iodine on the external fixation pins remained about 20–30%, after one year later, in our study we did not had any patients in this series, presented with any sort of skin dermatitis, or any cytotoxic effect, in term of bone non union, or chronic non healed pin sites, even those who were treated because of pin site infection, they were responded well to the dressing with 10% Povidone-iodine itself.

5. Conclusions

Pin tract infection, is a common complication associated with Ilizarov frame application and the incidence rate was 71%. Most of infection is superficial, and this will not plague the device. Shanz screws get infected more than wires and the infection was more frequently seen in metaphysal regions. Our current protocol is valid in minimizing the incidence of pin tract infection.

6. Recommendations

The findings of this study were initially confirmed by, this prospectivestudy, but further confirmation is needed in the field of blind randomized controlled clinical trial, that enrolling, different operative protocols, different care methods, different type of solutions, and different care frequencies.

This study layout the overall incidence rate of pin tract infection in series of patients who underwent Ilizarov for different indications but figuring out the incidence rate of pin tract infection in series of patients with specific condition are

of great importance.

Treatment of the literature diversity, regarding the issues of pin tract care and incidence rate can be initiated by conducting an international multi-center studies and meta-analysis, to determine the optimum, that in order to speak one languishes.

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