AUCTORES
Globalize your Research

Clinical Medical Reviews and Reports

Molgara Nikhila *

Open Access

Review Article

A Comprehensive Review on The Significance of Vesicular Drug Delivery Systems in Dermatological Therapy

Molgara Nikhila*, A Krishna Sailaja

Department of Pharmaceutics, RBVRR Women's College of Pharmacy, Barkatpura Hyderabad, India.

***Corresponding Author:** Molgara Nikhila, Professor, Department of Pharmaceutics, RBVRR Women's College of Pharmacy, Barkatpura Hyderabad, India.

Received date: October 09, 2025; **Accepted date:** October 24, 2025; **Published date:** November 10, 2025

Citation: Molgara Nikhila, A Krishna Sailaja, (2025), A Comprehensive Review on The Significance of Vesicular Drug Delivery Systems in Dermatological Therapy, *Clinical Medical Reviews and Reports*, 7(8); **DOI:**10.31579/2690-8794/290

Abstract

Vesicular drug delivery systems (VDDS), including transferosomes, invasomes, and some advanced lipid vesicles, have revolutionized therapeutic approach for several dermatological diseases by enabling the efficient transdermal delivery of drugs and also the possibility for systemic action of the drug. The vesicle which is inact and the drug that is encapsulated into the vesicle can penetrate deeply into the dermis and potentially reach systemic circulation by surpassing the formidable barrier of the stratum corneum. Non-invasive systemic therapy for medications that were previously restricted to oral or injectable routes is facilitated by this dual ability, which also improves local bioavailability at the site of application. This review shows about the structural properties, the clinical outcomes of key vesicular systems alongwith its systemic-transdermal efficacy, their penetration methods mostly outlining the applications in treatment of chronic skin problems, hormonal therapy, pain, and systemic diseases.

Kew Words: systemic delivery; vesicular drug delivery; skin barriers; dermatological diseases; non-invasive therapy

Introduction

Skin is the most accessible organ along with being the largest organ and it is the skin that mediates interaction between the human body and the outside world offering vital protective,sensory as well asregulatory functions. Nevertheless, the stratum corneum is the outermost layer and acts as a strong barrier which prevents majority of therapeutic substances from penetrating causing a reduction in the efficacy of topical therapies for a various dermatological condition. There is a need for a patient-friendly, efficient, and tailored treatment as traditional delivery techniques such as oral or injectables, generally have problems with hepatic first-pass metabolism, and systemic side effects, inadequate bioavailability [1-5].

A wide range of medication including both lipophilic and hydrophilic, can be encapsulated in vesicular systems that act as acutting-edge platformwhichprovides prolonged release and regulated release of the drug. By improving the permeability, the nanosized carriers including transethosomes, transferosomes, ethosomes and invasomesintendto penetrate skin barrier and also facilitate transportation of the drug into the deeper layers of the skin and also some amount into systemic circulation.

These systems act their best for delivery of the drug to both the local and systemic circulation in order to show a perfect effect for the treatment of variety of dermatological infections because of their versatility, including the deformability, penetration boosters like terpenes and ethanol and their capability toshield labile medications [6-10].

Structural Aspects and Composition

The organised, nanoscale assemblies of amphiphilic molecules make up the vesicular drug delivery systems (VDDS) are formed from one or more lipid bilayers when exposed to aqueous conditions. These provide flexible methodsfor the delivery of the drug for treatment of dermatological infections by encapsulating both hydrophilic and lipophilic medications where the hydrophilic drug gets encapsulated in the aqueous core while the lipophilic drug gets entrapped in the lipid bilayer. Some of the main systems which show their effect both trans dermally and systematically are as follows [11-13]

4.1 Invasomes

Structure: Invasomes are bilayered.The lipid bilayer when compared to liposomes has ethanol and terpenes which make the membrane less rigid, more soft and flexible.

Ethanol's role is to improve the fluidity of the lipid bilayer and it also interacts with lipids in the stratum corneum to break their densely packed structure and increase the permeability of the skin.

Terpene's role is to penetrate the stratum corneum and destabilizing the lipid structure so that terpenes can improve its penetration into the skin.

Composition: Mainly composed of phospholipids, ethanol, one or more terpenes. They produce the flexible vesicleswhich are calledinvasomes.

Morphology: The size is generally bilamellar or unilamellarspherical vesicles varying between 90 and 150 nm, on the basis of amount of

terpene included.These have distinct shape with small particle size allowing it to pass through the stratum corneum's intercellular gaps and enter the follicular pathways leading to both dermal and systemic absorption. Some of the terpenes which affect vesicle size are citral, eugenol, limonene, and cineole.

Penetration mechanism: They break down during penetration and produce phospholipid fragments and terpene molecules which improves permeability and fluidise the skin's lipids. Smaller intact invasomes use either the follicular pathway or tiny intercellular channels to enter the stratum corneum's deeper levels.

Delivery: These are useful for targeted transdermal delivery improving the therapeutic ability mainly because of composition that causes effective encapsulation of drugs leading to increased cutaneous and systemic absorption [14-16].

4.2 Transferosomes

Structure: These are havingbilayered lipid structure primarilyconsisting of phospholipids such as soy phosphatidylcholine or soy lecithin. These phospholipids can entrap the hydrophilicdrugs in the aquatic core to create flexible, spherical vesicles.

These include edge activators like single-chain surfactants such as sodium cholate, Tween 80, or Span 80 which are embedded into the phospholipid bilayer. These edge activators act as membrane softeners and show improvement in the bilayer's fluidity and elasticitymaking the vesicle extremely malleable.

Composition:Transferosomes are called as ultra-deformable vesicles and are generally made up of phospholipids along with an edge activator which are surfactants like sodium cholate, Span 80, Tween 80. These add flexibility to the vesicles.

This is a self-regulating vesicle which can adjust quickly to any kind of mechanical stress in the skin when phospholipids and surfactants are combined in the right amounts, allowing intact vesicle penetration into the deep skin layer.

Flexibility and Deformability: These can shrink and pass through skin pores and become almost 5 times smaller than their own size without being destroyed because of the edge activators.

Penetration mechanism: They enter the skin mainly via osmosis which is a moisture gradientdriven techniquewhere the vesicles movedeeper into the skin layers. They also combine with the lipid bilayers of the skin to release medications locally or promote systemic absorption [17-18].

4.3 Bilosomes

Structure: When compared to niosomes, these have a closed vesicle structure which is bilayer but are having difference in the part where bile salts are incorporated into the bilayer. Phospholipids like soy lecithin, soy phosphatidylcholine, non-ionic surfactants such as Span 80, Span 60, Span 40, Tween 80 andbile salts including sodium deoxycholate, sodium taurocholate as well as cholesterol make up most of the lipid bilayer.

Bile salts: They play a role in improving the deformability of vesicles along with its flexibility as they actas edge activators. These bile saltsimprove membrane permeability and alsostabilise the vesicular membrane against harsh environment as that of the one present in gastrointestinal tract facilitating systemic absorption following oral and topical application.

Surfactants and Cholesterol: Non-ionic surfactants are added in order to control the vesicular size, permeability, encapsulation effectiveness.Whereas the cholesterol used here is generally added to update the lipid bilayer rigidity and stability.

Morphology: Most of functional bilosomes are of nano-sized 100–200 nm while its vesicle size ranges between 90 nm to 3 mm. Studies which are using transmission electron microscopy and dynamic light scattering prove that these are having smooth spherical shape and show great colloidal stabilityeven in a cold environment.

Encapsulation of drug: The flexible nature of these says that even sensitive biological components and some of the challenging hydrophobic compounds remain intact during transport and while drug entrapment occurs therefore proving that it protects the encapsulated drugs from adverse environmental conditions like stomach acids, enzymes in both oral and topical dosage forms [19]

4.4 Transethosomes

Structure: They are built around the common phospholipid bilayer made of lecithin or soybean phosphatidylcholine. The bilayer has a polar or hydrophilic group which is head and a non polarhydrophobic group which is tail.

Function of Ethanol: It is used in high concentration and thus improves penetration by lipid bilayer fluidization and also the lipids present in the skin allowing for more effective and deeperdelivery.

Edge activators: For seeing a further improvement in the membrane elasticity these edge activators are combined with ethanol and added. This causesvariation in transethosomes from other systems enabling it to pass through tiny pores of skin.

Morphology: These are smooth and spherical nanosized vesicles ranging from 90–170 nm obtained on the basis of transmission electron microscopy (TEM) and scanning electron microscopy (SEM) data. Both the ethanol 30–40%and the edge activator like sodium cholate span 80tween 80 differentiate these from other systems.

Ultra-Deformability: These systems show a greater deformability compared to transferosomes and ethosomes because of the cooperation and a combined effect shown by phospholipids, edge activators, ethanol [20].

Vesicular system	Method	Disease	Organism	Symptoms	Systemic effect	Therapeutic role
Invasomes	Ethanol injection or thin film hydration	Onychomychosis, Lyme disease	Trichophyton rubrum, Borrelia burgdorferi	Erythema migranschronic plaques	Joint, cardiac and nervous effect	Deeper penetration for systemic and local action
Transferosome	Thin film hydration	Herpes simplex lesions, Staphylococcal Scalded Skin Syndrome	Herpes simplex virus, Staphylococcus aureus	Fragile blisters,desquamation,erythema	Multiorgan failure, fever, Malaise,myalgia	Antibiotic,antiviral transdermal administration enters systemic circulation

Bilosomes	Reverse phase evaporation, thin film hydration	Cutaneous Cryptococcosis, Blastomycosis, Candidiasis	Cryptococcus, Blastomyces, Candida	Abscesses, ulcers plaques, cellulitis	Lung infections, CNS effects	Local and systemic administration of antifungal drugs with more stability
Transethosome	Ethanol injection, thin film hydration	Pyoderma gangrenosum	Immune factors, enetric bacteria	Ulcers, fever, sores, arthralgia,	Systemic inflammation, abdominal pain	systemic,local administration of immunomodulators and corticosteroids with improved penetration

Vesicular Systems and Its Role

Systems	Therapeutic significance	Local action	Systemic action
Transferosomes	Drug loading is high, deformability is maximum, shows effects on deeper structures	Vesicles physically cross barrier, site specific action, hydration of skin increases	Effective as carriers for proteins and peptides, delivery of huge therapeutic agents
Transethosomes	Combines parts of ethosome transferosomes to form flexible vesicles lets drugs pass better making it more stable.	Ethanol- fluidizes membrane Edge activators-vesicle deformation, improved bioavailability	These squeeze intactly through pores of skin causing drugs to enter dermis and epidermis as well as systemic circulation.
Cubosomes	High therapeutic load, delivery in a controlled way, cubic symmetry in a nanoscale manner	Target site of lesions on skin Anti-inflammatory action-extended release on inflamed areas of skin	Cubic lipid nano structure assists in constant drug levels for longer time, no first pass metabolism
Invasomes	Flexible, vesicle deformation enhanced skin penetration Terpenes-fludize bilayer	Maximum intradermal release	Disruption of stratum corneum,improving flexibility of vesicle, large molecule transport

Vesicular System and Its Significance

Mechanism Of Skin Penetration

7.1 Invasomes

Invasomes are the natural agents which momentarily loosen those fortress's bricks that is the lipid layers of the skin without actually causingany damage. These have similarity with that of a discreet penetrator containing molecular agents like terpenes and ethanol. Due to their versatile, phospholipidcomposition that acts as a backbone, these can infiltrate profoundly into the skin barrier and be able to deliver both hydrophilic and lipophilic drugs to the targeted cells which require it the most without causing any other systemic side effects or distractions. These consists of terpenes, phospholipid as well as ethanolthat together disturb and fluidise the lipid bilayers of the skins outermost layer stratum corneum.Invasomes deformation ability combined with its extra small size helps it to penetrate while intact and improve the intradermal release of the drug while reducing the systemic exposure[21].

7.2 Transferosomes

These act as super flexible vehicles using the osmotic water gradient as a resourceful guide to change its shape to be able to fit and pass through small openings of skin. These vesicles stay stable throughout and carry the drugs mostly high weight compounds like proteins and peptides that are typically difficult to deliver within the skin layers. Phospholipids and edge activators like surfactants generally disorganize the lipid layer in order toenhance the flexibility of the membrane can be found in this vesicular system.The osmotic gradient helps in driving the transferosomes further deep into the skins lipid layers and simultaneously releasing the drug exactly at targeted site and in some cases helps in systemic absorption if required.

7.3 Transethosomes

Transethosomes are at the frontline of novel vesicular drug delivery systems as they have a combination of two effective and robust mechanisms which is the exceptional deformability because of the use of edge activators and also the interference of skin lipids because of the ethanol. This duo makes it feasible for these systems to effectively penetrate the skinbarrier causing an improved local effect at its targeted site of action and alsosystemic absorption. The technique of transethosomes helps in bypassing the first-pass metabolism which is a major issue in the case of oral drugs providing a non-invasiveroute for systemic treatment with increased bioavailability and diminishedorgan toxicity [22].

7.4 Cubosomes

Cubosomes are the nanostructured particles having 3D honeycomb lipid matrix. These have an excellent bioadhesion that is its interaction with skin. This is made possible because of itsstructur which issimilar to that of the outer layer of skin that is stratum corneum. These are having large surface area as well as nano size that enablesit for efficient penetration.Because of its structurecubosomes have the ability for deeper dermal diffusion of the encapsulated drug which includes both hydrophilic andlipophilic and sometimes even amphiphilic components.These are alsohaving the ability to provide sustained and prolonged release of the drug and protect soem of the labile drugs from exposing to harmful environments and avoid degradation. Cubososmes also improve the therapeutic efficiency of the medication and also show systemic action.

Overall, these vesicular drug delivery systems have the ability to mimic the structure and alter the penetration ability and amplify it and also cause the physical deformationto promote the passage of the medications through the complex skin barrier and ensure a reliable delivery [23].

Therapeutic Applications in Dermatology

8.1 Invasomes

Efficient administration of immunosuppressants for inflammatory skin conditions such as psoriasis. The phospholipids ethanol and terpenes which are present combine and work together to provide invasomes remarkable skin permeation.Because of their deep penetration into the skin immunosuppressants and alsoantioxidants can be given which are very useful in the tratmentof inflammatory skin conditions, psoriasis, and in some cases acne. This increased penetration ability and deformation abilityincrease local therapy and systemic exposure.

8.2 Transferosomes

Due of its extremely flexible membrane that ispropelled by the skin moisture gradient these are show an exceptional delivery of high weight molecules like that of peptides and proteins. They transport drug which is still intact into the deeper skin layer which is dermis making it optimal for treatment of dermatological infections like eczema, psoriasis, atopic dermatitis,skin inflammation, chronic wounds. Transferosomes maintain localisedlevels of drugs and lower dose frequency along with increasing the patient compliance they can also improve the analgesic and the corticosteroid therapy for diseases like psoriasis and dermatitis.

8.3 Transethososmes

Transethosomes are the vesicles having excellent flexibility and enhancrd penetration ability by using the combination of edge activators along with high ethanol. They have shown immense outcomes in treating inflammatory conditions such as psoriasis or eczema some fungal infections in the case of candidiasis and dermatophytosisand some skin malignancies like squamous cell carcinoma or melanoma. It has the ability to deliver biomolecules and alsotiny medication transdermallyby improving the systemic bioavailability without a serious risk of causing toxicity. These act as a robustsystem in dermatological therapy as their capability to administer anticancer drugs dermally and alsoproviding a non-invasive technique for treating melanoma.

8.4 Cubososmes

Melanoma, psoriasis, cutaneous candidiasis, acne, vitiligo,alopecia are some of the skin conditions which can be treated by using this vesicular delivery system that is cubosomes. There is an increasing usage of cubososmes for the treatment of skin diseases with the benefit of prolonged drug release. Theseregulate a medication's time period on the skin and preventing it from deteriorating and by enhancing the therapeutic effectiveness. They are effective for skin care and disease management since studies have shown that they are beneficial in wound healing, antibacterial treatments, and improving the effectiveness of topical and systemic drug in dermatology [24-25].

Conclusion

As they allow for both systemic and local delivery of the drug through the skin vesicular drug delivery systems like cubosomes, bilososmes, invasomes, transferosomes, transethosomes becamerevolutionary systems in dermatological therapy. They can easily pass through the skin’s outermost layer that is the stratum corneum barrier because of theirexceptional compositions and remarkable flexibility that promotes the targetedpenetration of the medication, prolonged retention,sustained and controlled releaseand alsoincreased bioavailability. Countless dermatological infections that include acne, eczema, psoriasis, chronic wounds, fungal infections and in some cases melanomaand other skin malignancies arefruitfully treated with the help of these systems. They offer customised local delivery of drug reducing the systemic exposure and alsotoxicity while simultaneouslyaugmenting the therapeutic ability. These vesicular systems also have the capability to bypass the hepatic first-pass metabolism and improve the patient compliance. Certain specific vesicular delivery systems liketransethosomes, transferosomes show non-invasive absorption of drugs even for the macromolecules such as peptides and proteins. These vesicular systems that act as carriers have the potential to redefine the therapeutic strategies in the treatment of dermatological infections by combining the benefits of low side effects, goodbiocompatibility, different drug loading capability for both hydrophilic and hydrophobic medicines. Massformulation and stability issues still exist till now but there has been a continuous research development regarding the nanocarriers. Ultimately vesicular drug delivery systems play a vital role in the improvement of the treatment of dermatological diseases that will improve the outcomes and quality of life.

Reference

1. Margalit R, Okon M, Verushalmi N, Avidor E. (1992). Bioadhesive liposomes for topical drug delivery: molecular and cellular studies. J Control Release. 19(3):275-287.
2. Jeschke MG, Barrow RE, Hawkins HK, Yang K, Hayes RL, Lichtenbelt BJ, et al. (1999). IGF-1 gene transfer in thermally injured rats. Gene Ther. 6(11):1015-1020.
3. Jones DS, Moss GP. (2010). Themed issue: recent advances in transdermal drug delivery. J Pharm Pharmacol. 62(6):669-670.
4. Vijaya R, Ruckmani K. (2011). In vitro and in vivo characterization of the transdermal delivery of sertraline hydrochloride films. Daru. 19:424-432.
5. Jain S, Jain P, Umamaheshwari RB, Jain NK. (2003). Transfersomes – A novel vesicular carrier for enhanced transdermal delivery: Development, characterization and performance evaluation. Drug Dev Ind Pharm. 29:1013-1026.
6. Mishra D, Garg M, Dubey V, Jain S, Jain NK. Elastic liposomes mediated transdermal delivery of an antihypertensive agent: Propranolol hydrochloride.
7. Garg T, Jain S, Singh HP, Sharma A, Tiwary AK. (2008). Elastic liposomal formulation for sustained delivery of antimigraine drug: in vitro characterization and biological evaluation. Drug Dev Ind Pharm. 34:1100-10.
8. El-Maghraby GMM, Williams AC, Barry BW. (2001). Skin delivery of 5-fluorouracil from ultra deformable and traditional liposomes in vitro. J Pharm Pharmacol. 53:1069-1076.
9. Guo J, Ping Q, Sun G, Jiao C. (2000). Lecithin vesicular carriers for transdermal delivery of cyclosporine A. Int J Pharm. 194:201-207.
10. Shaji J, Bajaj R. (2018). Transethosomes: A new prospect for enhanced transdermal delivery. Int J Pharm Sci Res. 9(7):2681-2685.
11. Sravani A, Shyamala SJ. (2019). An updated review on transethosomes. World J Pharm Res. 2019;8(13):629-637.
12. Kumar L, Verma S, Singh K, Prasad D, Jain A. (2016). Ethanol based vesicular carriers in transdermal drug delivery: Nanoethosomes and transethosomes in focus. NanoWorld J. 2(3):41-51.
13. Kumar B, Sahoo PK, Manchanda S. (2022). Formulation, characterization and ex vivo study of curcumin nano-invasomal gel for enhanced transdermal delivery. OpenNano. 7:100058.
14. Dalal A, Kaushik D, Jain S. (2022). Invasomes: A novel deformable vesicular nanocarrier for enhanced transdermal drug delivery. Br J Pharm Med Res. 7(05):4045-4048.
15. Nayak D, Tippavajhala VK. (2021). A comprehensive review on preparation, evaluation and applications of deformable liposomes. Iran J Pharm Res. 2021 Winter;20(1):186-205.
16. Babaie S, Rahmani Del Bakhshayesh A, Ha JW, Hamishehkar H, Kim KH. (2020). Invasome: A novel nanocarrier for transdermal drug delivery. Nanomaterials. 10(2):341.
17. Sharma M. (2014). Applications of nanotechnology-based dosage forms for delivery of herbal drugs. Res Rev J Pharm Nanotechnol. 2014;23-30.

18. Gangwar S, Singh S, Garg G. (2010). Ethosomes: a novel tool for drug delivery through skin. J Pharm Res. 3(4):688-691.
19. Kumar D. (2012). Lipoidal soft hybrid biocarriers of supramolecular construction for drug delivery. Int Scholar Res Network Pharm. 2012;1-14.
20. Dua JS, Rana AC, Bhandari. (2012). Liposome: methods of preparation and applications. Int J Pharm Stud Res. 14-20.
21. Talegaonkar S. (2006). Vesicular systems: an overview. Indian J Pharm Sci. 68(2):141.
22. Li VHK, Lee JRR, Lee VHL. (1987). Controlled drug delivery: fundamentals & applications. New York: Marcel Dekker
23. Li Y, et al. S (2021). mart nanostructured lipid carriers for transdermal drug delivery. Front Pharmacol. 12:658-670.
24. Cheng X, et al. (2020). Nanostructured lipid carriers in dermal drug delivery. J Cosmet Dermatol. 19(1):37-44.
25. Kumar A, et al. (2020). Enhanced dermal penetration of bioactive compounds using cubosomes. Pharmaceutics. 12(5):450.

DOI:10.31579/2690-8794/289