Complications of Ilizarov Technique: Review Article

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Abstract

Background: Many complications may arise during the long course of treatment with the Ilizarov technique. Most are preventable or correctable and will not interfere with successful results of treatment. Muscle contractures are usually a result of tension generated on the muscle due to distraction. They tend to occur in the overpowering muscle groups. The most common predisposing factor is preexisting joint instability. Even in the absence of preoperative instability, the imbalanced muscle tension that develops during lengthening may lead to subluxation. Occasionally a hematoma will form and may lead to a compartment syndrome. If this is recognized during surgery, prophylactic fasciotomy should be performed. If postoperatively clinical examination and pressure measurements should be performed to confirm the diagnosis.Urgent fasciotomy is carried out on the involved compartments. Premature Consolidation is most commonly diagnosed as a failure of the osteotomy to open after the initiation of distraction. In the majority of cases, the problem is an incomplete osteotomy rather than premature consolidation. Premature consolidation, when it does occur, is usually due to an excessive latency period, allowing significant callus healing to block the distraction of the osteotomy. The wires can be seen to bow, with their convex sides facing each other on opposite sides of the osteotomy

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Introduction:

Many complications may arise during the long course of treatment with the Ilizarov technique. Most are preventable or correctable and will not interfere with successful results of treatment **(Golyakhovsky and Frankel, 1993).**

Paley in 1990, classified the unwanted events into problems, obstacles and complications. A problem is defined as a potential expected difficulty that arises during the distraction or fixation period that is fully resolved by the end of treatment by non-operative means. An obstacle is defined as a potential expected difficulty that arises during distraction or fixation period that is fully resolved by the end of treatment by operative means. Complication include any local or systemic intraoperative or perioperative difficulty during distraction or fixation period that remains unresolved at the end of the treatment period.

Muscle Contractures:

Muscle contractures are usually a result of tension generated on the muscle due to distraction. They tend to occur in the overpowering muscle groups **(Simard et al, 1992)**.

There may be a difference in the rate and maximum potential for histogenesis between muscle and bone. A contracture arises when the muscle length becomes relatively short compared to that of the bone. Another etiologic consideration is transfixion of muscles or tendons by the pins of the apparatus. Transfixion of tendons and fascia may restrict joint motion more than transfixion of muscle **(Paley, 1990)**.

The primary preventive measures include physiotherapy, splinting, and fixation across the joints. Physiotherapy should focus on passive stretching exercises. Active exercises as well as electrical stimulation are believed to also help stimulate muscle regeneration. Night positioning is essential **(Paley, 1990)**.

If the surgeon and physiotherapist cannot overcome an evolving joint contracture with splinting, hands-on passive stretching or other strategy (such as extending the fixator across the joint), the wisest course is to abandon the goal of treatment, stop bone fragment movement, and commence a course of intensive physiotherapy.For this purpose, the patient may have to be admitted to the hospital for supervised care. If the contracture does not improve, the fixator may have to be modified into a contracture correction configuration and the bone elongation or deformity elimination may have to postponed. If significant contracture remains after removal of the apparatus and is resistant to physiotherapy, it may become necessary to perform a tendon lengthening **(Green, 1991)**.

Thus, if the contracture is dealt with by non-operative means, it is considered a problem. If it is treated operatively before the end of treatment, it is an obstacle. If it remains at the end of treatment and is resolved nonoperatively, it is a minor complication. If it requires tendon and capsular release after the end of treatment, it is a major complication **(Paley, 1990)**.

Joint Luxation:

The most common predisposing factor is preexisting joint instability. Even in the absence of preoperative instability, the imbalanced muscle tension that develops during lengthening may lead to subluxation **(Paley, 1990)**.

Joint subluxation can be treated by physiotherapy to stretch the deforming muscle force. In more severe cases and in the case of dislocation, the apparatus may need to be extended across the joint in order to first distract the joint and then relocate it immediately or gradually. If left untreated or unrecognized until after the apparatus is removed treatment with physiotherapy, traction and Dyna splint may be tried. More likely tendon and capsular releases or reapplication of the Ilizarov apparatus may be necessary **(Paley, 1990)**.

Thus, joint subluxation may present as a problem, an obstacle, a minor complication or a major complication **(Paley, 1990)**.

Neurologic Injures:

1. Pin-related Nerve Injury:

This is best prevented by placement of wires in safe anatomic planes and tapping the wires in the soft tissues to avoid wrapping up the nerve that would probably cause significant local mechanical and thermal damage. In this condition, the patient awakens with severe pain localized to the area of the offending pin. Also, tapping on the pin with a metal object will elicit paraesthesias in the distribution of that nerve. The pin should be then removed **(Paley, 1990).**

2. Corticotomy-related Nerve Injury:

This may be due to direct injury from the osteotome or more likely a stretch injury from the osteoclasis maneuver used to ensure that the osteotomy is complete. Compartment syndrome is an other cause of nerve deficit **(Paley 1990).**

3. Distraction-related Nerve Injury:

It is a much less common etiology as nerves and vessels can tolerate up to 2 mm of distraction a day in many locations around the body If identified early, the first signs are hyperesthesia and pain. This is followed by hypoesthesia, then by decreased muscle strength, and finally by paralysis. If treated early paralysis should never occur. The treatment should emphasize increased physiotherapy and especially functional loading and weight bearing of the limb. The rate of distraction should be decreased or even stopped completely **(Green, 1991)**.

Distraction should then be restarted at a slower rate, 0.25-0.5 mm less that before. In the event of motor weakness or paralysis, the limb should be shortened to try to recover the situation. With the

Ilizarov technique, one cause of distraction nerve injury is related to tenting of a nerve over a wire that previously was not disturbing the nerve **(Paley, 1990).**

Paley in 1990, considers all intraoperative nerve injuries true complications whether they recover during treatment or not. On the other hand distraction related nerve dysfunction that recovers during treatment is considered a problem only. If a nerve is decompressed prophylactically, it is an obstacle. If any residual dysfunction remains at the end of treatment, it is considered a true complication.

Vascular Injuries:
This rarely leads to problems because of the small diameter of the wires used. If the problem is recognized at the time of surgery, the wire should be removed and pressure applied to tamponade any bleeding **(Paley, 1990)**.

Direct vascular damage can also result from the osteotome while performing the humeral corticotomy . Displacement of these osteotomies may also be the cause of vascular damage. In all of these cases simple compression will usually resolve the problem **(Paley, 1990).**

Compartment Syndrome:
Occasionally a hematoma will form and may lead to a compartment syndrome. If this is recognized during surgery, prophylactic fasciotomy should be performed. If postoperatively clinical examination and pressure

measurements should be performed to confirm the diagnosis.Urgent fasciotomy is carried out on the involved compartments **(Paley, 1990).**

Edema:
Edema is a common problem during lengthening. It takes several months after removal of the apparatus until the edema finally disappears **(Paley, 1990)**. It is not known whether this edema occurs from hypervascularity of the limb secondary to the distraction or due to increased stasis from lack of normal muscle contraction **(Eldridge and Bell, 1991).**

If skin impinges on the frame near the end of treatment slip thin pieces of cardboard, with a slot for the wires between the skin and the frame. This prevents pressure necrosis against the edge of the rings by increasing the area of contact. If skin impingement on the frame occurs early in the treatment, frame modification is almost always necessary **(Taylor, 2001)**.

Arteriovenous Fistula:
It is a rare complication that can result from perforation of both an artery and vein simultaneously. The proximity of a pin to a pulsating artery can result in late erosion with pseudoaneurysm formation **(Paley, 1990)**. Also, false aneurysm can be secondary to direct arterial injury by the osteotome or a bone fragment. Haematoma is contained within the tissue spaces and subsequent liquefaction leaves a

cavity with direct arterial communication. Embolistation is a successful method of treatment **(Rickman et al, 1999)**.

Hypertension:

Hypertension is a manifestation of distraction of the arteries. It is usually caused by too rapid distraction **(Paley, 1990)**.

Axial Deviation:

This is due to the imbalance between the muscle forces on different sides of the bone. The other cause of axial deviation is instability. This may be caused by an inadequate construct, loss of tension in the wires, or loosening of the pins **(Paley, 1991)**.

If axial deviation is noted early and is mild (less than 5º), it may be sufficient to overlengthen on the side of the deviations as compared to the opposite side five 0.25 mm turns per day on the lateral side versus three

0.25 mm turns per day on the medial side. Once the axial deviation is greater than 5º, modifications of the apparatus to include a hinge is usually required. In larger lengthening, it may be necessary to insert an additional olive wire to pull the bone out of its deviated position.

Thus axial deviation may present as a problem, an obstacle or a complication. If it is allowed to heal in deviated position, it is considered a minor complication if less than 5º and a major complication if greater than 5º **(Paley, 1991)**.

Premature Consolidation:

This problem is most commonly diagnosed as a failure of the osteotomy to open after the initiation of distraction. In the majority of cases, the problem is an incomplete osteotomy rather than premature consolidation. Premature consolidation, when it does occur, is usually due to an excessive latency period, allowing significant callus healing to block the distraction of the osteotomy. The wires can be seen to bow, with their convex sides facing each other on opposite sides of the osteotomy **(Paley, 1990)**.

Continued distraction can be carried out until the consolidated bridge of bone ruptures. The patient must be warned that this will be sudden, unexpected and painful and that they may hear and /or feel a crack or a pop. To relieve their pain, they must back up the distraction by the number of millimeters of distraction that have been applied since the time the bone consolidated. If this not done, a large diastasis may be created, predisposing to delayed or nonunion. Alternatively the patient may be taken to the operating room and under a brief general anesthetic have a closed rotational osteoclasis attempted. If this too is unsuccessful then a repeat percutaneous corticotomy is performed. Attention should be paid to the possible massive bleeding that may result from cutting through regenerate bone.

The use of a tourniquet is recommended. Premature consolidation, if treated nonoperatively is considered a problem, if it is treated operatively it is considered an obstacle. It is a true complication only if it causes the surgeon to quit lengthening prematurely **(Paley, 1990).**

Delayed Consolidation:

This may be caused by a variety of factors. The technical factors to consider are traumatic corticotomy, initial diastasis, instability, and too rapid distraction. The patient factors are infection, malnutrition, and metabolic e.g. hypophosphatemic rickets. Frame instability should be suspected if the trabeculae seem to wander across the distraction gap rather than being all parallel and longitudinally oriented.

Delay in regeneration is diagnosed by the delayed onset of regenerate new bone on plain radiographs. When it occurs after the regenerate has already formed, it is manifested as a widening of the interzone between the proximal and distal trabeculae. If delayed consolidation occurs, it should be treated by going reverse and then forward again one or more times (accordion maneuver). Proper tension in the wire should be checked and the construct should be biomechanically sound. New pins can be inserted and the old ones removed. On occasion, there have been cystic changes within the regenerate bone on ultrasound. When this occurs, it is difficult to recover the situation, so bone grafting may be necessary.

Delayed consolidation treated nonoperatively is a problem. If treated by the addition of more pins, it would be considered an obstacle. If treated by bone grafting, it would be a true complication **(Paley, 1990).**

Refracture and Late Bending:

Refracture can best be avoided by careful analysis of the regenerate bone in the distraction gap prior to removal of the apparatus.This bone should have an even consistency with evidence of neo-croticalization and opacity similar to its surrounding bone. A favorite saying is; it is better to remove the apparatus one month too late than one day too early **(Paley, 1990)**.The pattern and location of the fractures is variable; within the regenerate itself, at the junction between the regenerate and the original bone, and at distant sites in the limb **(Simpson and Kenwright, 2000).**

Refracture should be treated with either a cast or reapplication of the apparatus, depending on the particular case **(Paley, 1990).**

All refractures are considered true complication. Those leading only to a buckle fracture and loss than 1cm of length or less than 5º of angulation are considered minor. Those leading to greater than 1cm length loss or greater than 5º angulation are considered major.

Pin Site Problems:

Pin tract problems are related to pin-skin motion, the amount of soft tissue between skin and bone, and the diameter of the pin used. Also, improper pin insertion technique and lack of postoperative pin hygiene can predispose to pin track infections **(Paley, 1990)**.

Improved pin insertion technique e.g. minimizing wrapping up the soft tissues, drilling with pauses, avoiding tenting the skin or forcing the wire to the ring. Switching from steel to titanium pins decreases the rate of pin-site sepsis 40% or more **(Green, 1994)**.

Maintaining adequate wire tension is important in order to minimize the pin-skin and pin-bone motion. Applying pressure to the skin stabilized to the pin is another useful method. This can be accomplished by using gauze compressed by rubber stoppers. The foam sponge also acts as a barrier between the air and the skin. Antiseptic or antibiotics can be applied to the sponge.

Different authors use different approaches to pin hygiene. **Eldridge and Bell** in 1991 used hydrogen peroxide to promote tissue fluid drainage and added alcohol based disinfectant to the sponge. **Paley** in 1990 applied antiseptics or antibiotics to the sponge. Although solutions such as hydrogen peroxide and betadine are certainly bactericidal, they are also toxic to the tissues. In addition, they can inhibit host tissue defenses at the pin site. Simply, cleansing it with a mild soap and water in the shower seems adequate **(Gordon et al, 2000)**.

It is best to keep in mind the acronym KISS (Keep it Simple with Saline) **(Nepola, 1996)**.

Good pin site hygiene can prevent most pin infection but nearly every patient will experience an inflamed pin track during their course of lengthening. They should be provided with oral antibiotics to begin in case of increased pin site redness or pain. This can help to control the infection while they are making arrangements to be checked by the physician for mechanical pin problems **(Eldridge and Bell, 1991)**.

Pin sites are graded on the scale of 0 to 5 (Table 1) **(Gordon et al, 2000)**. **Paley** in 1990 simply classified pin track problems into three grades, Grade 1: Soft tissue inflammation, Grade 2: Soft tissue infection with purulent discharge and Grade 3: Bone infection.

Table (1): Pin site infection classification and treatment (Gordon et al, 2000).

Grade	Appearance	Treatment
0	Clean	Weekly pin care
1	Pain or erythema or drainage	Daily pin care
2	Pain, erythema and serous drainage	Antibiotics

3	Pain, erythema and purulent drainage	Antibiotics
4	Pain, erythema and purulent drainage with radiographic osteolysis.	Remove pin
5	Ring sequestrum or osteomyelitis	Debridement

Pin track infections treated by local measures, antibiotics or even pin removal are considered problems. If the addition of a new pin is required, it is considered an obstacle. Any true bone infection is considered complication **(Paley, 1990)**.

Joint Stiffness:

Joint stiffness is a late complication. This occurs due to persistent muscle contractures or may be due to stiffness of the joint due to the increased pressure on the joint surface during lengthening. The latter is a theoretical consideration but is a concern for the long term.

If a joint is suspected of being at a high risk for residual stiffness and the apparatus is still on, the apparatus can be extended across the joint (if it is not already) and the joint can be distracted 5 mm. The apparatus can then be used to mobilize the joint prior to its removal.

All joint stiffness is considered a true complication; the severity of the complication depends on the function limitation created. Obviously, 15º loss of knee extension and ankle dorsiflexion is much more serious than a 15º loss of knee flexion and ankle plantar flexion **(Paley, 1990)**.

Pain:

Pain is the most common complaint during limb lengthening. Surgical pain may be quite intense the first few days after surgery. Contraction of any muscle transfixed by pins is initially painful but resolves within a week or two. The amount of pain obviously increases with the number of osteotomies.

During the distraction phase of lengthening a chronic dull aching pain is often experienced. This varies from patient to patient. It is more common with longer lengthening. The probable cause is most likely the stretching of the muscles and nerves. The pain, while present at all times, is usually only noticed at night and during physiotherapy and walking. For pain, acetaminophen with codeine derivatives can be given and when the degree of pain is not well tolerated by the patient, the rate of distraction should be decreased by 0.25 mm at a time **(Paley, 1990)**.

Soft Tissue Dystrophy:

Soft tissue dystrophy and pain may be related to neurological injury

(Paley et al, 1989). Also, increasing fixation instability further inhibits functional limb use, creating a cycle of discomfort and disuse that characterizes reflex sympathetic dystrophy: altered vascularity, edema, joint stiffness and osteoporosis **(Ilizarov, 1990)**.

Psychological Problems:

Depression and behavioral disturbances secondary to persistent pain, poor function and unsatisfactory cosmetic appearance can develop **(Paley, 1990)**

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