Comparison of the pain severity, drug leakage and ecchymosis rates caused by the application on tramadol intramuscular injection in Z-track and Air-lock techniques

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Objective. To compare the pain severity caused by the application of the Z-track and Air-lock intramuscular injections. Methodology. Unblinded clinical trial, where 90 female subjects aged between 18 and 60 years old were randomly assigned to two groups; the first group received the tramadol intramuscular injection using the Z-track technique (ZT) and the second group received it through the air-lock method (AL). A 10 centimeter linear visual scale was used to evaluate the injection pain. The scale length was considered as the pain severity. Data were analyzed using the SPSS version 13. Groups’ age, Body Mass index (BMI), and pain intensity were compared using unpaired student’s t test. Results. The study showed that the pain severity of patients in the AL method group was lower than in the ZT technique group (p<0.05). There was no significant statistical difference between the age, the number of injections previously applied and the BMI between the groups. Conclusion. AL method produced less pain than the ZT technique; therefore it can be considered a better choice for intramuscular injections.

Key words: randomized controlled trials as topic; pain, injections; intramuscular.

Resumen

Objetivo. Comparar la severidad del dolor y las tasas de escape de líquido y equimosis causadas por la aplicación intramuscular de tramadol usando las técnicas de cámara de aire y Z-track.

Comparación de la severidad del dolor y las tasas de escape de líquido y equimosis causadas por la aplicación intramuscular de tramadol usando las técnicas de cámara de aire y Z-track.
Medications can be administered to patients by a variety of routes, including oral, topical, and parenteral\(^1\) routes. Within the category of parenteral medications are intramuscular (IM) injections in which the skin is punctured with a needle and syringe and the medication is administered deeply into a large muscle of the body for prophylactic or curative purposes.\(^2\) In addition the IM injection can be carried out with different methods like the Z-track (ZT), air-lock (AL) and standard methods, each of them require a specific style of injection. The appropriate areas for the IM injection methods include vastuslateralis, ventrogluteal and deltoid areas, among which the ventrogluteal has been introduced as the more suitable area for adults as well as children above 7 months old.\(^3\) Complications following IM drug administration can occur at the site of the injection, some of them include: leakage of the injection solution and/or bleeding from the injection site onto the skin, pain, irritation, and even skin lesions.\(^4\)

In previous researches, 40% of the people who received IM injections described it as very painful.\(^5\) Pain is an awful and annoying characteristic of IM injections.\(^6\) It causes discomfort to the recipient and may prevent patients from receiving injections.\(^7\) Some techniques are tested for reducing pain from IM injections such as Eutectic...
Mixture of Local Anesthetics (EMLA) patch, the manual pressure technique, Massage, ZT and AL. However, there is little evidence in the literature comparing different techniques or assessing effects of particular techniques on the IM injection pain. Therefore, this study was carried out to compare the pain severity, drug leakage and ecchymosis rate between the ZT and AL methods.

**Methodology**

This study is a double blinded clinical trial; subjects consisted of 90 female patients aged between 18 and 60 years old who were referred to the Shahid Beheshti hospital of Yasuj in the southwest of Iran. With the help of a visual analogue scale (VAS) the pain severity in patients with renal colic diagnosis was evaluated, the patients whose pain was between 4-7 were selected as the research samples. The subjects were randomly assigned to two equal groups. One group received the IM injection through the ZT technique (ZT group). In this method, in patients lying in a prone position with toes facing inside, the skin was moved and held from the injection site, aspiration on the syringe to assure that a blood vessel wasn't penetrated was done, and then the medication was injected slowly. The other group received the injection through the AL method (AL group), positioning the patients as in the ZT group. In this method, 0.5 ml of air was added to the syringe content, after aspiration the medication was injected at the same site of the ZT group. The air bubble was also injected following the medication injection.

All cases received 50 milligrams of Tramadol as medication. 2 milliliter syringes were purchased from Soha Company of Iran with a 23 gauge needle 23. A 10 centimeter linear visual scale was used to evaluate the injection pain; the scale length was considered as the pain severity. Studied individuals marked a point on this line between zero, meaning no pain existence, and 10 meaning the most severe pain situation. In this way the pain severity was determined. In this study, in order to validate the VAS, the content analysis method for validity, and equivalence testing to confirm reliability of the aforementioned scale were used. On purpose, all injections were applied by a Yasouj University of medical sciences nursing faculty member. The drug leakage rate was measured using sterile blotting paper, immediately after removing the needle sterile blotting paper was placed on the injection site and the soaked region diameter was measured. In addition, the patients were surveyed about the presence of ecchymosis in the injection site, and in case of availability its diameter was recorded. Those with first injection, drug addiction, skin allergies and lesions at the injection site, illiteracy, hearing and sight disorders were excluded from the study. Age and number of previous injections were also recorded in data sheets. The body weight/height² ratio, referred to as BMI (kg/m²) was calculated to all subjects. Data were analyzed by using SPSS version 13. The applied statistical methods included descriptive indexes to determine the frequency, mean and standard deviation, X² and the independent t test to compare the complications severity in both groups were used. This research has been accepted by the Yasouj University of Medical Sciences ethical committee and written consent was obtained from the patients before they were selected to participate in the study.

**Results**

Findings of the study are shown in Table 1. Regarding to the general characteristics it can be appreciated that the groups are equal in the age (39 years), BMI (26.5) and number of previous injections (3.9) averages. Almost the same in the married women proportion (73.3% in AL and 45.6% in ZT). Regarding to the study variables significant differences for ecchymosis (0.85 vs. 0.40), drug leakage (2.1 vs. 1.1), and pain severity (2.84 vs. 4.56) were observed between the AL and the ZT groups.
These factors may affect the outcome and result of the different findings. The AL technique may reduce pain by inhibiting drug leakage through locking the needle path.12

Other results of the study were the existence of significant statistical difference between drug leakage and ecchymosis among both groups, the severity of these complications in the AL group was lower than ZT group. The Mac Gabhann, Quatermin and Taylor studies have confirmed that drug leakage and bleeding after injection through the AL method is lesser than the injection through the ZT method.10,13 Since in the AL method the available air at the bottom of the syringe allows the available drug through the syringe and needle channels to be completely discharged, the lower drug leakage rate in this method compared with the ZT method is logical. Besides that, the lesser the drug and blood leakage, the lower the pain and ecchymosis of the area. Also, some studies regarding the comparison of pain, ecchymosis and drug leakage severity between the standard and the ZT methods suggested that the ZT method is preferable than the standard method.11,14,15 Therefore it could be concluded that the pain severity, ecchymosis and drug leakage in the ZT me-

### Table 1. Comparison of variables according to study group.

<table>
<thead>
<tr>
<th>Variable</th>
<th>AL</th>
<th>ZT</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean±SD)</td>
<td>40.3±13.7</td>
<td>39.9±12.8</td>
<td>≥0.05*</td>
</tr>
<tr>
<td>BMI (mean±SD)</td>
<td>26.5±4.2</td>
<td>26.5±4.3</td>
<td>≥0.05*</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married (%)</td>
<td>73.3</td>
<td>75.6</td>
<td>≥0.05†</td>
</tr>
<tr>
<td>Unmarried (%)</td>
<td>26.7</td>
<td>24.4</td>
<td></td>
</tr>
<tr>
<td>Previous injection number (mean±SD)</td>
<td>3.9±0.45</td>
<td>3.9±0.15</td>
<td>≥0.05*</td>
</tr>
<tr>
<td>Pain severity of injection (mean±SD)</td>
<td>2.84±1.242</td>
<td>4.56±1.66</td>
<td>&lt;0.05†</td>
</tr>
<tr>
<td>Ecchymosis (mean±SD)</td>
<td>0.85±3.8</td>
<td>0.4±2.0</td>
<td>&lt;0.05†</td>
</tr>
<tr>
<td>Drug leakage (mean±SD)</td>
<td>2.1±3.6</td>
<td>1.1±2.1</td>
<td>&lt;0.05†</td>
</tr>
</tbody>
</table>

* p-value of t-test is not significant; †: p-value of Chi square test is not significant; ‡ p-value of t-test is significant

### Discussion

The findings showed that the AL technique is more effective in reducing pain caused by the IM injection compared with the ZT technique. The results also showed a significant statistical difference between drug leakage and ecchymosis in both groups in such way that the average rate between both complications in the AL group is almost half of the ZT technique group one.

Keen11 reported that patients receiving their medication through the AL technique experienced less pain than the ZT technique. Mac Gabhann10 reported that there was no significant difference between the effects of either technique on pain severity, but he suggested that the AL technique is more effective in reducing leakage and causes less discomfort.

Few studies are available of the AL IM injection technique effects and pain perception. There are some differences between the method used by Mac Gabhann and us, including pain measurement scale (Likert type against visual scale), needle gauge (21 vs. 23) and in our study all the injections were applied by the same person, while in the Mac Gabhann study10 injections were applied by different nursing staff.
Method are lower than that of the standard method and these complications are lower in AL method compared with the ZT method. So it seems that the AL method has fewer complications than the standard and the ZT methods.

In summary our study showed that the AL method has lower injection pain, drug leakage and ecchymosis compared with the ZT method. More studies are needed to compare other injection complications such as long-term pain in people receiving standard, AL and ZT methods injections. It is also better to evaluate the patients in relation to their culture, race, etc. but unfortunately it is not being done and it is one of the limitations of the present study.

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References